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EFFECTS OF PRE-SOWING TREATMENTS ON GERMINATION AND EARLY SEEDLING GROWTH OF *PTEROCARPUS ERINACEUS* POIR

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ABSTRACT

A study on the effect of different pre-sowing treatments on germination and early seedling growth of P. erinaceus was assessed at the Forest Nursery of the Department of Forestry Technology, Federal College of Forestry, Jos Plateau State Nigeria. The experiment was arranged in a Completely Randomized Design (CRD) with three replicates. Descriptive and inferential statistics were employed to analyze collected data (Percentages, Analysis of Variance and Duncan Multiple Range Test). The pre-sowing treatments were soaking seeds in cold water at room temperature for 24 hours (T1), hot water (T2), sulphuric acid (at 98% concentrated) for a minute (T3), sulphuric acid (diluted at 50%) for a minute (T4), hydrogen peroxide (H_2O_2) for 24 hours (T5), nicking treatment (T6), and no treatment as control (T7). Forty-two seeds were planted (Six seeds for each treatments). Seed germination percentage, plant height, number of leaves, leaf length and stem diameter were assessed from week five to twelve after germination. Seeds with nicking treatment commenced germination after 30 days and achieved 43.3% germination which was significantly different ($P < 0.05$) from other treatments, especially seed immersed in 95% sulphuric acid, which exhibited lowest germination of 20% and commenced first germination after 51 days. Results also indicated a significant difference ($P < 0.05$) in plant height, number of leaves, leaf length and stem diameter and non-significant difference ($p \geq 0.05$) at 8^{th} weeks after germination (WAG) (leaf length); 7^{th} to 9^{th}, 11^{th} and 12^{th} WAG (stem diameter) respectively. Nicking treatment gave the best pre-sowing treatment when compared to other treatments that enhanced seed germination and seedling growth of P. erinaceus. Thus nicking treatment is recommended as the most suitable pre-sowing treatment for enhancing seed germination and early growth of P. erinaceus in the nursery for plantation purposes.

Keywords— *Pterocarpus erinaceus*, Pre-Sowing Treatment, Germination, Seedling Growth

INTRODUCTION

Pterocarpus erinaceus Poir. belonging to the family Fabaceae and subfamily Faboideae, is a perennial, deciduous leguminous tree of African Savannas and dry forest origin with enormous socio-economic benefits in its native range and beyond. They are popularly known as African rosewood and are famous for producing one of the finest woods in its native region. The tree produces attractive golden yellow flowers that completely cover the canopy and has considerable potential as an ornamental tree. Rosewood is a small to medium-sized tree with a diameter of 1.2 – 1.8 m. It grows up to a height of 12 – 15 m with exceptionally tall ones growing up to 35 m and the fruits are winged pods. The stem bark is dark grey and scaly, the leaves

are compound and imparipinnate, up to 30cm long. The tree exudes a red sap, which is used as a dye in tanning and cloth making. As a legume, the tree harbors rhizobia and is useful as a nitrogen-fixing plant to improve nutrient-depleted farmland. The tree has several medicinal uses, including reduction of fever and cough suppression as reported by (Arbonnier, 2002; Orwa *et al*., 2009).

Pterocarpus erinaceus is of great interest for agroforestry systems, as it helps to improve soil fertility. Increased demand for rosewood as a timber species is competing greatly with its importance as a source of fodder, uses that are crucial to the livelihoods of the farmers and cattle rearing in regions where they are located (Abdul-Rahman *et al*., 2008). One of the problems with this species according to Karsten *et al*., (2014), is the difficulty of raising seedlings from seeds due to its hard impermeable seed coats restricting the entry of both water and oxygen that will aid its germination.

This study was conceived to experiment on the best pre-treatment method that would ensure fast seed germination and early seedling growth of *P. erinaceus* for incorporation into plantation programmes. The specific objectives were to assess germination of *P. erinaceus* seeds in various pre-sowing treatments and also to assess growth responses in various pre-sowing treatments of *P. erinaceus* seeds.

