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Assessment of seed germination and growth performances of *Tectona grandis* L. in the seedbeds and polybags under the same environmental conditions

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ABSTRACT

Forests play a vital role in improving the environmental conditions of any country in the world. Tree species are the dominant resources of forests. Fermented and mature seeds are important for increasing tree species in forest areas. The tree resource of forests relies on seed quality and germination. The objective of the present study is to assess the germination percentage and growth performances of Tectona grandis L. in two different media under the same environmental conditions. Seeds were collected from selected mother trees and sown in five seedbeds and polybags. Germination percentages of seeds of the seedbeds and polybags were 58% and 75%, respectively. Germination percentage and growth performances significantly differed ($p<0.05$) in different media. The germination periods were 12-50 days in the seedbed and 10-30 days in the polybags. The average root length and shoot length varied from 3.30 to 14.51 and 6.84 to 29.40 cm, respectively. The higher root length and shoot length were found in the polybags. The study revealed a higher vigour index (3293) in the polybags. The study indicated that the polybags had more collar diameters (5.97 cm). The study revealed that surviving rate of seedlings was 65, 67, 70 and 76 in the seedbed and 72, 75, 77 and 80 in the polybags at 3, 6, 9, and 12 months old, respectively. Finally, all kinds of developing parameters indicated that the seedlings of the polybags were better than the seedbed. So, polybags can be selected for raising seedlings of Tectona grandis in suitable tropical regions of the world.

Key Words: *Tectona grandis;* Seeds; Germination rate; Survivability; Vigour index and Growth performances

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I. Introduction

Tectona grandis L. is a large deciduous forest tree species belonging to the family Verbenaceae. Normally, *Tectona grandis* attains up to 50 meters in height with 2.50-5.00 meter diameter (Hossain,

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2015). The bole is straight clear and brown. Leaves simple, opposite decussate and inflorescence is terminal. Flowers pedicelled, pedicels 2-3 mm long. Fruit is drupe 1.20-1.80 cm long and wide. *Tectona grandis* sheds leaves in winter (December to February) and remains leafless from February to March. New leaves appear from April to May and depend on edaphic conditions, location and climatic factors. The flowering season varies from June to August or September. The fruit ripens from November to January and fall gradually. *Tectona grandis* is indigenous to the South Asian and Southeast Asian regions. *Tectona grandis* was first introduced in Bangladesh in 1871 from Myanmar. It was the first artificial plantation program with the help of *Tectona grandis* in the Indian Sub-continent and the place was selected at Kaptai under Rangamati Hill tracts District of Bangladesh. Subsequently, its plantation was developed in the greater Hill Tracts district, such as Rangamati, Bandarban and Khagrachhari districts and other places in Bangladesh. *Tectona grandis* is the dominant forest tree species in hill forest areas of the country.

The commercial name of *Tectona grandis* is teak. Teak grows in warm and moderately moist tropical conditions. The optimum yearly rainfall range is about 1500 to 2000 mm (Kadambi, 1972). It tolerates a wide temperature variation ranging from 0-48°C (Troup, 1921). Alluvial soils and neutral or slightly acidic soil are preferable for teak growing (Seth and Khan, 1958). *Tectona grandis* is one of the most valuable timber tree species in Bangladesh. Timber is much valued for furniture, construction purposes and shipbuilding (Das and Mohiuddin, 2001). Teak is a model wood for air seasoning. The bark is used as an astringent. Roots, flowers and bark are used to treat bronchitis. The leaves yield an olive or yellow dye which is suitable for dying silk. Wood power in plaster form is used to relieve severe headaches, piles and is also used as vermifuge, while oil extracted from seeds is used for hair growth and in the treatment of skin diseases like scabies (Kirtikar *et al.*, 1935). Flowers are used for the treatment of biliousness, bronchitis and urinary disorders. Flowers and seeds are also used as diuretics. The oil from the seed is reported to promote growth of hair. Leaves contain yellows or red dye recommended for dyeing silk, wool and cotton. The bark is a good source of oxalic acid and black liquid tar is collected from heartwood, which is applied to sores in cattle (Tewari, 1992).

