EFFECT OF PRESOWING TREATMENTS ON *TECTONA GRANDIS* L. f. SEEDS AND INITIAL SEEDLING DEVELOPMENT IN THE NURSERY

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Abstract

Seeds of *Tectona grandis* L. f. were given eleven presowing treatments to study the germination and initial seedling growth in the nursery of the Institute of Forestry and Environmental Sciences, Chittagong University, Bangladesh. The results revealed that seeds soaked in concentration H_2SO_4 for seven minutes followed by cold water washing (T5) provide the highest germination (51.33%). This was followed by 48% and 44% germination in seeds treated with concentration H_2SO_4 for five minutes (T4) and soaking the seeds in cold water for 48 hours following wet pit storage for 12 days (T1) respectively. Significantly lowest germination (18.67%) was obtained for the control treatment (T0). Highest germination value (4.52) and germination energy (47.33) was also obtained for T5 treatment. Similarly, the seedling height, root length, collar diameter and leaf number followed the same trend of higher value of T5 and T4 treatments respectively following T1 treatments. Similar trends were also found in shoot, root and total seedling dry weight, seedling vigor index and seedling quality index.Therefore, presowing treatments of T5 and T4 (seeds soaked in concentration H_2SO_4 for seven minutes or five minutes followed by cold water washing) or, T1 (soaking the seeds in cold water for 48 hours following storage in wet pit for 12 days) may be recommended for the maximum germination and quality seedling production of *T. grandis* in the nursery.

Key words: Presowing treatment, germination, teak, seedling growth, quality index.

Tectona grandis L. f. popularly known as Teak (Family: Verbenaceae) is a large deciduous tree which is naturally distributed in Southeast Asia including most of Peninsular India, Myanmar, and parts of Loas and Thailand (Kadambi, 1972, Ryan 1982). Teak plantations were established in India as early as 1840 (Keogh 1979) and the plantations now extend in Southeast Asia, Australia, Africa and Latin America (White, 1991). The inherent good qualities of the timber, its early fast growth and the ease in plantation establishment make teak the most preferred species among users, foresters, farmers and private entrepreneurs in many countries (Indira and Basha. 1999). Its timber is used for heavy and light construction, furniture, boxes, boat building, flooring, fancy articles, laboratory fittings, joinery and turnery. It is virtually the most important tree species in tropical forestry and is extensively planted both as a native and as an exotic species (Kandya and Kandya, 1989).

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The fruit of teak is drupe and about 2 cm in diameter enclosed in a thick covering which contains 1-3, occasionally four true seeds (Jackson, 1994). The fruit is hard, irregular, and globose. The drupes retain their viability for a long time, and may lie dormant on the forest floor for many years. The germination under nursery conditions is relatively low (25-35%) and sporadic and causes a large variation in both quantity and quality of seedlings in nurseries (Keiding, 1985). Thus, many methods have been recommended to accelerate and improve germination of teak seeds. Bourke (1914) concluded from observation that teak seed germinates better even without any pretreatment, after storing for one or two years that do the freshly collected seeds. Another methods is to scorch the seeds in a light running fire of dry leaves or grass on earth (Tuggerse, 1925a). Tuggerse (1925b) also described alternate soaking and baking method, the method of burying the seeds for a specific period in the earth. Chaturvedi (1942) described the success of his experiments on alternate wetting and drying the teak seeds in a seedbed. Gopal *et al.* (1972) investigated removal of mesocarp and soaking the seeds in a nutrient solution or in water to enhance the germination capacity. Suangtho (1980) did a number of experiments on teak seeds germination and concluded that good germination could be obtained by heat treatment of the seeds before sown, either for 1-2 weeks at 50°C, or for a few hours to 48 hours at 80°C.

Treatment of teak seeds to promote germination was not deemed necessary inTrinidad (Lamb 1957). In Thailand seeds were soaked in running water for 3 days before planting (Kushalappa, 1977). Seed pretreatment using six combinations of soaking and drying regimes indicated that soaking in standing water for 48 hours followed by alternate soaking and drying on a 12 hours cycle provides the best germination (Muttiah, 1975).

Teak was introduced in the plantation forestry in Bangladesh in 1871 and the species is a demanding one owing to its timber value but the poor germination discouraged the foresters and farmers in the large-scale plantation programmes of the species. Thus, the experiment is an initiative to determine the maximum germination and healthy seedling production procedures of teak in the nursery and to disseminate the results among plant growers at public and private sector.