MATERIALS AND METHODS

Study Area

The study was conducted within the nursery of the Department of Forestry Technology, Federal College of Forestry Jos, Plateau State. The study area lies in the Northern Guinea Savannah situated at 9°55' latitude and 8°54' longitude with an elevation of about 118m above sea level. The mean annual rainfall for the location is between 1200 mm and 1250 mm and mean temperature ranges between 23 ^{o}C and 25 ^{o}C. The soil is sandy-loam, light to dark in colour. The climate of the State is cool due to its high altitude and rainy season is usually between April and September while the dry season is from October to March (UJMS, 2000; Alao and Adeoye, 2004).

Seed Collection and Viability Test

The seeds of *P. erinaceus* were sourced from the mother tree in Federal College of Forestry, Jos Plateau State, Nigeria. The seeds were subjected to a viability test using the Floatation Test Method. Seeds were put in a basin of water and left undisturbed for an hour. All suspended seeds were discarded and the sunken ones collected. Seeds which sunk were perceived to have had higher specific gravity due to more stored food reserves.

Seed Pre-sowing Treatment

Pterocarpus erinaceus seeds were pre-treated as follows: The seeds were soaked in cold water at room temperature (20 – 25 ^{o}C) for 24 hours (Cold water treatment: T_1); Also, water was boiled and allowed to cool for ten minutes before the seeds were soaked in it for 24 hours (Hot water treatment: T_2); Sulphuric acid (98% concentration) was used as standard method as described by Hasnat, *et al*, (2016). Seeds were immersed in a beaker containing concentrated H_2SO_4 for a minute, the solution was drained off and repeatedly the seeds were rinsed in a running tap before planting (T_3). Seeds were also immersed in a beaker containing 50% diluted H_2SO_4 for a minute, the solution was drained off and repeatedly the seeds were rinsed in a running tap before planting (T_4); Pre-sowing treatment using 5mM H_2O_2 was carried out using standard method as described by Barba-Espin, *et* al, (2010). Seeds imbibed hydrogen peroxide (H_2O_2) (5 mM) for 24 hours (T_5). The seeds were then washed two times with distilled water before planting. The seeds of *P. erinaceus* were also treated mechanically (punctured or nicked) at the distal end of the seed with a secateur away from the embryo before planting (T_6) while untreated seeds served as control (T_7).

Experimental Design and Layout

The experiment was laid out in Completely Randomized Design (CRD) at the Forestry nursery in the study area. The study involved the use of seven (7) pre-sowing treatments and three (3) replicates. The treatments were cold water, Hot water, Acid scarification (Concentrated and Diluted), H_2O_2, Nicking treatments and a control. Total of 42 seeds were planted for the study. This study was observed for the duration of twelve (12) weeks while growth parameters were measured weekly starting the 4^{th} week after germination.

Data Collection and Analysis

Weekly observations were made to determine the effects of pre-sowing treatments on germination of *P. erinaceus* seeds. Data on growth variables were measured; these included: seedling heights which were measured from the soil level to the tip of the seedlings by the use of meter rule; leaf numbers were counted and the mean number of leaves per replicate determined; leaf length was measured with a meter rule and the mean leaf length per replicate was determined; stem diameter was measure using a thread clung round the stem of each seedling and after which the thread was stretched on a graduated meter rule in order to obtain the measurement in centimeters.

Data collected on seed germination and growth variables (seedling heights, number of leaves, leaf length and stem diameter) were subjected to descriptive statistics (percentages, mean and standard deviation) and inferential statistics (analysis of variance (ANOVA) were used to analyze data collected in the study area. Where significant differences occurred between the treatments means, Duncan multiple range test method was used to separate the means.