Tectona grandis is famous for its wood quality. The main purpose of teak plantations is wood harvesting. The whole parts of *Tectona grandis* are used in various ways due to their multipurpose uses. *Tectona grandis* is the most important forest tree species in Bangladesh and its demand is increasing day by day at the geometrical rate. Teak is one of the most popular well adapted forest tree species in the hilly regions of Bangladesh. But, poor germination is the main obstacle to massive plantations nationwide. So, the higher germination percentage is essential for seedling production of teak, which helps in the massive plantation. Seedlings are converted into stumps and planted to develop trees. It is most important to innovate techniques for the higher germination of teak. Therefore, an attempt has been made to investigate the assessment of germination percentage and growth performances in the seedbeds and polybags.

II. Materials and Methods

The study area

The study was conducted in the Bangladesh Forest Research Institute (BFRI) nursery, Sholashahar, Chattogram, Bangladesh, under Seed Orchard Division from January 2021 to December 2022. Geographic position of the study area is situated between 22°22′27" and 22°22′27" North latitudes and 29°46′30" and 29°46′30" East longitudes. The climate of the study area is tropical and characterized by hot, humid summer and cool, dry winter. The maximum and minimum temperature in the area varies from 28.30 to 31.90 °C and 15.20 to 25.20°C, respectively (Hossain and Arefin, 2012). Mean annual rainfall is around 3000 mm, mainly from June to September.

Seeds collection and sowing in seedbeds and polybags

Seeds were collected in the middle of January 2021 from 30-35 years old mature mother trees from Kaptai National Park of Rangamati Hill Tracts district. Then, the seeds were dried in sunlight for 7days and stored in air-tight polybags. Shrinkage, discolored and damaged seeds were separated from collected seeds and only healthy seeds were used for the experiment. The calyx is removed by rigorous rubbing and winnowing. Its fruit varies from 15000-2000 per kilogram. The fruits can be stored in gunny bags and sealed tins for up to 2 years. The seed viability varies from 40-85 % and gradually degraded. Germination behaviour causes a large variation in both quality and quantity of seedlings in

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nurseries (Keiding, 1985). Hard seeds need pre-sowing treatment. Pre-sowing teak seed treatment has improved germination (Tewari, 1992). Seed treatment by pit method is widely used in Bangladesh. Other methods are alternatively soaked and dried at intervals of 24 hours for 2-3 weeks. Another method is soaking the fruits in running water for 48 hours. Soaking the seeds in water at night, drying them in the sunlight during the day and repeating the process for a few weeks has been recommended for successful germination. In Bangladesh, the popular pre-sowing treatment is the pit process, where the seeds are rotten in a pit for few days with sufficient moisture (Hossain *et al*., 2001). Pit method was followed in the present experiment. The soil and cow dung ratio was 3:1 by volume in the seedbed and polybags. Seeds were sown in the seedbeds and polybags at 0.50- 1.00 cm depth. The sizes of polybags were 9×12 cm. Four seeds were sown in each polybag and arranged in the nursery beds.

Experimental design

Experiments were conducted in Completely Randomized Design (CRD) with five replications. Two treatments were applied to assess their effects on seed germination and seedlings growth attributes. The treatments were i) seedbeds and ii) polybags. In each replication, five hundred (500) seeds were sown and 1000 seeds were used for germination trials in the seedbed and poly bags of the nursery. Watering and weeding were carried out manually when necessary.

Seed germination and seedling growth performance in seedbeds and polybags

The number of seeds germinated in each treatment was recorded regularly. The starting and closing dates of germination and other parameters were also measured. Germination percentage estimates the viability of a population of seed. The number of seeds germinating each day in each replication of treatments was counted to calculate the germination percentage (Kumar, 1999; Almodares *et al.*, 2007). Collar diameter and seedling vigour index were also calculated (Baki & Anderson, 1973). Growth performance was estimated by measuring root length and shoot length. Three, six, nine and twelve months old ten seedlings from each replication were selected for measurement. The collar diameter was also measured from the same seedlings. The collar diameter was measured at the collar region, transitional zone between root and shoot of the seedlings with a vernier calliper. Shoot length was measured from the collar region to the shoot tip of the seedlings. Root length was measured from the lower region of the collar and the total length of ground parts.

Statistical analysis

Statistical analysis of data was done using the computer software package Statistical Package for the Social Sciences (SPSS) version 21. The analysis of variance (ANOVA) was studied by applying Duncan's Multiple Range test (DMRT).

