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Comparative Study of Pre-Germination Treatments and their Effects on the Growth of Tectona Grandis (Linn. F) Seedlings *(Pp. 368-378)*

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Abstract

A comparative study was conducted for three months to investigate the effect of pre-germination treatment on morphological and physiological characteristics of Tectona grandis (Linn. F) seedlings. Matured seeds of Tectona grandis were collected from mother trees in Uyo and exposed to four pre-germination treatments – soaking in running water (SRW) for 24 hours, soaking in stagnant water (SSW) for 24 hours, soaking in boiled water (SBW) for 5 minutes and no treatment as control. Treated seeds were sown in the of Forestry and Wildlife Department nursery, University of Uyo by broadcast

method in germination boxes. At two-leaf stage, fairly uniformed seedlings from each treatment were selected and transplanted into polypots filled with topsoil and laid on the field in completely randomized design, replicated three times. Morphological and physiological features were assessed after two weeks of transplanting and fortnightly thereafter. Data were subjected to ANOVA and the significant means separated using F-LSD. The result showed that pre-germination treatment had significant effect ($p>0.05$) on seedling height, number of leaves, stem collar diameter and biomass production while there was no significant effect ($p<0.05$) on leaf area. The seeds soaked in running water produced seedlings with the highest seedling height (9.26cm), number of leaves (11.88), stem collar diameter (0.44cm) shoot dry weight (1.05g/month) and relative growth (11.72g/month) while boiled water, stagnant water and control produced seedlings with the least values for seedling height (7.62cm), for root dry weight (0.51g/month) and for number of leaves (10.05) respectively. Pre-germination treatments of seeds soaked in running water (SRW) for 24 hours were found to be more effective in seedlings growth and biomass production.

Keywords: Tectona grandis, pre-germination treatment, seed dormancy, seedling growth

Introduction

Tectona grandis is one of the most valuable timbers in the world on account of its outstanding properties (Robertson, 2002). Teak has probably been more widely and intensively studied than any other tropical tree because of its strength, durability, working qualities and dimensional stability (Webb et al., 1984). It possesses excellent properties and as such, it has a very wide range of uses, including flooring, decking, framing, cladding, electric poles among others (Hart, 1973). Despite the wide range of uses this tropical tree possess, it has been noticed that its seeds take a longer time to germinate when sown in the nursery even through the seeds are viable, the delay in germination of Tectona grandis seeds is usually attributed to seed dormancy due to its stony impermeable endocarp (Unikrisham and Rejeer, 1990).

According to Lars (2000) seed dormancy refers to a state in which viable seeds fail to germinate in the presence of favourable environmental conditions. Several types of dormancy exist, and sometimes more than one type of dormancy occurs in the same seed. In nature, dormancy is broken gradually or by a particular environmental event. The type of event that may break dormancy depends on dormancy type. Nwoboshi (1982) classified

dormancy into physical and physiological dormancy. Physical dormancy takes the form of hard impervious seed coats which either prevent water and in some plants, oxygen from reaching the embryo or prevent the embryo from enlarging and breaking the testa even though water has been able to pass in. This type of dormancy is quite common in several tropical and sub-tropical genera, example, it occurs in Pterocarpus angolensis, Terminalia superba, Albizia lebbek, Ziziphus spp, Tectona grandis, Eucalyptus pauciflora and several others (Turnbull and Doran, 1987). Physiological dormancy may be caused by the presence of inhibitors or substances that blocks the germination process. The dormancy may also be due to incomplete maturation of the embryo (Nwoboshi, 1982). The presence of inhibitor has been shown in seed coat of Albizia spp (Kannan et al., 1996). In seed handling, dormancy is simulated during the process of pretreatment (Lars, 2000). Samples of Tectona grandis seeds may without any pre-germination treatment start germination at 16 – 67 days after sowing, while samples of Tectona grandis which are subjected to pre-germination treatment such as soaking seeds in running water may start germination at 10 – 15 days after sowing (Robertson, 2002).

This study was carried out to assess the effects of pre-germination treatments on the early growth of Tectona grandis seeds and to recommend the best pre-germination treatment that could be used to break seed dormancy to tree planters and silviculturists.