RESULTS

Effect of Pre-Treatments on Germination Percentage of *P. erinaceus* Poir

Percentage seed germination reveals nicking treatment recording the highest mean percentage germination of 43.3%. This was followed by seeds immersed in cold water (40%), seeds without any treatment (Control = 36.7%), seeds immersed in hot water and hydrogen peroxide (H_2O_2) (30%) respectively. Amongst sulphuric acid treatments, seeds immersed in 50% (diluted) sulphuric acid recorded higher germination (23.3%) when compared with seeds immersed in 98% sulphuric acid, which exhibited lowest germination percentage (20%) (Figure 1).

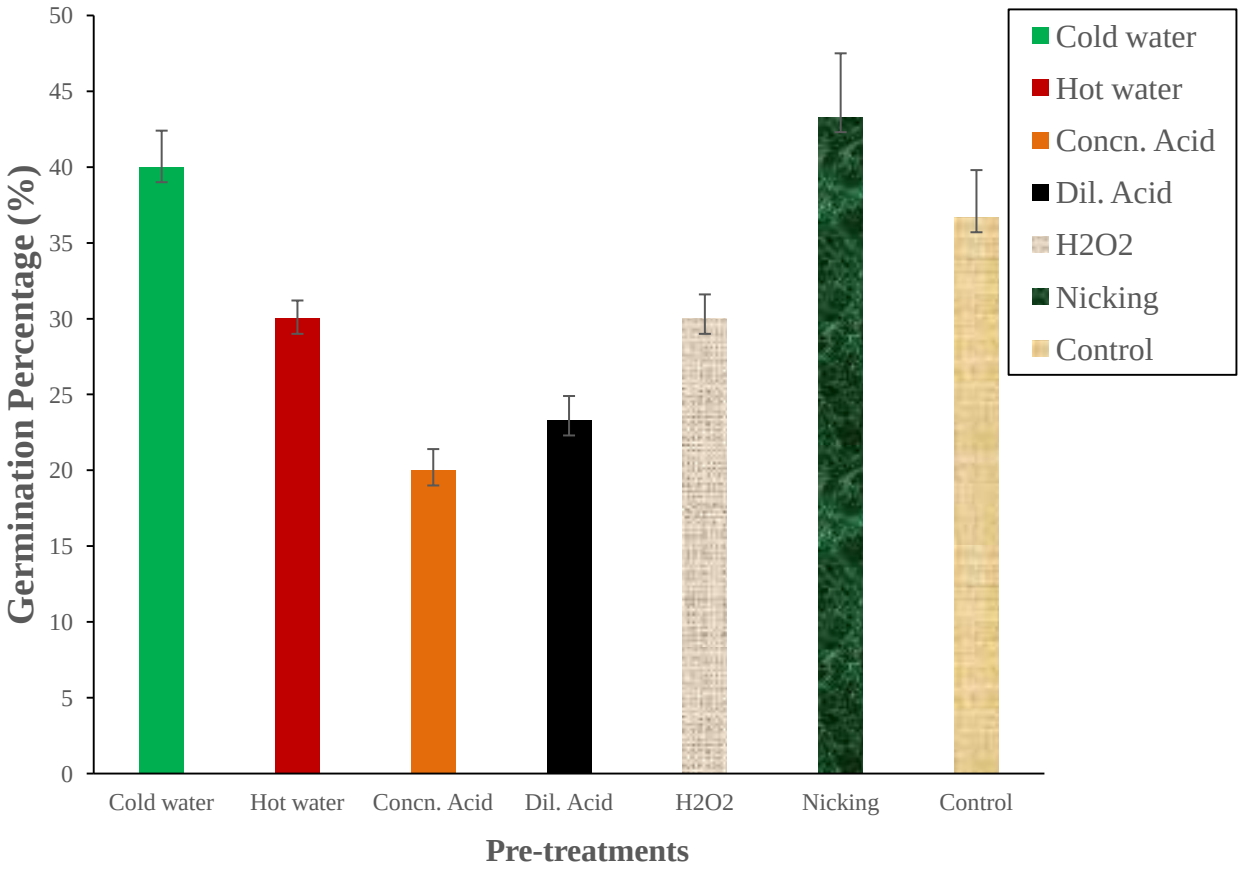

Figure 1: Effect of Pre-Sowing Treatment on Percentage Germination of *P. erinaceus*

