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Germination and Growth Performance of A Native Threatened Tree Species *Quercus gomeziana* A. Camus in Nursery Stage: Case of Bangladesh

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Abstract

This study was conducted to investigate the effect of different pre-sowing treatments of seeds on germination and growth performance of native threatened tree species *Quercus gomeziana* A. Camus at the nursery of Chittagong University, Bangladesh. Furthermore, seedling growth attributes under different doses of fertilizer (urea) was also experimented to find the best dose of fertilizer on this tree species at the nursery stage for better field level growth. Seeds were placed to six pre-sowing treatments e.g. control (PT_0), treated with sand paper rubbing (PT_1), nicking (PT_2), seeds immersed in cold water for 48 hours (PT_3), seeds immersed in cold water for 7 days (PT_4) and seeds sown at propagator house with increased temperature (PT_5). It was found from the study that germination was started earlier (at 31 days) in treatments sand paper rubbing (PT_1) and nicking (PT_2). The highest germination percentage (93%) was in PT_1 followed by 86% in seeds immersed in cold water for 7 days (PT_4) and 80% in PT_0 (control). Germination percentage was observed least (63%) in PT_2 even though germination started earlier. For fertilizer dose experiment to seedlings at the nursery level, treatment FT_1: 100 kg/ha (0.33679 g urea/pot/seedling) comparing with other treatments FT_0: 0 kg/ha (Control), FT_2: 200 kg/ha (0.67358 g urea/pot/seedling), FT_3: 300 kg/ha (1.01037 g urea/pot/seedling) showed better performance in case of collar diameter (6.74 mm), number of leaves, shoot dry weight (19.74), total dry weight (28.16 g), total fresh weight (67.96 g), volume index (3904.82), sturdiness (127.69). Finally, it can be concluded that *Quercus gomeziana* seedlings revealed better performances under the treatment FT_1 in growth and biomass production. Findings of this study will be helpful to take decision on organic fertilizer dose application to seedlings of *Q. gomeziana* for large scale plantation and conservation of this species.

Key Words: *Quercus gomeziana*, pre-sowing treatments, germination, quality index, volume index

Introduction

Quercus gomeziana A. Camus. (locally known as Dholia-batna, Goorja-batna, Sil-batna) is an important timber species belonging to the family of Fagaceae. Worldwide, there are more than 1,000 species belonging to the Fagaceae. All Fagaceae species are woody plants and are spread throughout the northern hemisphere, from the tropical to the boreal regions. The family comprises seven genera (Govaerts and Frodin 1998), and the number of species is extremely variable among genera: Castanea (12), Castanopsis (100 to 200), Chrysolepis (2), Fagus (11),

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Lithocarpus (300), Quercus (450 to 600), Trigonobalanus (3).Oaks (Quercus), chestnuts (Castanea), and beeches (Fagus) are widely used in forestry for wood products over the three continents (Asia, Europe, and America) and are important economic species. Consequently, they have received more attention in forest genetic research than other genera.

This species is naturally grown in tropical forest mainly in south east Bangladesh and Myanmar (Uddin 2009). In Bangladesh, this tree is naturally grown in Teknaf Wildlife Sanctuary located in the southeastern corner of Bangladesh and in Lawachara National Park, Sylhet. Normally the tree attains 25 m tall and 25 cm diameter at breast height. The wood is heavy and hard, suitable for construction works. The fruits are nut, depressed, lepidote-tomentose (Uddin 2009). Once the species was abundant in hill forests but are becoming very rare because of habitat destruction. Seeds possessed very hard seed coat that produces poor natural germination and ultimately the population of the species is becoming very poor in natural forests.

Ali et al. (1997), Hossain (1995) and Haider et al. (2014) conducted some research studies on pre-treatment effects of several plantation species in Bangladesh. But information of seed pre-sowing treatment and initial seedling growth performance of *Quercus gomeziana* for ensuring their early and successful germination is absent, but this is very essential for efficient nursery management and plantation establishment of this species. Through identification of best pre-sowing seed treatment, farmers will be benefitted as it may minimize their production cost of seedlings on a large scale. Moreover, effect of organic fertilizer on the growth of seedling of this species will be investigated to standardize the appropriate organic fertilizer dose (urea) at the nursery level. Finally, this study established a standard nursery technique of Sil-batna (*Quercus gomeziana*) for easy dissemination of the findings for private nursery growers and Forest Department.

