The effects of pre-germination treatments and soil media on seed germination and seedling growth of Tamarind *(Tamarindus indica* (Linn) in Katsina State, Nigeria

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ABSTRACT

Astudy was conducted to investigate the effects of pre-germination treatments and soil media on seed germination and seedling growth of Tamarind *(Tamarindus indica)* in Katsina State, Nigeria. Germination was monitored in the Nursery Section of the Federal University Dutsin-Ma, Katsina State, Nigeria. The experiment was laid in a Completely Randomized Design with four replications. Seedling height (SH), stem diameter (SD) and number of branches (NB) were measured at two week intervals and analyzed using Analysis of Variance. Means were separated using Least Significant Difference (LSD $P \leq 0.05$). Mechanically scarified seeds (MS), sown in top soil (S_1) (S_1MS) and seeds treated with 60 % concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes (A_{10}) and sown in S_1 (S_1A_{10}), MS sown in S_2 (S_2MS), seeds treated with A_{10} and sown in S_2 (S_2A_{10}), MS sown in top soil plus river sand plus manure (S_3) (S_3MS) and seeds treated with A_{10} and sown in S_3 (S_3A_{10}) germinated in first five days after sowing (DAS) while those in the control germinated after nine days. Treatment with A_{10} resulted in 100 % germination while MS resulted in 97.5 % germination**.** MS and seeds soaked in H_2SO_4 for five (5) minutes (A_5) had higher SH values of 8.30 cm and 30.81 cm respectively and NB values of 2.92. A_{10} and MS had SD values of 3.20 cm and 3.20 cm respectively. It is concluded that seeds treated with H_2SO_4 for 10 minutes and MS at the micropyle are the best pre-germination treatment for breaking *T. indica* seeds and recommended for seed sowers so in order to achieve regeneration that can meet various needs of man.

Key words: Germination- seedlings-growth- *Tamarindus indica*- pre-sowing-techniques- tetraoxosulphate (VI) acid-scarification- soil media-nursery

INTRODUCTION

T. indica is a tree species which is native to tropical Africa (Mercola 2014).The tree grows in the wild throughout the Sudan and was long ago introduced into and adapted to India (Morton 1987). It has often been reported that it was apparently from this Asiatic country. In India, Iran and the Middle East, the tree is called "*tamarhindi*" (Indian date, from the date-like appearance of the dried pulp), giving rise to both its common and generic names. Interestingly, the specific name "*indica*", also perpetuates the illusion of Indian origin. The fruit was well known to the ancient Egyptians and the Greeks in the 4th century BC (Abubakar and Muhammad 2013).

T. indica is a leguminous tree in the family Fabaceae. The genus is a monotypic taxon,

having only a single species (Mercola 2014). The species is a slow-growing, long lived massive tree which under favourable condition reaches a height of 12-24m and a trunk circumference of 7.5 m. It has bright green, fine feathery foliage composed of pinnate leaves, each having 10–15 pairs of oblong 1.25-2.5 cm long and 5-6mm wide leaflets which fold at night (Hopkins and Stanfield 1966). The leaves shed briefly in very dry areas during the hot season. The flowers are composed of five yellow with orange or red streaks petals. The fruits are flattish, bean like, irregularly curved and have bulged pods which are borne in great abundance along new branches. The diameter of the fruits varies from 5 to 16 cm long and 2 to 3.3 cm (Von Maydell1990). The pods may be brown or greyish brown which are composed of about 1-12 fully formed hard seeds. The seeds are glossy burn, squarish in form (1.1-1.25cm in diameter), and each is enclosed in aparchment-like membrane. The species grows well in clay, loam, sandy and acidic soil types, with a high drought and aerosol salt resistance. A matured tree under favourable conditions may yield 150-225 kg of fruits annually (Morton 1987).

T. indica is one of the common agroforestry trees of the tropics. Tamarind is a multipurpose plant. The pulp of the fruit has, for a long time, been used as a spice in Asian cuisines, especially in the southern part of India, (Pugalenthi *et al.* 2004). Almost all parts of the tree find a use in the food, chemical, pharmaceutical or textile industries, or as fodder, timber and fuel (Pugalenthi *et al.* 2004).