Effect of Pre-Sowing Treatments on Seedling Growth of *P. erinaceus*

Table 1 result shows mean effect of pre-sowing treatment on height of *P. erinaceus* seedlings following pre-treatment with cold water, hot water, sulphuric acids (concentrated and diluted), hydrogen peroxide (H_2O_2), nicking and control on the germination and early seedling growth of *P. erinaceus*. Seedling height values recorded for each treatment were significantly ($p \leq 0.05$) different at 5^{th} to 12^{th} weeks of data collection. Results of the study thus revealed that the values recorded for each treatment increased as the age of seedlings progressed after germination from 5^{th} to 12^{th} weeks. Despite the differences observed from height of seedlings for the different pre-treatments for weeks after germination, nicking treatment exhibited highest overall value. This was followed by seeds treated with cold water > control (no treatment) > hot water treatment > hydrogen peroxide (H_2O_2) > concentrated sulphuric acid > diluted sulphuric acid.

Table 1: Effect of Seed Pre-Sowing Treatment on Mean Seedling Height (cm) of *Pterocarpus erinaceus*

Treatments	Seedling Height (cm)							
	5WAG	6WAG	7WAG	8WAG	9WAG	10WAG	11WAG	12WAG
Cold water	0.38^{b}	0.47^{bc}	1.04^{ab}	1.28^{ab}	1.57^{b}	2.15^{b}	3.27^{b}	4.31^{ab}
Hot water	0.11^{c}	0.17^{d}	0.49^{b}	0.65^{b}	0.94^{b}	1.22^{bc}	1.57^{c}	2.47^{b}
Concn. acid	0.00^{c}	0.00^{d}	0.52^{b}	0.73^{b}	0.87^{b}	1.07^{c}	1.40^{c}	1.80^{b}
Dil. acid	0.00^{c}	0.00^{d}	0.62^{b}	0.85^{b}	0.85^{b}	0.94^{c}	1.23^{c}	1.72^{b}
H_2O_2	0.00^{c}	0.27^{cd}	0.91^{ab}	1.15^{ab}	1.25^{b}	1.43^{bc}	2.00^{bc}	2.41^{b}
Nicking	0.69^{a}	1.01^{a}	1.57^{a}	1.85^{a}	2.74^{a}	3.21^{a}	4.93^{a}	5.82^{a}
Control	0.41^{b}	0.63^{b}	1.18^{ab}	1.49^{ab}	1.59^{b}	1.89^{bc}	2.56^{bc}	3.25^{bc}
SE	**0.05**	**0.09**	**0.218**	**0.27**	**0.29**	**0.34**	**0.46**	**0.59**
p-value	***0.000***	***0.000***	***0.006***	***0.023***	***0.000***	***0.000***	***0.000***	***0.000***

Values (in the same column) with the same subscript letters do not differ significantly from each other according to the Duncan multiple range test.

Key: WAG = Week after Germination

Significant variations ($p \leq 0.05$) were observed for number of leaves among pre-treatments at 5th to 12th weeks after germination (Table 2). Highest mean leaf number for 5 and 6 weeks after germination were obtained from nicked seed treatment, this was followed by control > cold water treatment > hot water treatment > H_2O_2 treatment > concentrated and diluted acid treatment. At 7 to 9 weeks post germination, highest mean leaf number was also recorded on nicked treated seeds and the order of performance were control (seeds without treatment) > H_2O_2 treatment > cold water treatment > diluted acid treatment > hot water treatment > concentrated acid treatment. However, the result equally revealed a change in that nicked seeds exhibited the highest values for weeks 10 to 12 post germination and the order of increase at that stage were cold water treatment > H_2O_2 > control > hot water treatment > diluted acid > concentrated acids respectively.

