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Effects of pre-sowing treatments on germination parameters of *Tectona grandis* L.f. under nursery condition

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Abstract
A study was undertaken in the nursery area of College of Horticulture and Forestry, Jhalawar to assess the influence of different pre-sowing treatments on the germination of *Tectona grandis* (Teak) seeds. Seeds were subjected to 4 treatments including control (P_0), Alternate wetting and drying (12 hours) for 21 days (P_1), Soaking in cow dung slurry for 7 days (P_2) and Soaking in concentrated H_2SO_4 (75%) for 20 minutes (P_3). The results of the study indicated that pre-sowing treatments had significant influence on the germination parameters. The highest germination percentage, germination speed, faster germination and lowest mean germination were observed in seeds treated under alternate wetting and drying (12 hours) for 21 days (P_1) followed by seeds soaked in cow dung slurry for 7 days (P_2). Among the pre-sowing treatments seeds treated under alternate wetting and drying (12 hours) for 21 days can be recommended for *Tectona grandis* on a broad scale. These research findings will provide valuable insights for making informed decisions on the cost-effective cultivation of *Tectona grandis* (Teak) seedlings on a large scale, ensuring their rapid germination.

Keywords: Pretreatment, seed germination, *Tectona grandis*, H_2SO_4, mean germination time, germination index

1. Introduction
Teak (*Tectona grandis* Linn. f.), belongs to family Lamiaceae, is a large deciduous tree growing up to 30 m height and 100 cm or more dbh. Teak is naturally distributed in South East Asia. In India, most important Teak forest are found in Madhya Pradesh, Tamil Nadu, Karnataka, Kerala, Uttar Pradesh, Gujarat, Orissa, Maharashtra and Rajasthan (Troup, 1921) [22].
The distribution of Teak is largely controlled by climate, geology and soil (Balagopalan, 1995) [4]. Teak grows best in well drained, fairly moist, warm, tropical climate with base-rich soils having high organic carbon and exchangeable calcium with pH 6.5 to 7.5 (Kulkarni, 1951) [11]. Generally, Teak grows well in areas receiving annual rainfall ranges 800-2500 mm and from sea level to an altitude of about 1,200 m. It is distributed naturally over a wide range of rainfall; from very dry area in which the annual rainfall is less than 800 mm to the very moist areas mostly within the west coastal regions of India with an annual rainfall of over 3,500 mm (Palanisamy *et. al*., 2009) [18].
Teak is known as king of timber and it yields one of the world's most beautiful and stable wood with excellent wood quality. Teak furniture is highly durable and the durability is accredited to the deposition of polyphenols in its heartwood. Because of its high dimensional stability and easy workability, it is considered as the best timber for making furniture, cabinet, tool handles, agricultural implements, ship and boat building, decorative flooring, wall panelling, carom board frames, mathematical instruments and wood packing etc. (Luna, 1996) [4]. Apart from its use as timber, other parts of the tree such as; flowers, fruits, seeds, leaves and bark are also useful (Orwa *et. al.*, 2009) [17].
Although Teak has a great economic value, people don't get interest in raising Teak seedling in nursery due to low germination percentage and the more average time required for the seed germination (Luna, 1996) [14]. Naturally, Teak seeds germinate within a drupe. In fact the drupes

germinate slowly and irregularly if it is untreated (Jackson, 1994) [9]. The delayed and unpredictable germination of *Tectona grandis* seeds in the nursery poses a significant hurdle for effective nursery management and successful plantation establishment. Therefore, it is crucial to identify pre-sowing techniques for these seeds to ensure earlier and successful germination, ultimately aiding in the reduction of seedling production costs on a large scale.

In light of the current situation, the primary objective of this study is to explore the most suitable pre-sowing treatments for overcoming the seed dormancy and production of quality planting material of *Tectona grandis* through the use of various pre-sowing treatments and finally to recommend cost-effective pre-sowing treatments that maximize germination and other germination quality parameters of this valuable species. This will help people to minimize their production cost of seedlings on a broad scale.

2. Materials and Methods

2.1 Study area

The experiment was conducted in green house of Department of Forest Biology and Tree Improvement, College of Horticulture & Forestry, Jhalrapatan City, Jhalawar. Geographically the district is situated between 23º45'20" and 24º52'17" North latitudes and 75º27'35" and 76º56'46" East longitudes at 131.14 m above mean sea level. The climate of this region is ordinarily sub-humid and characterized by extremes of temperature both in summer and winter. Maximum temperature in summer is high as 45.72 ºC and minimum during winter is 4.14 ºC. The normal yearly precipitation within the region is almost 954.7 mm mainly received from South-West monsoon amidst June to September and sometimes meagre showers amidst winter season.