T. indica seeds contain a variety of biologically active phytochemical compounds, especially phenolic constituents, flavonoids, anthocyanins, vitamin C and carotenoids (Galili and Hovav 2014). These phytochemicals positively influence human health and indicate high antioxidant activity (Pérez-Jiménez *et al.* 2008). In Africa, *T. indica* constitutes part of the rich plant biodiversity.Natural regeneration of any plant species is essential for conservation and maintenance of biodiversity, which help in developing plant population of an area in time and space (Hossain *et al.* 2004). However, in the savanna regions, deforestation, desertification and erosion cause biodiversity loss as well as soil degradation (Bello and Gada2015). These limiting factors can be addressed and ultimately minimized through afforestation and re-afforestation or regeneration programmes. Domestication of *T. indica* and its subsequent integration into the agro-ecosystem requires mass production of its seedlings. Propagation through seeds is a very cheap method of agroforestry tree establishment (Oyebamiji *et al.* 2018 a, b). However, seed dormancy with its attendant poor, slow and difficult germination hampers agroforestry and afforestation efforts (Zavala 1991).

The germination of *T. indica* seeds and growth of its seedlings are affected by hard seed coats that cause dormancy and soil which is used as a medium for raising seedlings. Despite the fact that many researchers in plant physiology study seed dormancy, there is still limited information about the dormancy types and the seed germination of *T. indica* considering the high economic value of these tree seeds (Ajiboye 2010). Promotion of pre-germination methods of *T. indica* seeds in order to make them available in raising seedlings for reaforestation for production of its products for both local and international demands is therefore important. Hence, the study focused on the assessment of the effect of pretreatment of *T. indica* seeds and soil media on germination and growth of seedlings.

MATERIALS AND METHODS

Location of experimental sites

This study was carried out in the Nursery Section of the Federal University of

Dutsin-Ma, Katsina State, Nigeria. The area lies between latitude 12^{0}28'18.3" N and longitude 07^{0}29'15.4" E (Figure 1). Dutsin-ma is found within Latitude 12°27′18″ N and Longitude 07°29′29″ E. It is also found in the basement complex derived soils of Katsina State (Oguntoyinbo, 1983). The area receives an annual rainfall of 700 mm, which is spread between May and September. The mean annual temperatures range from 29^{o}to 31^{o}C. High temperatures normally occur in April/May and the lowest in December through February (Tukur *et al.* 2013).