Table 2: Effect of Seed Pre-Sowing Treatment on Mean Number of Leaves of *Pterocarpus erinaceus* Seedlings

Treatments	Number of Leaves							
	5WAG	6WAG	7WAG	8WAG	9WAG	10WAG	11WAG	12WAG
Cold water	1.00^{b}	1.73^{c}	2.73^{bc}	3.93^{b}	4.60^{b}	6.20^{b}	7.87^{b}	8.40^{b}
Hot water	0.40^{c}	0.93^{cd}	1.60^{c}	2.80^{b}	3.07^{b}	4.40^{b}	5.20^{b}	6.27^{b}
Concn. acid	0.00^{c}	0.00^{d}	1.60^{c}	2.93^{b}	2.93^{b}	4.27^{b}	5.47^{b}	5.40^{b}
Dil. acid	0.00^{c}	0.00^{d}	2.20^{bc}	3.87^{b}	3.93^{b}	4.60^{b}	5.87^{b}	5.87^{b}
H_2O_2	0.00^{c}	1.20^{c}	3.60^{abc}	5.13^{ab}	5.40^{ab}	6.60^{b}	7.73^{b}	7.80^{b}
Nicking	1.87^{a}	4.00^{a}	5.13^{a}	7.80^{a}	8.07^{a}	11.13^{a}	13.00^{a}	13.20^{a}
Control	1.40^{ab}	2.87^{b}	3.87^{ab}	5.20^{ab}	5.53^{ab}	6.27^{b}	7.60^{b}	7.73^{b}
SE	**0.17**	**0.38**	**0.68**	**0.27**	**1.09**	**1.32**	**1.59**	**1.57**
p-value	***0.000***	***0.000***	***0.003***	***0.029***	***0.023***	***0.007***	***0.016***	***0.017***

Values (in the same column) with the same subscript letters do not differ significantly from each other according to the Duncan multiple range test.

Key: WAG = Week after Germination

The length of *P. erinaceus* seedling leaves increased for all the treatments from 5th through 12th week post germination. Growth of leaf length increased significantly from week 5 to 7, 9 to 12 and non-significant at

week 8. Nicking treatment of seeds exhibited the highest leaf length for post germination of seeds. This was followed by cold-water treatment which was higher and the order of performance were nicking > cold-water treatment > control (untreated seeds) > H_2O_2 treatment > hot water treatment > concentrated acid treatment > diluted acid treatment as shown in Table 3.

Table 3: Effect of Seed Pre-Sowing Treatment on Mean Length of Leaves of *Pterocarpus erinaceus* Seedlings

Treatments	Length of Leaves (cm)							
	5WAG	6WAG	7WAG	8WAG	9WAG	10WAG	11WAG	12WAG
Cold water	0.13^{b}	0.57^{bc}	1.37^{ab}	1.74^{ab}	1.95^{ab}	1.95^{ab}	2.28^{ab}	2.31^{ab}
Hot water	0.05^{c}	0.30^{cd}	0.77^{b}	1.03^{b}	1.15^{b}	1.15^{b}	1.35^{b}	1.42^{b}
Concn. acid	0.00^{c}	0.00^{d}	0.89^{b}	1.21^{b}	1.24^{b}	1.24^{b}	1.45^{b}	1.45^{b}
Dil. acid	0.00^{c}	0.00^{d}	1.04^{b}	1.38^{b}	1.38^{b}	1.38^{b}	1.45^{b}	1.45^{b}
H_2O_2	0.00^{c}	0.45^{c}	1.57^{ab}	1.79^{ab}	1.83^{ab}	1.85^{ab}	2.12^{b}	2.12^{b}
Nicking	0.25^{a}	1.23^{a}	2.33^{a}	2.69^{a}	3.01^{a}	3.04^{a}	3.57^{a}	3.57^{a}
Control	0.19^{ab}	0.93^{ab}	1.61^{ab}	1.91^{ab}	1.95^{ab}	2.02^{ab}	2.31^{ab}	2.31^{ab}
SE	**0.02**	**0.13**	**0.33**	**0.41**	**0.42**	**0.41**	**0.46**	**0.45**
p-value	***0.000***	***0.000***	***0.021***	***0.105***	***0.043***	***0.033***	***0.014***	***0.015***

Values (in the same column) with the same subscript letters do not differ significantly from each other according to the Duncan multiple range test.