III. Results

Germination is one of the most critical processes for seedlings development. Typically, higher viability is found in orthodox seeds and germination capacity gradually decreases day by day. *Tectona grandis* is an orthodox seed and contains a hard seed coat. The present study indicated that germination behaviour varied between different media, such as seedbeds and polybags. The higher germination percentage was found in polybags at 75% than in seedbeds at 58%. Germination periods were 10-30 and 12-50 in polybags and seedbeds, respectively. The present study indicated that germination behaviour varied in different media, such as seedbeds and polybags. The higher germination percentage was 75% in polybags than in seedbeds, which was 58%. Germination periods were 10-30 and 12-50 in polybags and seed beds, respectively. It was mentioned that the germination period was also lower in polybags compared to seedbeds (Table 01). Seed germination was started 10 days after sowing and continued up to 30 days in the polybags. Again, seed germination started 12th day after sowing and continued up to 50 days in the seedbeds (Table 01). The germination percentage in the seeds sown in the polybags was significantly ($p<0.05$) higher than in seedbeds.

Table 01. Germination period and germination percentage

Seedbeds		Polybags	
Days	**Germination (%)**	**Days**	**Germination (%)**
12-50	58	10-30	75

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Growth was essential for developing sustainable forest plantations and growth was variable in different media. The root length and shoot length of seedlings of the polybags were 3.89, 5.35, 11.21, 14.51 7.42, 16.10, 23.60 and 29.40 cm at 3, 6, 9 and 12 months old, respectively (Table 02). The root length and shoot length of seedlings of the seedbeds were 3.30, 5.10, 9.30, 13.45, 6.84, 13.90, 19.60 and 27.80 cm at 3, 6, 9 and 12 months old, respectively. (Table 02). The present study indicated that higher root and shoot length were found in the seedlings of the polybags. The vigour index was one of the most important indicators for healthy seedlings. It was calculated based on the germination percentage and average value of root and shoot length. The study revealed that a higher vigour index was also found in the seedlings of the polybags (Table 02).

Table 02. Variations of root length, shoot length and vigor index at different ages in the nursery

Months	Seedbeds			Polybags		
	Average root length (cm)	Average shoot length (cm)	VI	Average root length (cm)	Average shoot length (cm)	VI
3	3.30±.14	6.84±0.05	588	3.89±0.04	7.42±0.11	848
6	5.10±0.29	13.90±0.08	1102	5.35±0.09	16.10±0.06	1609
9	9.30±0.21	19.60±0.14	1676	11.21±0.11	23.60±0.13	2611
12	13.45±0.12	27.80±0.11	2393	14.51±0.08	29.40±0.10	3293

VI=Vigour index

Seedlings survival rate at different media

After germination, seedlings were kept in the seedbed for about one year. In this case, some seedlings were died due to edaphic, pathogenic and other environmental factors which were also common scenarios of the nursery levels of Bangladesh. The study revealed that 65, 67, 70 and 76% of surviving seedlings were found in the seedbeds and 72, 75, 77 and 80% of surviving seedlings were also found in the polybags (Figure 01). The polybags at different ages, such as 3, 6, 9 and 12 months seedlings, had a higher survival rate. The survivability of seedlings also indicated that more survivability was found in the polybags.

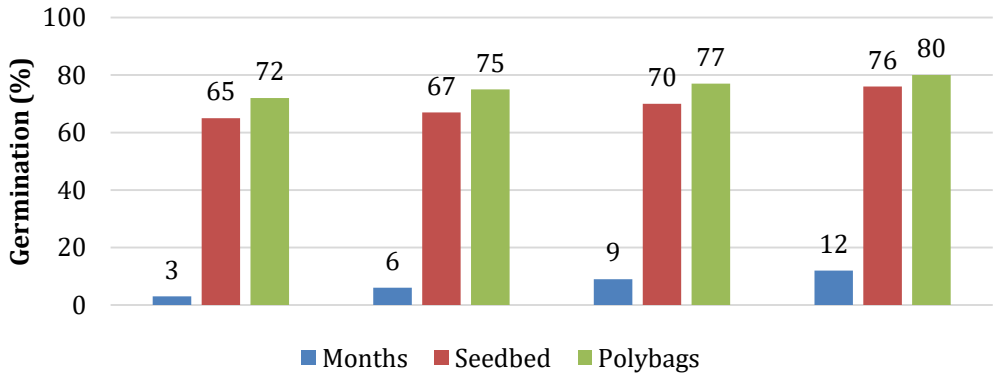

Figure 01. Variations of seedlings survivability in different media.