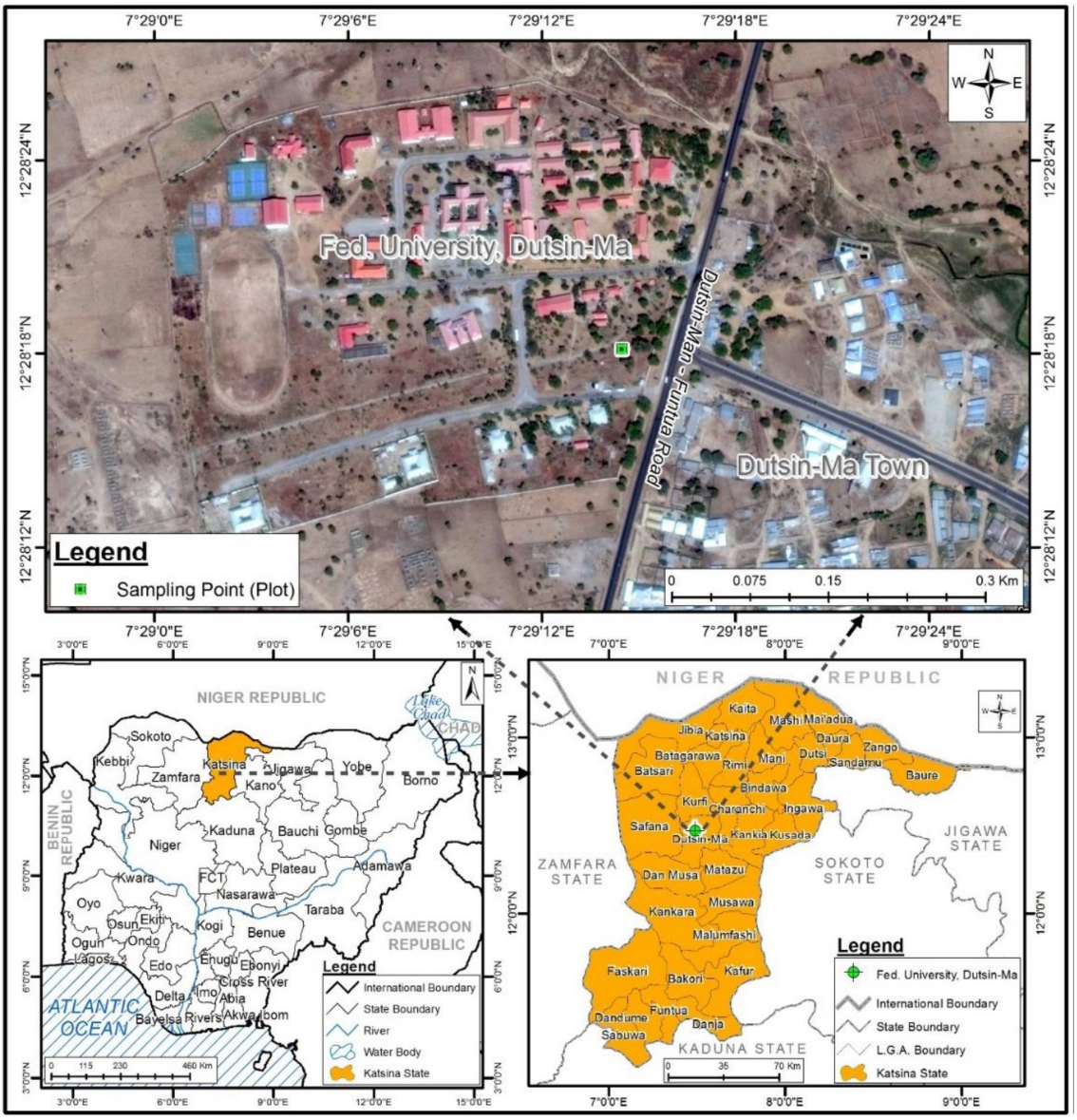

Figure 1: Federal University Dutsin-Ma in Katsina State showing the study area.

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

Experimentation and data analysis

The experimental materials usedwere60 %concentrated Tetraoxosulphate (VI) acid (H_2SO_4) solution, water, river sand, top soil and cow dung, watering can, 30 cm x 30.6 cm polythene tubes and emery cloth. Potting mixture was prepared by sieving the river sand, 0top soil and cow dung with mixture ratio of 1:1:1 (top soil plus river sand plus manure) using 2 mm sieve. The top soil and river sand used were collected from the Department of Forestry Dutsin-Ma Local Government of Katsina State. Cow dung and *T. indica* seeds were purchased from Wednesday market in Dutsin-ma Local Government of Katsina State.The viability test was carried out before experimentation using simple floating method. The seeds were dropped in a beaker containing water. The seeds that floated indicated that they were not viable. Such seeds were removed and replaced. A total of 150 viable seeds of was used in each of the treatments to make the total of 600 seeds. Experiment was then laid out as 3 x 5 factorial in a Completely Randomized Design (CRD) with sowing media and pre-germination treatments as factors.

Table 1: Dormant seeds of Tamarind (*T. indica*) subjected to pre germination treatments and sown in different soil media

Treatment	Description
S_1	Top soil
S_2	River sand
S_3	Top soil plus river sand plus manure (1:1:1)
MS	Mechanically scarified seeds at the micropyle
S_{24h}	Seeds soaked in water at room temperature for 24 hours
A_5	Seeds soaked in 60% concentrated $H_2SO_4$for five (5) minutes
A_{10}	Seeds soaked in 60% concentrated $H_2SO_4$for ten (10) minutes
C	Seeds not treated (Control)

Observation of seed germination was done on daily basis while data were collected 2 weeks after sowing (WAS) for12 weeks. The number of days for seeds sprouting from each pot was observed and the mean of the days the seeds emerged were recorded.