Materials and Methods

The experiment was conducted at the nursery of the Department of Forestry and Wildlife, Faculty of Agriculture, University of Uyo, Uyo, Nigeria. Uyo lies within the tropical rainforest zone of Nigeria at 4□58' to 5□05'N and longitude 7□54' to 8□00E of the equator. The mean annual rainfall of the area is 2000mm; the mean annual temperature is 32□C while the mean relative humidity is 78% (Offiong et al., 2000). Uyo town covers an area of 10 kilometers radius and has a total land area of 15,750 hectares (Akpabio et al., 2004).

Matured fruits of Tectona grandis (Linn.F) were collected from the mother tree and processed by depulping the husk from the seeds. A total of 800 seeds with no visible sign of infection were selected and divided into four sub-seed lots of 200 seeds each and were subject to different pre-germination treatments as follows: soaking in running water (SRW) for 24 hours, soaking in stagnant water (SSW) for 24 hours, soaking in boiled water (SBW) for 5

minutes and control. Seeds were sown in germination boxes (24cm x 18cm x 16cm) filled with washed and sterilized river sand to raise seedlings for the study. At two-leaf stage, a total of fifty four (54) uniformly growing seedlings from each treatment were selected and transplanted into polypots (16cm x 14cm x 12cm) filled with topsoil and laid on the field in completely randomized design, replicated three times. Two weeks after transplanting the following growth parameters were assessed fortnightly. Shoot height, number of leaves, stem collar diameter, leaf area. The height measurement was taken from the collar to the tip of the apical bud using a meter rule, calibrated in centimeter. A veneer caliper, calibrated in centimeter was used to measure seedling stem collar diameter, number of branches and leaves were determined by visual counting, leaf area was determined by graphical method (Offiong, 2008). Data collected were subjected to ANOVA at 5% probability level and the least significant difference among the treatment was used to compare the difference means (Akindele, 1996).

Biomass production was assessed at monthly interval. In each study, a total of five seedlings were randomly selected from each treatment. The seedlings were partitioned into shoot and root for biomass measurement and were oven dried at 80□C for 24 hours for biomass production. The dry weights were then used to calculate the relative growth rate (RGR); Average growths rate (AGR) and shoot/root ratios according to the formula of Offiong (2008) as follows:

(i) $$\text{RGR (g/month)} = \frac{(\text{LnTDW}_2 - \text{LnTDW}_1)}{t_2 - t_1}$$

(ii) $$\text{AGR (g/month)} = \frac{(\text{LnTDW}_2 - \text{LnTDW}_1)}{t_2 - t_1}$$

(iii) $$\text{Shoot/Root Ration} = \frac{\text{Dry weight of shoot}}{\text{Dry weight of root}}$$

where:

TDW_1 = Initial total dry weight

TDW_2 = Final total dry weight

t_1 = Initial time (in months)

t_2 = Final time (in months)

RGR = Relative growth rate

AGR = Average growth rate

Ln = Natural logarithm

RESULTS

Morphological Characteristics Tectona Grandis Seedlings as Affected by Pre-germination Treatments

(i) Seedling height - The result showed that pre-germination treatments had significant effect ($p<0.05$) on seedling height (Table 1). The seeds soaked in running water (SRW) had significantly higher (9.26cm) mean seedling height than seeds soaked in stagnant water (SSW), seeds soaked in boiled water (SBW) and the control had statistically similar mean shoot height values. There was no significant difference in seeds soaked in boiled water and control. These seedlings recorded the mean height of 7.62cm. Seeds treated with stagnant water recorded the mean height of 7.86cm (Table 2).

(ii) Number of leaves - Pre-germination treatments had significant effect ($p<0.05$) on leaves production by the seedlings (Table 1). As shown in Table 2, seeds soaked in running water (SRW) produced seedlings with a mean number of leaves of 11.88, seeds soaked in boiled water (SBW) produced seedlings with the mean number of 10.38, while seeds soaked in stagnant water (SSW) and control produced seedling with mean value of 10.17 and 10.05 respectively. The result revealed that seeds SRW gave significantly higher number of leaves than seeds SSW, seeds SBW and seeds in control treatments. These treatments, SBW and control had statistically similar number of leaves ($p<0.05$).