Collar diameter measurement

The collar diameter is the most important indicator for healthy seedlings. The collar diameter in the seedlings of the polybags were 1.13, 2.17, 3.10 and 4.90 cm at 3, 6, 9 and 12 months old seedlings, respectively (Figure 02). The collar diameter varied from 1.13 to 4.90 cm in the seedlings of the seedbeds. The collar diameters of the seedlings of the seedbeds were 1.63, 2.67, 3.49 and 5.67 cm at 3, 6, 9 and 12 months old, respectively. The range of collar diameter among the seedlings of the polybags was 1.63 and 5.79 cm. The higher collar diameter was found in the seedlings of the polybags at 3, 6, 9 and 12 months old, respectively.

IV. Discussion

Tectona grandis is one of the most suitable forest tree species in the hilly regions of Bangladesh, such as Rangamati, Bandarbans, Khagrachhari and greater Sylhet districts. Typically, at completion of pit method, seeds were sown in the seedbeds for germination. Several authors have argued that different pre-sowing treatments enhance the germination rate and speed up the germination process (Azad et

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al., 2010). Some findings revealed that seeds of *Tectona grandis* under different treatments ensured better germination periods, germination percentages and values. The present findings of the study revealed a great significant difference between the germination percentage and growth performances of seedlings of the seedbeds and polybags. Several scientists reported that seed germination and growth performances were influenced by different pre-sowing treatments such as *Vitex glabra, Garuba pinnata* and *Canarium resiniferum* (Hasnat et al., 2017; Hossain et al., 2018).

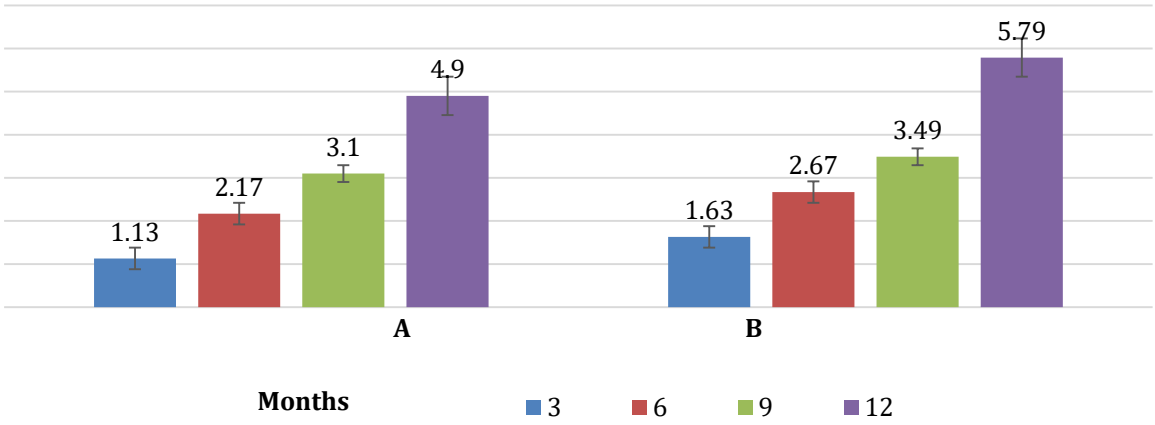

Figure 02. Collar diameter at different ages in seedbeds (A) and polybags (B)

Naturally, the hard coat of teak seeds tends to protect germination in the interior parts of the seeds, which results in slower and more unsuccessful germination. Another study experimented with pre-sowing treatment of *Xylia kerrii* seeds in Bangladesh and found a higher germination rate (Azad et al., 2006). The study's results revealed a vital role of seedbeds and polybags treatments on *Tectona grandis* seeds in enhancing germination and growth performances. Germination behaviour varied between two different media. The present study indicated that pre-sowing treatment is essential for hard coat of seeds and sowing media also play a vital role in improving germination percentage and initial growth performances. Therefore, seeds sown in the polybags after pre-sowing treatment are highly recommended for maximum seed germination in shorter period. As it is cost-effective, seeds sown in polybags are recommended for large-scale seed germination of *Tectona grandis*.

V. Conclusion

Seeds germination percentage, seedlings survivability, collar diameter, root length, shoot length and vigour index were significantly affected by two different media of *Tectona grandis*. *Tectona grandis* is the most dominant and popular forest tree species in Bangladesh due to its wood quality. Its massive plantation is increasing daily, fulfilling wood demand and people have also agreed to increase plantation with teak species due to their greater adaptability to different environmental conditions. The present results of the study recommended that nursery owners or other seedling producer organizations use polybags for the expected germination percentage, survivability, better seedlings and an excellent vigour index.

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