Growth parameters namely seedling heights, stem diameters and number of branches were measured on five randomly tagged seedlings on:

The seedling heights (SH) of five tagged seedlings from each pot were measured from the root collar to the tip of the terminal shoot using ruler in (cm).

The stem diameters (SD) of five tagged seedlings from each pot were measured at 2 cm above the root collar using a vernier caliper.

The total number of branches (NB)of five tagged seedlings in each pot were counted and recorded starting from 14 days after sowing to the end of the experiment (12 weeks after sowing (WAS).

The percentages of seed germination were computed as follows:

$$\text{Germination percentage} = \frac{\text{Number of seed germinated}}{\text{Total number of seeds sown}} \times 100$$

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≤ 0.05) was used to separate the means of differences among the treatments.

RESULTS

Days of seedling emergence

The viability test was carried out using simple floating methodbefore sowing, and the one floating showed that the seeds were not viable. Out of the viable seeds, 150 seeds were mechanically scarified at the micropyle. The results showed that, one hundred and twenty seeds that were mechanically scarified at the micropyle (MS) and one hundred and twenty seeds that were treated with 60 %concentrated Tetraoxosulphate (VI) acid(H_2SO_4) for 5 minutes (A_5) had the shortest days of emergence of 5 days after sowing(DAS) and seeds not treated; control (C) had the longest days of emergence (10 days after sowing (DAS) in top soil plus river sand plus manure in 1: 1: 1 (S_3). This showed that seeds that were mechanically scarified at the micropyle (MS) and seeds treated with60 %concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 5 minutes (A_5) had the shortest days of germination (Figure 2).