2.2 Materials

Teak seeds were collected from the selected candidate plus trees (selected by single tree selection method, Zobel and Talbert, 1984) of Teak from Jhalawar region. The details of the selected candidate plus trees of *Tectona grandis* Linn.f**.** from Jhalawar region is given in the Table 1 The collected seeds were mixed together and from the collected seeds, healthy, uniform sized and good shaped seeds were selected to reduce non-treatment variation. The potting media used for the filling the poly bags under the experiment was mixture of soil, sand and vermicompost in 2:1:1 ratio. Pre-treated seeds were sown in polybags of size 6×10 inches. There were 150 polybags in each replication and altogether 600 polybags were arranged in a single treatment. A total of 2400 seeds of Teak were sown for the germination study.

Table 1: Details of the candidate plus trees (CPTs) of *Tectona grandis* Linn.f. selected from the Jhalawar region

SL. No	Plus tree	GPS (N)	GPS (E)	Location	Total height (m)	DBH (cm)	Clear Bole height (m)	Crown spread (m)	Crown length (m)	Bark thickness (mm)	Straightness score	Bole/Taper score
1.	PT_1	24⁰58'78.73"	76⁰15'97.62"	Jhalawar	15.50	19.10	5.00	11.05	10.50	11.00	4.00	3.00
2.	PT_2	24⁰58'78.92"	76⁰15'96.25"	Jhalawar	13.50	15.12	4.50	8.90	9.00	11.00	4.00	3.00
3.	PT_3	24⁰58'92.17"	76⁰15'73.27"	Jhalawar	23.00	25.47	6.00	12.35	17.00	12.00	4.00	3.00
4.	PT_4	24⁰58'92.55"	76⁰15'71.73"	Jhalawar	11.50	16.24	3.00	10.42	8.50	10.00	3.00	3.00
5.	PT_5	24⁰62'80.29"	76⁰15 '92.60"	Jhalawar	19.50	15.44	3.50	10.45	16.00	11.00	3.00	3.00
6.	PT_6	24⁰59'03.36"	76⁰16' 07.97"	Jhalawar	9.50	18.63	4.50	8.85	5.00	10.00	3.00	3.00
7.	PT_7	24⁰53'52.29"	76⁰17'21.34"	Jhalawar	10.00	17.28	4.50	9.00	5.50	10.00	3.00	3.00

Experimental Design

The experiment was laid out in a Complete Randomized Design (CRD) in green house. Seeds were subjected to four (4 treatments) *viz*. Control (P_0), Alternate wetting and drying (12 hours) for 21 days (P_1), Soaking in cow dung slurry for 7 days (P_2) and Soaking in concentrated H_2SO_4 (75%) for 20 minutes (P_3). There were 150 polybags in each replication and altogether 600 polybags were arranged in a single treatment. A total of 2400 seeds of Teak were sown for the germination study. The experimental data recorded during the course of study were subjected to statistical analysis as per method of Variance, (ANOVA) as suggested by Fischer, 1963. The treatment effects were determined by 'F' test by using the software OPSTAT.

2.4 Data collection and analysis

Number of seeds germinated was recorded on daily basis till the end of germination. The germination was recorded up to 60 days from the date of sowing. Based on the germination count, the following germination parameters *viz*. Germination percentage, Number of days taken for first germination, Number of days taken for completing the germination, Mean germination time and Germination index were recorded.

2.4.1. Germination parameters

- **Germination Percentage**

At the end of the germination period, the Germination percentage was calculated as per the following equation (Kumar D, 2017) [13].

$$\text{Germination (\%)} = \frac{\text{Total number of germinated seeds}}{\text{Total number of seeds sown}} \times 100$$

- **Mean germination time (MGT)**

Mean germination time (MGT) was calculated according to the following equation (Moradi Dezfuli *et al.*, 2008) [15].

$$\text{Mean germination time} = \sum(Dn)/\sum n$$

n= n is the number of seeds, which were germinated on day D.
D= D is the number of days counted from the beginning of germination.