Key: WAG = Week after Germination

Seedlings of *P. erinaceus* subjected to different pre-treatments displayed significant differences ($p \leq 0.05$) in seedling stem diameter at 5^{th}, 6^{th}, 10^{th} and 17^{th} to 22^{nd} week after germination and a non-significant different ($p \geq 0.05$) at 7^{th} to 9^{th}, 11^{th} and 12^{th} week post germination. Overall mean stem diameter after 5^{th} to 12^{th} and 17^{th} to 22^{nd} weeks after germination varied from 0 cm at week five to 2.16 cm at the 22^{nd} week (Table 4). Mean Seedling stem diameter was considerable highest in nicked seedlings at 5^{th} to 12^{th} and 17^{th} to 22^{nd} weeks after germination followed by cold water-treated seedlings, control, H_2O_2 treatment, diluted acid treatment, concentrated acid treatment and lowest in hot water-treated seedlings respectively.

Table 4: Effect of Seed Pre-Sowing Treatment on Mean Stem Diameter (cm) of *Pterocarpus erinaceus* Seedling

Treatments	Stem Diameter (cm)							
	5WAG	6WAG	7WAG	8WAG	9WAG	10WAG	11WAG	12WAG
Cold water	0.13^{c}	0.15^{bc}	0.29^{ab}	0.33^{ab}	0.44^{ab}	0.47^{ab}	0.88^{ab}	1.17^{ab}
Hot water	0.07^{cd}	0.07^{cd}	0.18^{b}	0.19^{b}	0.19^{b}	0.21^{b}	0.50^{b}	0.63^{b}
Concn. acid	0.00^{d}	0.00^{d}	0.21^{ab}	0.23^{ab}	0.23^{b}	0.23^{b}	0.70^{b}	0.70^{b}
Dil. acid	0.00^{d}	0.00^{d}	0.25^{ab}	0.28^{ab}	0.28^{ab}	0.28^{b}	0.78^{ab}	0.79^{b}
H_2O_2	0.00^{d}	0.10^{c}	0.33^{ab}	0.33^{ab}	0.35^{ab}	0.37^{ab}	0.97^{ab}	1.03^{ab}
Nicking	0.29^{a}	0.32^{a}	0.43^{a}	0.48^{a}	0.51^{a}	0.61^{a}	1.39^{a}	1.49^{a}
Control	0.20^{b}	0.23^{b}	0.31^{ab}	0.33^{ab}	0.36^{ab}	0.41^{ab}	1.13^{ab}	1.19^{ab}
SE	**0.03**	**0.03**	**0.07**	**0.08**	**0.08**	**0.09**	**0.21**	**0.22**
p-value	***0.000***	***0.000***	***0.279***	***0.251***	***0.097***	***0.020***	***0.089***	***0.073***

Values (in the same column) with the same subscript letters do not differ significantly from each other according to the Duncan multiple range test.

Key: WAG = Week after Germination

DISCUSSION

The result of this study on germination percentage shows a significant variation ($p \leq 0.05$) within pre-treatments. Germination started on the thirtieth (30^{th}) day after sowing in nicked seeds and lasted for 51 days in seeds immersed in 95% and 50% (diluted) sulphuric acid. The results agree with the findings of Missanjo *et al.,* (2014) which reported that earlier germination of nicked seeds is as a result of cracks or cuts made on the seed which made it easier for entry of water and exchange of gases resulting in enzymatic hydrolysis and thus transforming the embryo into seedlings.