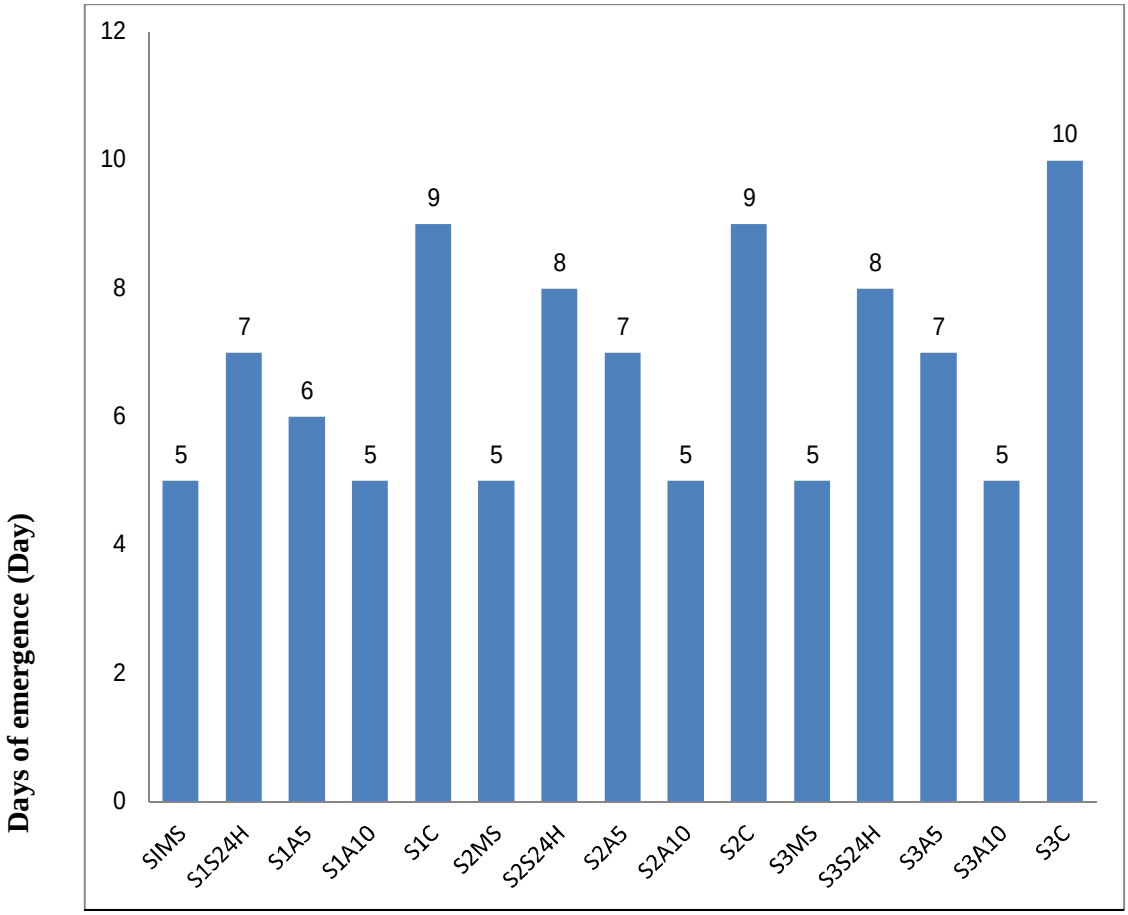

Figure 2: Days of emergence

Germination performance of *Tamarindus* seeds under different treatments

Seeds treated with 60 %concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes (A_{10}) and sown in river sand (S_2) had the highest germination percentage (100%) (S_2A_{10}) followed by seeds mechanically scarified (MS) and sown in top soil (S_1) had 97.5% (S_1M_S) and the lowest germination was recorded in the seeds not treated (C) and sown in top soil (S_1) (S_1C)with germination percentage of 65%. Germination of seeds were high with the seeds treated with (H_2S0_4) for 10 minutes (A_{10}) and seeds that were mechanically scarified (100 % and 97.5 %) respectively among others and low with the seeds that were not treated at all (Figure 3).