- **Germination index (GI)**

Germination index was calculated as described in the association of official seed analysis (AOSA, 1983) [2] by the following equation

$$\text{Germination index} = \frac{\text{Number of the germinated seeds}}{\text{Days of first count}} + .. + \frac{\text{Number of the germinated seeds}}{\text{Days of final count}}$$

3. Results

Pre-sowing treatments have significant effect on the germination parameters. The earliest initiation of germination was observed in P_1(14.00 days) followed by P_2 (19.75) whereas maximum number of days taken for first germination were recorded in treatment P_0 (32.00 days).The minimum number of days taken for completing germination (28.75 days) was recorded in the treatment P_1followed by P_2 (32.25) whereas the treatment P_0 recorded maximum number of days for completing the germination (43.00 days).The highest treatment germination percent was recorded in the treatment P_1(43.83%)which was statistically at par (39.67%) with treatment $P_2$and the minimum germination percent was observed in the treatment P_0 (20.50%). (Table 2)

Table 2: Effects of pre-treatment on Seeds germination, Number of days taken to initiate and complete germination and germination percentage of *Tectona grandis*

Treatments	Germination percent (%)	Number of days taken for first germination (days)	Number of days taken for completing germination (days)
P_0	20.50	32.00	43.00
P_1	43.83	14.00	28.75
P_2	39.67	19.75	32.25
P_3	33.16	24.25	36.25
C.D.	5.080	1.770	1.590
S.E(m)	1.631	0.568	0.510

The Mean germination time was differ significantly in different treatments. Significantly lower mean germination time was recorded in the treatment P_1 (20.00 days), followed by P_2(25.00 days) whereas significantly higher mean germination time (35.79 days) was recorded in the treatment P_0 (control) (Figure 1). Pre-sowing treatments had significant influence on germination index. Significantly higher germination index (3.43) was recorded in the treatment P_1 (alternate wetting and drying for 12 hours done for 21 days) whereas lower germination index (0.85) was recorded in the treatment P_0 (control) (Figure 2).

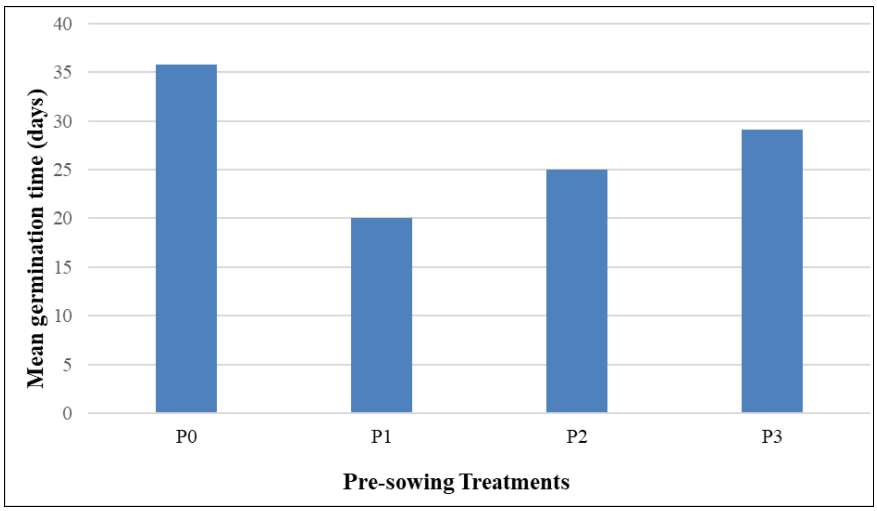

Fig 1: Effects of pre-sowing treatments on mean germination time (days) of Teak (*Tectona grandis* Linn. f.)

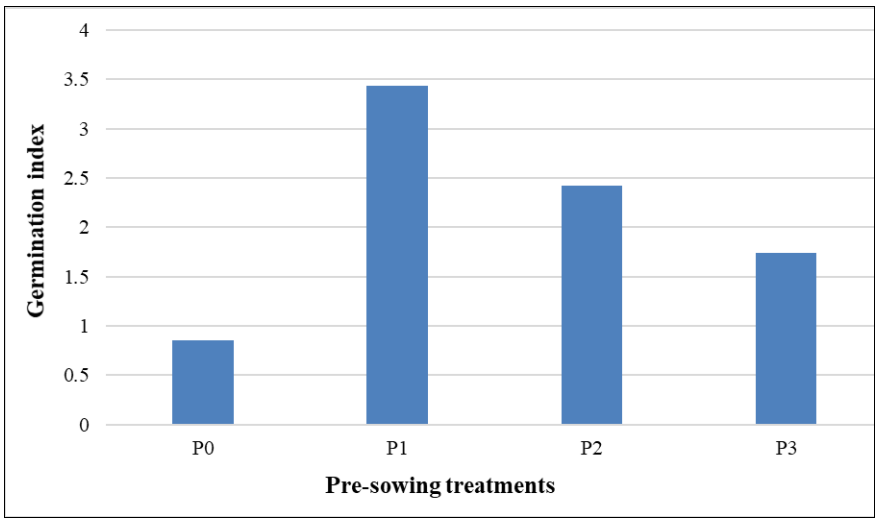

Fig 2: Effects of pre-sowing treatments on mean germination time (days) of Teak (*Tectona grandis* Linn. f.)