The results of seedling height of *P. erinaceus* implied that nicking was a suitable pre-sowing treatment for raising seedlings of *P. erinaceus*. This could be attributed to the entry of air and water into the seeds of *P. erinaceus* at a faster rate to stimulate germination and elongation of the embryonic axis. This result thus agrees with the findings of Hossain *et al.,* (2005) and Missanjo *et al.,* (2014) who reported that seedlings from nicked seeds showed better height than other treatments. Based on their findings, fast growth of seedlings in terms of height from nicked seeds occurred because seedlings which originated from nicked seeds had an advantage of absorbing much water and enhance photosynthesis process much faster than other treatments.

The highest number of leaves of *P. erinaceus* seedlings recorded under nicking treatment at that period revealed a better performance of these seedlings. This was in agreement with findings by Missanjo *et al*. (2014) who observed highest number of leaves on seeds of *Acacia polyacantha* and *Lupinus varius* from nicking treatment when compared with other treatments. Sahoo, *et al.* (2007) reported that nicking treatment among other pre-treatment methods gave highest leaf number on seed germination behaviour of *Parkia roxburghii*. The present result also corroborates with the findings of Gunaga *et al.* (2011) who reported higher number of leaves in *Mammea suriga* seedlings originated from nicked seeds.

Manual scarification through nicking exhibited highest leaf length of *P. erinaceus* seedlings amongst other treatments. The result agrees with the findings of Missanjo *et al.* (2013) who showed that nicking treatment was the best method for breaking dormancy of *Albizia lebbeck* seeds which resulted in an increased length of leaves. Mwase and Mvula (2011) also reported highest seedling growth (length of leaves) obtained from nicking of *Bauhinia thonningii* Schum seeds. The results of the present study are also supported by the findings of Travlos *et al*. (2006) who showed that among all the seed pre-treatments, nicking gave highest leaf length in *Tylosema esculentums* seedlings. The result on seedlings diameter growth of *P. erinaceus* implied that the best mean diameter (girth) was recorded in nicked seeds. There were significant differences in seedling stem diameter at 5^{th}, 6^{th} and 10^{th} week and a non-significant different at 7^{th} to 9^{th}, 11^{th} and 12^{th} week post germination for the different treatments used. The significance on the growth parameter in this study is similar to the findings of Chubamerenla *et al.* (2015) who reported a significant variation in growth of *Delonix regia* seedlings that emerged from different pre-treatments. This disagrees with the work of El-Juhany *et al*., (2009) who obtained best vegetative character (stem diameter) in seedlings raised from seeds soaked in sulphuric acid with increasing exposure regime from 2 to 10 minute on the seedlings of *Juniperus procera*. According to Ayisire *et al*. (2009), nicking has been found to be extremely effective for all vegetative growth and improvement for most tree species when compared with other treatments. The study is in line with the study carried out by Akinnifesi *et al*. (2007) where nicking improved germination and growth parameter (collar diameter) of *Sclerocarya birrea* seedlings.

CONCLUSION

The finding of this study showed that the germination percentage and early growth rate of *P. erinaceus* was best recorded in nicked seed. Seeds under nicking treatment recorded an overall higher percentage germination of 43.3% by the end of the germination period. Therefore, in order to enhance optimum and uniform seed germination and seedling growth, nicking gave the best pre-sowing treatment when compared to other treatments that enhance seed germination and seedling growth (height, leaf number, and leaf length and stem diameter) of *P. erinaceus*. Nicking is known to break physical dormancy of seeds with hard coats, which inhibits water uptake, and exchange of gases resulting in enzymatic hydrolysis and thus transforming the embryo into seedlings.

Recommendations

1. Nicking is recommended as the most suitable pre-sowing treatment for enhancing seed germination and early growth of *P. erinaceus* in the nursery for plantation purposes.
2. Tree farmers or nursery owners, who are interested in the production of *P. erinaceus* seedlings, should be advised to use nicking treatment to ensure early germination of the seeds.

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