Materials and Methods

Study site and growing media

The experiment was carried out in the nursery of the Institute of Forestry and Environmental Sciences, University of Chittagong, Bangladesh. The seeds were sown and grown in the soils collected from the forest areas of University Campus. The soil was sieved well (<3 mm) and mixed with decomposed cow dung in a ratio of

3:1 and laid on the cemented ground. All treated seeds of *T. grndis* were sown in random plots in the growing media.

Fruit collection and seed extraction

Fruits of *T. grandis* were collected from the plus trees of the University Campus. All fruits were dried in the sunlight and stored in airtight polybags till the treatments were given. Seeds were extracted from fruits by removing felty covering. Uniform seeds were taken for treatments from the lots to reduce non-treatments variation as seedling vigor was found positively correlated with seed size (Bonner, 1987).

Experimental design and treatment combinations

A randomized complete block design with three replicates was adopted for the study. A total of one thousand and six hundred fifty seeds were subjected to eleven different presowing treatments. Three replications of each treatment consisted of one hundred and fifty seeds, which were directly sown in the nursery at equal depth and 10 cm apart from each other. The presowing treatments used in the experiment are as follows:

T1	:	Control (seeds provided no treatment)
T1	:	Soaking the seeds in cold water for 48 hours following stored in wet pit for 12 days.
T2	:	Soaking the seeds in cold water for 48 hours following alternate soaking and drying at sun light for 12 hours cycle for seven days.
T3	:	Soaking the seeds in concentration H_2SO_4 for 2 minutes followed by cold water washing
T4	:	Soaking the seeds in concentration H_2SO_4 for 5 minutes followed by cold water ashing
T5	:	Soaking the seeds in concentration H_2SO_4 for 7 minutes followed by cold water washing
T6	:	Soaking the seeds in KNO_3 (5%) for 5 days
T7	:	Soaking the seeds in KNO_3 (10%) for5 days
T8	:	Soaking the seeds in Thiourea (1000 ppm) for 5 days
T9	:	Soaking the seeds in Thiourea (2000 ppm) for 5 days
T10	:	Cracking the seeds with hammer

Assessment of *T. grandis* seeds and seedlings

The effects of pre-sowing treatments were assessed periodically through counting germination and initial growth performance of the seedlings. The

germination was recorded daily from the date of sowing and continued upto last germination. The seedlings were allowed to grow altogether for five months. At the end of the experiment, five seedlings from each replicate were randomly selected and uprooted very carefully to estimate the seedling biomass. The seedlings were then separated into its shoot and root components. Shoots and roots were oven dried at 70°C for 48 hours and its weight was measured until the constant weight was obtained. Data were statistically analyzed for study the morphological growth variation under different presowing treatments.

Daily and cumulative germination counts

Germination counts were recorded everyday until the germination ceased. The seed germination criterion was visible protrusion on the surface of soil at least 0.5 cm of the cotyledon and hypocotyle of the seedlings. For each presowing treatment and each assessment date, daily germination percentages were summed upto obtained cumulative germination percent.

Germination phase, germination energy and germination value

The imbibition period (the number of days from sowing to commencement of germination) was recorded. The germination energy, defined as the germination percentages when the mean daily germination (cumulative germination percent divided by the time elapsed since sowing date) reached its peak, was also determined. Germination energy is also a measure of the speed of germination and hence, it is assumed as a measure of the vigor of the seed and of the seedling it produces. In addition, germination value (GV) which is a composite value that combines both germination speed and total germination provides an objective means of evaluating the results of germination test was calculated using the formula of Djavanshir and Pourbeik (1976).

$$GV = \left(\frac{\Sigma DGs}{N}\right)\frac{GP}{10}$$

where,

GV	=	Germination value
GP	=	Germination percentage at the end of the test
DG	=	Daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing
ΣDGs	=	The total germination obtained by adding every DGs value obtained from the daily counts.
N	=	The total number of daily counts, starting from the date of first germination
10	=	Constant

Seedlings vigor and quality index

The total height (from the soil surface to seedling tip) of each seedling in each sub-plot was measured using a ruler to the nearest 0.1 cm to assess the seedling vigor of the experiment. Vigor Index was calculated according to Abdulbaki and Anderson (1973) as germination percent X seedling total length i.e. total shoot and root length. Quality index to quantity seedlings morphological quality was calculated after Dickson *et al.* (1960).

$$QI = \frac{\text{Total Dry Weight (g)}}{\left[\frac{\text{Height (cm)}}{\text{Collar dia (mm)}}\right] + \left[\frac{\text{Shoot dry weight (g)}}{\text{Root dry weight (g)}}\right]}$$

Results and Discussion

The highest germination (51.33%) was observed in T5 followed by T4 (48%) and T1 (44%) treatments (Table 1). Significantly ($P<0.05$) lowest germination (18.67%) was observed in treatment T0. The cumulative germination percent of treatment T5 rises sharply from the 15th day to 45th day and remains constant upto 60th day (Fig.1). The next highest cumulative germination (%) was found in T4 and T1 treatments respectively, whereas the lowest value was found in T0 treatment.