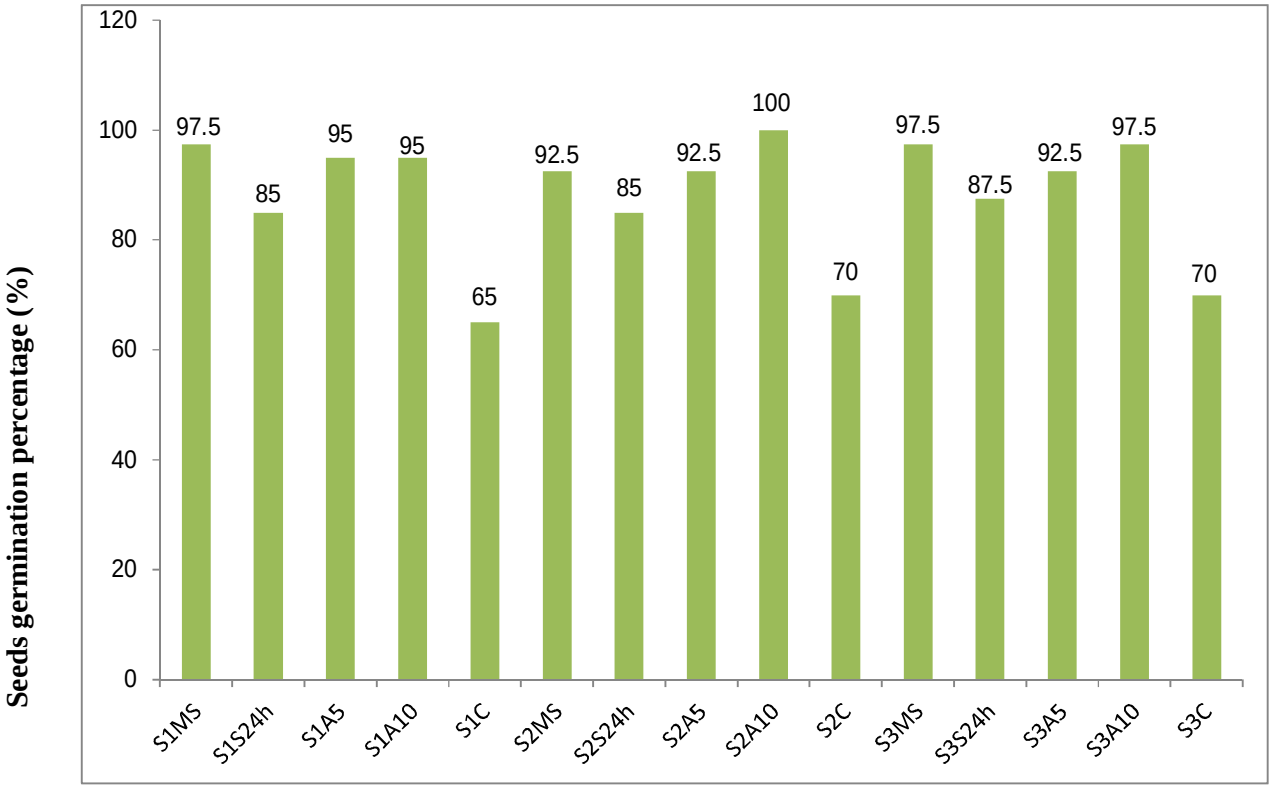

Figure 3. Seed germination percentage for different treatments

Determination of growth in seedling heights

Seeds sown in the soil media used had no significant ($p \leq 0.05$) effect on seedling height across the period of experiment. However, seeds mechanically scarified at the micropyle had significantly higher values($p \leq 0.05$)(8.30 cm, 31.10 cm)on seedling height at 2 and 12weeks after sowing (WAS), while, seeds soaked in 60 %concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes (A_{10}) had significantly lower value ($p \leq 0.05$) (29.40 cm) among others. There was no significant effect observed on seedling heights at 4-10 WAS in the seeds soaked in water for 24 hours at room temperature(S_{24h}), seeds soaked in H_2SO_4for5 minutes (A_5) and 10 minutes (A_{10}) respectively and the seeds that were not treated at all (control) (Table 2).

Table 2. Growth in heights of *Tamarindus* seedlings under different soil media and pre-germination treatments at intervals of 2 WAS

Seedling heights(cm)						
Treatment	**2WAS**	**4WAS**	**6WAS**	**8WAS**	**10WAS**	**12WAS**
Soil media						
S_1	7.70	13.30	18.02	22.22	26.02	30.20
S_2	8.13	13.52	18.10	22.03	25.80	30.32
S_3	7.94	13.32	18.0	22.23	25.90	30.20
SE±	0.264	0.450	0.457	0.521	0.595	0.671
Pre-germination treatments						
MS	8.30^{a}	13.80	18.63	22.82	26.70	31.10^{a}
S_{24h}	7.50^{c}	12.72	17.50	22.00	25.13	30.10^{ab}
A_5	7.63^{bc}	14.10	18.34	22.60	26.40	30.81^{a}
A_{10}	8.10^{ab}	13.20	17.60	21.60	25.73	29.40^{b}
C	8.13^{ab}	13.13	17.80	21.80	25.43	29.80^{ab}
SE±	0.330	0.578	0.586	0.671	0.768	0.861

a, b, c:indicates means within rows with different superscript are significantly different at 5 % level of probability using Least Significant Difference (LSD). **S_1**=Topsoil; **S_2**=River sand; **S_3**=Top soil + River sand + Manure; **MS:** Mechanical scarification, **S_{24h}:** Seeds soaked in water for 24 hours, **A_5:** Seeds soaked in Tetraoxosulphate (VI) acid for 5 minutes, **A_{10}:** Seeds soaked in Tetraoxosulphate (VI) acid for 10 minutes, **C:** Seeds not pre-treated; **SE±:** Standard error; WAS: Weeks after sowing.