Materials and Methods

The experiment was conducted in a propagator house and nursery located at the Institute of Forestry and Environmental Sciences, University of Chittagong (IFESCU) and at the Seed Research Laboratory of IFESCU, Bangladesh. Fruits of *Quercus gomeziana* were collected from the Ukhia-Teknaf reserve forest in August, 2017. After collection, the brownish seeds were dried for four days in open sun in order to reduce the moisture (Fig. 1).

Only healthy seeds were sown in polybags (15×10 cm) and propagator house. The media of the polybags was mixture of forest topsoil collected from forest floor and cow dung in a ratio of 3:1. The media used in propagator house was fine Sylhet sand. The experiment consists of six pre-sowing treatments with three replications (10 seeds per replication) in a randomized design. For each treatment, 30 healthy seeds were selected randomly and then provided with the treatments as follows:

PT_0: Seeds with no treatment and sown in polybag only (Control),

PT_1: Seeds treated with sand paper rubbing at distal end of the seed,

PT_2: Seeds treated with nicking/nail clipping at distal end of the seed,

PT_3: Seeds immersed in cold water for 48 hours,

PT_4: Seeds immersed in cold water for 7 days, and

PT_5: Seeds sown at propagator house with increased temperature

The effects of pre-sowing treatments were assessed periodically by counting germinated seeds. The germination was recorded daily from the date of sowing and continued till the germination ceased. The imbibition period (number of days from sowing to commencement of germination) and germination energy was recorded. In addition, germination value (GV) was also calculated using the formula of

Fig. 1. *Quercus gomeziana* seeds.

Djavanshir and Pourbeik (1976).

Germination value

GV= (DDGs/N)×GP/10

where DG is daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing.

DDGs is total germination obtained by adding DGs value obtained from the daily counts.

N is the total number of daily counts, starting from the date of first germination.

GP is Germination percentage at the end of the test and 10 as a constant.

Volume index and vigor index was calculated using the following formula:

Volume index

Volume index, (VI)=root collar diameter $(mm)^2$×shoot height (cm) (Manavalan 1990)

Vigor index

Seedling Vigor index (VI)=[seedling length (cm)× germination percentage] (Abdul-Baki and Anderson 1973)

The quality index (QI) as developed by Dickson et al. (1960) to quantify seedling morphological quality was calculated. Sturdiness of seedling was calculated using the following formula:

Sturdiness=Shoot height (cm)/Collar diameter (cm) of the seedling

Shoot growth

At the period of three months and six months of the experiment, five seedlings from each replication (15 seedlings in total) were measured for shoot height measurement.

Experimental design for fertilizer application

Second experiment under this study was set to investigate the effect of organic fertilizer (Urea) on the initial growth of *Quercus gomeziana* at the nursery for selecting the best fertilizer dose for field level plantation of this species. Only Urea fertilizer was used under this experiment for N fertility, because the soil under this experiment showed nitrogen deficiency and initially N enhance the seedling growth better than other fertilizers. A total of 120 healthy seedlings were selected from the first experiment to set up the fertilizer experiment. A randomized complete block design with four treatments (3 replications each) and ten (10) seedlings were used in each replicates. Before, fertilizer application, data on shoot height, collar diameter from the best ten (10) seedlings of each treatment was collected. Then different doses of fertilizers as different treatments were applied in April, 2018 to the selected seedlings. Watering was carried regularly by fine shower, which could not disturb the seedlings physically. Removal of weeds, grasses etc. were done as far as possible.

At the end of four months, again data on shoot height (cm) and collar diameter (mm) from the same seedlings/treatment were collected and then the seedlings were uprooted and separated into leaves, shoot and root components and were dried in electric oven at 70°C until the constant weight was obtained for studying biomass productions in different doses of fertilizer treatments. The following treatments were used as different doses of Urea fertilizer at the nursery:

FT_0: 0 kg/ha (Control), FT_1: 100 kg/ha=0.33679 g urea/pot/seedling, FT_2: 200 kg/ha=0.67358 g urea/pot/seed-

Table 1. Germination parameters of Sil-batna (*Quercus gomeziana*) seeds under different pre-sowing treatments