4. Discussion

The germination challenges of *Tectona grandis* adversely affect the quality of resulting seedlings when its seeds are sown untreated. Various authors have asserted that the implementation of different pre-sowing treatments can enhance the rate of germination and accelerate the overall germination process. (Teketay, 1996; Alamgir and Hossain, 2005 and Azad *et. al*., 2010) [21, 1, 3]. Similarly, the findings in the current study also showed that seeds of *Tectona grandis* under different pre-sowing treatments ensured better germination attributes *viz*. Germination percentage, Number of days taken for first germination and completing the germination, Mean germination time and Germination index.

The study showed that maximum germination percent (43.83%), Minimum Number of days taken for first germination (14.00) and completing the germination (28.75) was observed in P_1 followed by P_2. The maximum germination percent in alternate wetting and drying of 12 hours done for 21 days may be due to seeds soaking in water helped in softening the seed coat facilitate imbibition of water. These results are parallel to those reported by Saini *et. al*., (1999) [20] who reported that Teak (*Tectona grandis*) seeds treated with alternate soaking in fresh water for 72 hours exhibits good germination compared to control. The minimum number of days taken for first germination and complete the germination was recorded in alternate wetting and drying (12 hours) for 21 days (P_1). This may be due to expansion of cells during wetting and contraction during drying which leads to weathering of the seed coat, which could have facilitated the imbibition process. These results are in conformity with the findings of Pamei *et. al*., (2017) [19] in Teak, also noted that seeds treated by alternating wetting and drying (12 hrs) for 8 days recorded minimum number of days taken to initiate and complete the germination whereas control record maximum number of days taken to initiate and complete the germination.

Mean germination time is defined as the measure of rate and time spread of germination (Bewley *et. al*., 2013) [7]. As lower the mean germination time, faster the germination. The result of the mean germination time showed that significantly lower mean germination time (20.00 days) was recorded in alternate wetting and drying (12 hours) for 21 days (P_1) as compared to other treatments. Alternating hydration with dehydration involves a physical action that can be associated with scarification. This action results in rupture of covering layers, caused by the successive increase and decrease in seed volume (water gain and loss, respectively). Rupture of the seed coat allows water intake by the different seed covering layers (e.g., Testa and Endosperm) and seed embryo expansion (Kucera *et. al*. 2005) [10]. Uptake and loss of water result in loss of dormancy, perhaps due to reduction in germination-inhibiting hormones such as ABA in addition to the physical effect on the covering layers. By imbibing water, the seed embryo becomes biochemically active, synthesizing RNA, DNA and proteins. This leads to the emergence of the radicle which is considered as the completion of the germination process (Kucera *et al*., 2005) [10]. Likewise, similar results were elucidated by Veiga-Barbosa and Pérez-García (2014) [23] in *Plantago albicans*, N'Danikou *et. al*., (2015) [16] also noted that in *Vitex doniana* seeds treated by twenty-one days hydration – dehydration recorded minimum mean germination compared to control seeds recorded maximum mean germination time.

Germination index emphasizes on both germination percentage and its speed. Higher germination index value denotes higher germination percentage and rate of germination. (Bench Arnold *et. al*., 1991) [6]. The result of the germination index revealed that significantly higher germination index value (3.43) was found in alternate wetting and drying (12 hours) for 21 days (P_1). The study's results are in line with the observations made by Kumar (2016) [12] in Teak. Basra *et. al*., (2005) [5] in *Oryza sativa*.

5. Conclusion

The results of the present study unveiled that pre-sowing seed treatment plays a substantial role in advancing the germination process. Because of the hardness of Teak's seed coat, the germination process is prolonged, leading to a lower percentage of successful germination in nursery establishment. Despite this, the successful germination of the seeds can be ensured through the application of effective pre-sowing treatments. Out of the treatments administered in the experiment, seeds treated in alternate wetting and drying (12 hours) for 21 days (P_1) was found more effective in respect to faster germination, germination percentage and germination index. Seed germination under alternating wetting and drying is quite simple and cost-effective as it requires no particular equipment. Therefore, it can also be recommended for cultivation of *Tectona grandis* on a broad scale. The use of concentrated H_2SO_4 treatment is not advisable due to its high cost and the complications associated with its application at the local farmer level on a large scale. The study's findings will prove beneficial for nursery practitioners, offering insights into the influence of pre-sowing treatments on germination. This understanding allows them to implement these treatments effectively, resulting in the production of high-quality seedlings within a shorter time span.

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