(iii) Stem collar diameter - Stem collar diameter differed significantly ($p<0.05$) among the pre-germination treatments pre-germination treatments (Table 1). Seeds SRW produced seedlings with the mean stem collar diameter of 0.44cm, stagnant water and control produced seedlings with the mean value of 0.42cm and 0.40cm respectively, while seeds treated in boiled water produced seedlings with mean value of 0.35cm (Table 2). The result further showed that seeds SSW and seeds SRW gave significantly higher stem collar diameter of seedlings. No significant differences existed between the stem collar diameter values of seeds SSW and seeds SRM. Seeds SBW treatment had the least stem collar diameter result. The following treatments

had statistically similar stems collar diameter values ($p<0.05$) SSW and the control.

(iv) Leaf Area (cm^2) - There was no significant effects ($p<0.05$) among the pre-germination treatments on the leaf area of Tectona grandis (Table 1). Seeds soaked in stagnant water (SSW) produced seedlings with a mean value of $27.46cm^2$ while seeds soaked in boiled water (SBW) produced seedlings with a mean value of $23.10cm^2$. Seeds soaked in running water (SRW) and control treatment recorded seedlings with a mean value of $26.71cm^2$ and $24.79cm^2$ respectively (Table 2).

Effect of Pre-germination Treatment on Seedling Biomass

(i) Shoot dry weight - The result showed that pre-germination treatments had significant effect ($p<0.05$) on shoot dry weight (Table 3). Although seeds SRW had significantly higher shoot dry weight (1.05g/month) than seeds SSW (0.73g/month), the result was statistically similar to those of seeds SBW (0.77g/month) and the control treatment (0.77/month) (Table 4).

(ii) Root dry weight - The result showed that pre-germination treatment had significant effects ($p<0.05$) on root dry weight (Table 3). Table 4 shows that seeds SRW had significantly higher root dry weight (0.79g/month) than seeds SSW (0.51g/month). However, seeds SRW had similar ($p<0.05$) root dry weight as the control treatment (0.57g/month) and seeds SBW. There was no significant difference between the mean root dry weight results of the control, seeds SBW and seeds SSW treatments.

Physiological characteristics of Tectona Grandis Seedlings as Affected by Pre-germination Treatments

Summary of relative growth rate (RGR), average growth rate (AGR) and shoot root ratio of seedlings of Tectona grandis as affected by pre-germination treatments is presented on Table 5. The result indicated that AGR values among the pre-germination treatments. The highest AGR with a mean value of 0.18g/month was obtained from the seedlings produced by the seeds that were treated with running water while seeds SSW recorded seedlings with the least AGR with a mean value of 0.09g/month respectively.

Relative growth rate also varies among the pre-germination treatments. Seeds SRW recorded seedlings with the highest (11.72g/month) RGR. The least RGR was recorded by the seedlings produced by the seeds SSW with a mean value of 1.58g/month. Seeds SBW produced seedlings with a mean RGR of 3.50g/month while seedlings in control plot recorded the mean value of

1.92g/month. Seeds soaked in running water produced seedlings with the mean shoot/root ratio of 18:13 , while seeds soaked in boiled water produced seedlings with the least shoot/root ratio of 4:3. The seeds soaked in stagnant water and control produced seedlings with mean shoot/root ratio of 13:9 respectively.

Discussion

Tectona grandis present difficulties in germination which has serious effect on the seedlings produced by its seeds in many parts of the world if sown untreated. However, pre-germination treatments such as soaking seeds in water have been used successfully to overcome seed dormancy. Soaking seeds in water dissolves and leaches out the chemicals causing dormancy which would have hindered the growth of the seedlings produced by such seeds (Deghan et al., 2003). Growth is increase in size and formation of new tissues in plants (Nwoboshi, 1982). Nevertheless, pre-germination treatment increased growth and development of seedlings of Tectona grandis (Lin. F)

From the present study, it was observed that seeds soaked in water significantly affected important morphological parameters and biomass production such as seedling height, stem collar diameter, number of leaves, root and shoot dry weight. This is in agreement with the findings of Hossian et al., (2001) who reported that seeds of Terminalia chebula soaked in cold water for 48 hours enhanced growth of seedlings height, number of leaves, stem collar diameter and shoot dry weight while root dry weight was enhanced by the seeds treated with boiled water.