Table 1. Effect of different presowing treatment on germination, imbibition, germination values and germination energy of *T.grandis* seed

Treatment	Germination (%)	Imbibition (days)	Germination value	Germination energy
T0	18.67 f*	19 ab	0.65	16
T1	44 abc	13.33 b	3.12	38
T2	40.67 abcd	18 ab	2.77	38.67
T3	24 ef	21.33 a	0.98	20.67
T4	48 ab	16 ab	3.07	41.33
T5	51.33 a	14 b	4.52	47.33
T6	28.67 def	19.33 ab	1.32	24
T7	32 cde	19 ab	1.48	29.33
T8	35.33 bcde	18 ab	2.05	32
T9	39.33 abcd	17.33 ab	2.36	32
T10	40 abcd	14.66 ab	2.48	31.33
F	6.08	1.40		
P	0.00	0.241		

* = Means followed by the same letter(s) are not significantly different at $P < 0.05$, Duncan's Multiple Range Test (DMRT)

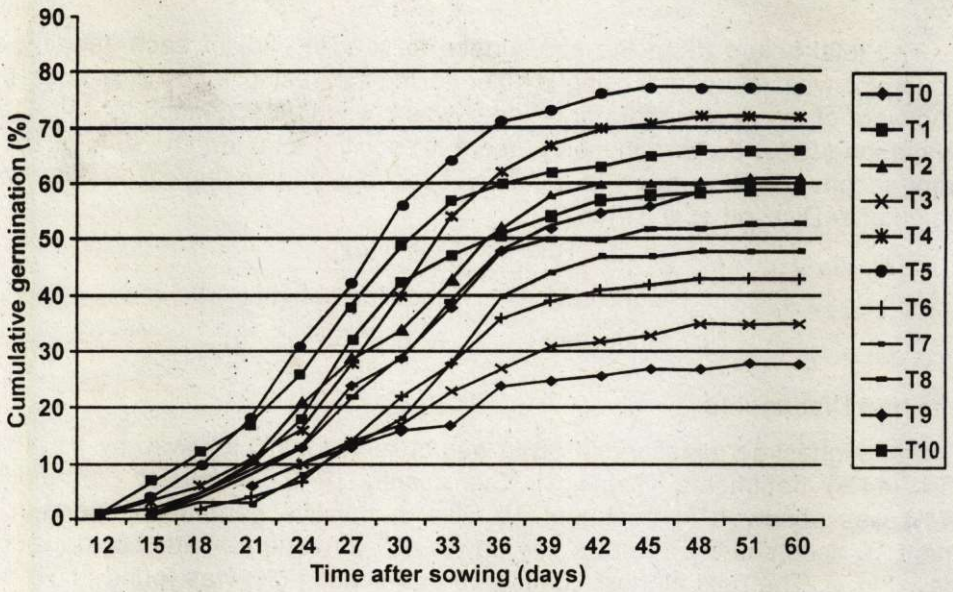

Fig.1. Effects of different pre-sowing treatments on cumulative germination percent of *Tectona grandis* seeds.

Pre-sowing treatments had significantly different effects on seed imbibition. The imbibition period was shortest in T1 (13.33) but was not significantly different from other treatments except T3 (Table 1), whereas highest imbibition was found for 21.33 days in treatment T3. Germination value was highest (4.52) for treatment T5 followed by T1 (3.12) but germination energy was highest (47.33) in T5 followed by T4 treatment (41.33).

Seedling morphological growth

Seedling morphological growth, like height, root length, collar diameter and number of leaves in seedlings were significantly different among the pre-sowing treatments grown in the nursery (Table 2). The mean height of the seedlings was found to be highest (71.66 cm) in T4 followed by T5 (70.66 cm) and T1 (67.66 cm) treatment (Table 2). The lowest (32.33 cm) height was found in T3 treatment. Considering the collar dia of the seedlings, T5 has highest collar dia (18.76 mm) followed by T4 (17.86 mm) and is significantly different from T0, T3, T6, T7 and T8 treatments. Similarly, the mean number of leaves were highest (18) in T5 and T4 treatments and significantly ($P<0.05$) different from T0, T30, T6, T7 and T8 treatments (Table 2).