Growth in stem diameters

There was no significant effect of soil media observed on the stem diameters across all the periods of growth in the experiment. However, seeds soaked in60 %concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes (A_{10}), seeds not treated (control) had significantly higher impacts on stem diameters with values ranging from 3.20cmto 4.12cm at 4 and 12 weeks after sowing(WAS), while seeds soaked in cold water for 24 hours (S_{24h}) had significantly lower values ($p \leq 0.05$)ranging from 3.12cm to 4.01cm at 4 and 12 WAS among others. There was no significant difference among pre germination treatments employed on stem diameters at 2, 6, 8 and 10 WAS respectively (Table 3).

Table 3. Growth performance of stem diameters of Tamarindus under different soil media and pre-germination treatments on at interval of 2 WAS

	Stem diameters (cm)					
Treatment	**2WAS**	**4WAS**	**6WAS**	**8WAS**	**10WAS**	**12WAS**
Soil media						
S_1	3.21	3.20	3.20	3.30	3.50	4.00
S_2	3.30	3.20	3.23	3.30	3.53	4.10
S_3	3.25	3.20	3.22	3.30	3.53	4.12
SE±	0.033	0.022	0.022	0.022	0.027	0.032
Pre-germination treatments						
MS	3.30	3.20^{ab}	3.23	3.31	3.53	4.12^{ab}
S_{24h}	3.22	3.12^{b}	3.20	3.30	3.50	4.01^{b}
A_5	3.20	3.20^{ab}	3.22	3.30	3.53	4.10^{ab}
A_{10}	3.21	3.20^{a}	3.22	3.30	3.50	4.10^{ab}
C	3.31	3.20^{ab}	3.21	3.30	3.53	4.12^{a}
SE±	0.042	0.029	0.029	0.029	0.035	0.043

a, b, c: indicates means within rows with different superscript are significantly different at 5 % level of probability using Least Significant Difference (LSD). **S_1**=Topsoil; **S_2**=River sand; **S_3**=Top soil + River sand + Manure; **MS:** Mechanical scarification, **S_{24h}:** Seeds soaked in water for 24 hours, **A_5:** Seeds soaked in Tetraoxosulphate (VI) acid for 5 minutes, **A_{10}:** Seeds soaked in Tetraoxosulphate (VI) acid for 10 minutes, **C:** Seeds not pre-treated; **SE±:** Standard error; WAS: Weeks after sowing.

Number of branches per plant

The soil media did not have any significant effect on the number of branches formed from seedlings raised across all the period of the experiment; 2-12 weeks after sowing (WAS). Seeds not treated (control) had significantly higher impacts on the number of branches formed at 2weeks after sowing(WAS) among others. Seeds mechanically scarified at the micropyle (MS),seeds soaked in water for 24 hours at room temperature (S_{24h}), seeds soaked in 60 %concentrated Tetraoxosulphate (VI) acid(H_2SO_4) for5 minutes (A_5) and 10 minutes (A_{10}) respectively were not significantly had influence on the number of branches per plant. Moreover, significant impact of the pretreated seeds were observed on the number of branches per plant at 4-12 WAS (Table 4).

Table 4. Response in branch formation under different soil media and pre-germination treatments at interval of 2 WAS

	Number of branches					
Treatment	**2WAS**	**4WAS**	**6WAS**	**8WAS**	**10WAS**	**12WAS**
Soil media						
S_1	2.90	5.90	8.00	10.10	12.80	16.50
S_2	2.80	5.80	7.90	10.00	12.60	16.50
S_3	2.80	5.60	8.00	10.10	12.30	16.40
SE±	0.110	0.242	0.265	0.288	0.285	0.339
Pre-germination treatments						
MS	2.92^{ab}	6.10	8.30	10.30	12.70	16.92
S_{24h}	2.70^{b}	5.60	7.60	9.50	12.20	15.92
A_5	2.70^{b}	5.60	8.10	10.20	12.83	16.60
A_{10}	2.70^{b}	5.92	8.00	10.10	12.33	16.42
C	3.00^{a}	5.50	7.70	10.10	12.60	16.33
SE±	0.136	0.311	0.339	0.371	0.372	0.434

A, b, c: indicate means within rows with different superscript are significantly different at 5 % level of probability using Least Significant Difference (LSD). **S_1**=Topsoil; **S_2**=River sand; **S_3**=Top soil + River sand + Manure; **MS:** Mechanical scarification, **S_{24h}:** Seeds soaked in water for 24 hours, **A_5:** Seeds soaked in Tetraoxosulphate (VI) acid for 5 minutes, **A_{10}:** Seeds soaked in Tetraoxosulphate (VI) acid for 10 minutes, **C:** Seeds not pre-treated; **SE±:** Standard error; WAS: Weeks after sowing.