The result of the physiological growth revealed that seeds soaked in running water had significant influence on the relative growth rate (RGR) and average growth rate (AGR) of the seedlings while seeds soaked in boiled water influenced the shoot/root ratio of the seedlings. Seeds soaked in running water significantly influenced the morphological and biomass production, it was found to be more effective. This could be so because chemicals which would have hindered the growth were dissolved and leached out during the pretreatment period. This agrees with the findings of Khan et al., (2001) who reported that pre-sowing treatment had significant effect on seedling growth of Tectona grandis

Conclusion

It has been observed that among the pretreatments applied in the experiment for Tectona grandis, seeds soaked in running water for 24 hours were found more effective in respect to seedling growth and biomass production in

comparison to control and other pretreatment. Generally soaking seeds in water will be useful to both the local tree planters and silviculturists to break the dormancy of Tectona grandis seeds. This method is simple to apply and inexpensive as it requires no special equipment, it can be used to tackle all the different types of dormancy and helps to modify the seed coat, remove inhibitors and soften the seed for easy germination and seedling growth. This will form important element in the quality of seedlings produced for the establishment of Teak plantation, both in Nigeria and beyond.

Table 1: Analysis of variance on the effect of pre-germination treatment on morphological growth of seedlings of Tectona grandis

	Parameters	Degree of freedom	Means of squares	F-ratio
1	Seedling height			
	Treatment	3	2.3794	5.8419*
	Error	8	0.4073	
	Total	11		
2	Number of leaves			
	Treatment	3	3.0771	5.3265*
	Error	8	0.5777	
	Total	11		
3.	Stem collar diameter			
	Treatment	3	0.0059	19.6667*
	Error	8	0.0003	
	Total	11		
4.	Leaf area			
	Treatment	3	27.9695	3.6746^{NS}
	Error	8	7.6116	
	Total	11		

*Significant (p>0.05).

Table 2: Mean values on morphological growth of seedlings of Tectona grandis as affected by four pre-germination treatments

Pre-treatments	Seedling height (cm)	Number of leaves	Stem collar diameter (cm)	Leaf area (cm^2)
Soaking in Running Water (SRW)	9.26^{a}	11.88^{a}	0.44^{a}	26.71
Soaking in Stagnant Water (SSW)	7.86^{b}	10.17^{b}	0.42^{ab}	27.46
Soaking in Boiled Water (SBW)	7.62^{bc}	10.38^{bc}	0.35^{c}	23.10
Control	7.62^{bc}	10.05^{bc}	0.40^{b}	24.79
F-LSD	1.20	1.43	0.03	

Values with similar superscript are not significantly different ($p<0.05$).

Table 3: Analysis of variance for effect of pre-germination treatment on biomass production

	Source of variation	Degrees of freedom	Mean of squares	F-ratio
1.	Shoot dry weight			
	Treatment	3	0.1541	5.1538*
	Error	8	0.0299	
	Total	11		
2.	Root dry weight			
	Treatment	3	0.1254	5.9714*
	Error	8	0.0210	
	Total	11		

*Significant ($p<0.05$).

Table 4: Mean biomass of seedlings of Tectona grandis grown from seeds of different pre-germination treatment.

Pre-treatments	Shoot dry weight(g/month)	Root dry weight(g/month)
Soaking in Running Water (SRW)	1.05^{a}	0.79^{a}
Soaking in Stagnant Water (SSW)	0.73^{b}	0.51^{b}
Soaking in Boiled Water (SBW)	0.77^{abc}	0.69^{abc}
Control	0.77^{abc}	0.57^{abc}

Values with similar superscripts are not significantly different ($p< 0.05$).

Table 5: Mean table of relative growth rate (RGR), average growth rate (AGR) and shoot/root ratio (S/R) of Tectona grandis as affected by four pre-germination treatments

Treatments	RGR (g/month)	AGR (g/month)	S/R
Soaking in Running Water (SRW)	11.72	0.18	18:13
Soaking in Stagnant Water (SSW)	1.58	0.09	13:9
Soaking in Boiled Water (SBW)	3.50	0.16	4:3
Control	1.92	0.10	13:9

g/month = grams per month.

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