Table 2. Effect of pre-sowing treatments on height, root length, total length, other diameter and number of leaves of *T. grands* seedlings in the nursery

Treatment	Height (cm)	Root length (cm	Total length (cm)	Collar dia (mm)	Leaf number
T0	34.66 cd*	34.33 d	69 d	8.83 c	12.66 e
T1	67.66 ab	68.66 ab	136.33 a	17.42 a	17.33 ab
T2	60 abc	63.33 ab	123.33 ab	16.37 a	16.33 abc
T3	32.33 d	35 d	67.33 d	7.26 c	12.66 e
T4	71.66 a	72.66 ab	144.33 a	17.86 a	18 a
T5	70.66 ab	74 a	144.66 a	18.76 a	18 a
T6	44.33 bcd	38 d	82.33 cd	10.30 bc	13.33 d
T7	46.33 abcd	43.60 cd	90.bcd	9.46 c	14.66 cd
T8	58.33 abcd	55.66 bc	114.abc	15.67 a	15.33 bcd
T9	64.66 ab	65 ab	129.66 a	17.03 a	16.66 abc
T10	54.33 abcd	59 abc	113.33 abc	14.76 ab	17.abc
F	2.98	8.13	5.55	5.89	7.11
P	0.01	0.00	0.00	0.00	0.00

* = Means followed by the same letter(s) are not significantly different at $p < 0.05$, Duncan's Multiple Range Test (DMRT).

Dry matter production, vigor index and seedling quality index

The oven dry weight of the seedling components (shoot and root) of different treatments was statistically analyzed (Table 3). Mean shoot dry weight (g) and root dry weight (g) of the seedlings were highest for T5 treatments (Table 3). In case of total seedling dry weight, T5 attained the highest (99.10 g) biomass followed by T4 (97.58 g) and T1 (96.76g). Control treatment (T0) attained the lowest seedling dry weight (16.68 g).In case of vigor index, T5 attained the highest value followed by T4 and the lowest value for T0 (Table 3). Similarly, T5 attained the highest seedling quality index (15.91) followed by T4 (15.18) and significantly different from T0, T3 and T7 treatments.

Generally the legume seeds with hard seed coats are reported to enhance germination with presowing treatments (Doran *et al.* 1983, Kariuki 1987, Napier 1987, Palani *et al.*, 1996). If untreated, the drupes germinate slowly and irregularly often over a period of a year or more (Jackson 1994). However, the findings of the present study show that teak seeds treated with concentration H_2SO_4 increased germination, seedling growth and it is higher in comparison to the control treatments. However, Chaturvedi (1942) has described the successful germination on alternate wetting and drying the teak seeds. The results also support the findings of Chacko *et al.* (1991) and Tewari (1992) that soaking the seeds in water and drying them in the sun or partial shade for weeks time provides successful germination of teak seeds.

Table 3. Effect of pre-sowing treatments on shoot dry weight, root dry weight, total dry weight, vigor index and quality index of *T. grandis* seedlings in the nursery

Treatment	Shoot dry wt (g)	Root dry wt (g)	Total dry wt (g)	Vigor index	Quality index
T0	12.13 c*	4.55 c	16.68 c	1316 g	2.46 c
T1	70.47 a	26.28 ab	96.76 ab	5885.33 bc	14.86 ab
T2	67.68 ab	25.83 ab	93.52 ab	4772 cd	14.56 ab
T3	10.20 c	3.50 c	13.70 c	1638 fg	1.88 c
T4	70.31 a	27.26 a	97.58 a	6972 ab	15.18 ab
T5	71.51 a	27.58 a	99.10 a	7436 a	15.91 ab
T6	21.68 bc	8.87 abc	30.55 bc	2414 fg	4.44 abc
T7	16.01 c	7.79 bc	23.80 c	2876 ef	3.40 bc
T8	46.32 abc	17.51 abc	63.89 abc	3980 de	10.02
T9	56.13 abc	21.32 abc	77.46 abc	5088 cd	12.21 abc
T10	53.91 abc	25.4 ab	79.31 abc	4445.33 cd	15.16 ab
F	2.98	2.94	3.01	17.45	2.67
P	0.01	0.01	0.01	0.00	0.02

* = Means followed by the same letter(s) are not significantly different at $p < 0.05$, Duncan's Multiple Range Test (DMRT).

Conclusion

In the present study, seeds soaked in concentration H_2SO_4 for 7 minutes and 5 minutes provided significant higher germination percentage, highest seedling growth, biomass production and seedling quality index in comparison to control treatment. Therefore, these acid treatments may be recommended for the experimental or small-scale seed germination and seedling production programmes. But, considering the commercial aspects, availability and risk of using concentration H_2SO_4, seeds soaking in cold water for 48 hours following stored in wet pit for 12 days is recommended for the large-scale seed germination and seedling growth programmes.

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