DISCUSSION

The results of the study showed that there were no significant differences among the soil media, but significant among the pre-germination treatments on seedling height, stem diameter and number of branches. It is an indication that soil media measured had little or no significant effect on germination of Tamarind seeds despite the fact that adequate pre-germination treatments were carried out on them. Germination of *Tamarindus indica* seeds started 5 days after sowing (DAS). The seeds treated with 60 %concentrated Tetraoxosulphate (VI) acid(H_2SO_4) for 10 minutes (A_{10}) and the seeds mechanically scarified (MS) emerged 5 DAS. Seeds mechanically scarified and sown in top soil (S_1MS), seeds treated with 60% concentrated Tetraoxosulphate (VI) acid(H_2SO_4) for 10 minutes and sown in top soil (S_1A_{10}), seeds mechanically scarified and sown in river sand (S_2MS), seeds treated with 60% concentrated Tetraoxosulphate (VI) acid(H_2SO_4) for 10 minutes and sown in river sand (S_2A_{10}), seeds mechanically scarified and sown in top soil plus river sand plus manure (S_3MS) and seeds treated with 60% concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes and sown in top soil plus river sand plus manure (S_3A_{10})

germinated first at 5 DAS. Meanwhile the seeds that were not treated at all (control) (C) showed the longest days of germination at 9 DAS. These results agree with Olatunji *et al.* (2012) who reported that seeds soaked in acid for a few minutes not more than ten minutes enhance seed germination and its germination percentage. However, seeds that stayed in acid more than ten minutes may likely have its embryo destroyed and thereby be prevented from germination as confirmed by *Ariana et al.* (2011). Meanwhile, the best pre-sowing treatment observed to produce the highest germination percentage were with the seeds treated with 60% concentrated Tetraoxosulphate (VI) acid(H_2SO_4) for 10 minutes (A_{10}) and seeds mechanically scarified (MS) which gave the highest germination percentages respectively**.** This agrees with Sinhababu *et al.* (2007); Adelani *et al.* (2014); Oyebamiji *et al.* (2014) who reported that seeds experience high germination percentage when pre-treated with acid at 60% concentrated Tetraoxosulphate (VI) acid(H_2SO_4) for a few time minutes. Seeds of *T. indica* treated with 60% concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes (A_{10}) in soil media of top soil plus river sand plus manure (S_3) had the highest germination percentage (S_3A_{10}) in all treatments and soil media, followed by the seeds mechanically scarified (MS) in soil media of top soil plus river sand plus manure (S_3) and seeds not treated at all (control) (C) gave the least percentage in top soil (S_1) of germination respectively. This revealed that seeds treated with 60%concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes (A_{10}) gave the best germination percentage. One of the limitations this work faced was the attack of insects and rodents on the seedlings. This experience has vividly shown that this type of experiment is better conducted in a screen house to prevent any form of attack and damage to the seedlings, and this should be noted in further study of Tamarind seedlings.

CONLUSIONS

In this study, it may be concluded that the different soil treatments did not have any significant effects on seed emergence, germination percentage, seedling height, stem diameter and number of branches. Seeds pretreated with 60%concentratedTetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes and seeds mechanically scarified in all the soil media had the lowest days of emergence with five 5 DAS each across all the soil media and they equally had higher germination percentage. It is therefore concluded that, seeds treated withTetraoxosulphate (VI) acid (H_2SO_4) for 10 minutes and mechanically scarified at the micropyle are the best treatment for breaking *T. indica* seeds and recommended for seed sowers.

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