Treatments	Germination start (day)	Germination end (day)	Germination percentage (%)	Germination energy (%)	Germination value
PT_0-(Control)	51	146	80	43.33	2.15
PT_1-(Sand paper)	31	166	93.33	63.33	6.09
PT_2-Nicking)	31	166	63.33	40	2.50
PT_3-(Cold water, 48 hr)	32	165	76.67	63.33	3.07
PT_4-(Cold water, 7 days)	32	165	86.67	60	0.82
PT_5-(Seed in propagator house)	70	127	73.33	60	2.25

ling, FT_3: 300 kg/ha=1.01037 g urea/pot/seedling

Height of seedlings was taken from the ground level to the tip of the seedlings by using meter scales. Diameter at collar region of seedlings was measured at the ground level using slide calipers. After 120 days (4 months) of fertilizer application, seedlings were harvested and separated into root, shoot and leaf components. Finally, data on fresh weight (g) and dry weight (g) of each part of the seedling under four treatments were taken at the IFESCU laboratory. Data were statistically analyzed by using SPSS© and data were subjected to Duncan's Multiple Range Test (DMRT).

Results

Germination period and Germination percentage

Germination behavior of *Quercus gomeziana* seeds was significantly affected by immersion in cold water, sand paper rubbing and nicking (Table 1). Germination was started earlier (at 31 days) in seeds treated by rubbing with sand paper and nicking whereas seeds sown in propagator house took 70 days for initiation of germination (Table 1). Moreover, germination was started just after 32 days in seeds soaked in cold water for 48 hours and 7 days respectively. Germination of seeds continued up to 166 days in PT_1 and PT_2 (seeds treated by sand paper rubbing and nicking) but it took 165 days to complete germination in PT_3 and PT_4 (seeds soaked in cold water for 48 hours and 7 days). In addition, it was found that seeds sown in propagator house took 127 days to complete germination.

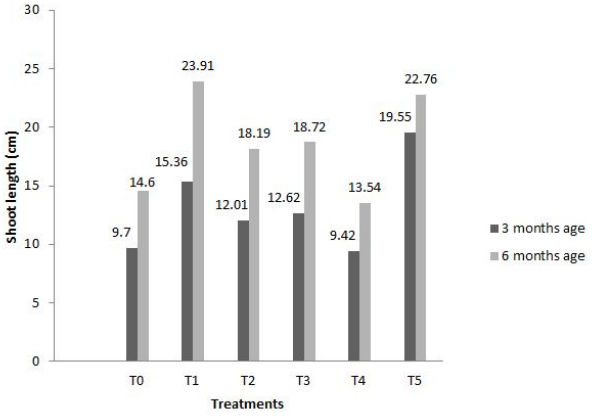

Fig. 2. *Quercus gomeziana* shoot growth in three and six month's age under different treatments

Therefore, it is evident from the study that there is no comparative results on days required for germination on seeds rubbed with sand paper (PT_1) and nicking (PT_2) and seeds immersion in cold water for 48 hours (PT_3) and 7 days (PT_4) but all the four treatments reduced the seed dormancy period (Table 1).

The highest germination percentage (93%) was observed in PT_1 (seeds treated with sand paper at distal end of the seed) followed by 86% in PT_4 (seeds immersed in cold water for 7 days) and 80% in PT_0 (Control), 76.67% in PT_3 (seeds immersed in cold water for 48 hours), 73% in PT_5 (seeds in propagator house) (Table 1). Germination percentage was least (63%) in PT_2 (seeds treated with nicking/nail clipping at distal end of the seed).

Shoot length

Highest mean shoot height (cm) after three months age of seedlings was observed in PT_5 (seeds in propagator house) (19.56 cm) followed by 15.36 cm in PT_1 treatment (seeds treated with sand paper at distal end of the seed), 12.62 cm in PT_3 , 12.01 cm in PT_2, 9.70 in PT_0 and 9.42 cm in PT_4 treatments (Fig. 2). After six months, highest mean shoot height (cm) of the same seedlings was recorded as highest 23.91cm in PT_1 (sand paper), 22.76cm in PT_5 (propagator house), 18.72 cm in PT_3 (cold water, 48 hr), 18.19 cm in PT_2 (nicking), 13.54 cm in PT_4 (cold water, 7 days) and 14.67 cm in PT_0 (control) (Fig. 2). Therefore, it is clear that highest mean shoot height in six months old seedlings at the nursery was observed in treatment PT_1 (sand paper rubbing).

Growth performance of the seedlings under different doses of fertilizer application

In case of the total length of seedlings, the value was highest (114.06 cm) in FT_1 (100 kg/ha=0.33679 g urea/pot/seedling) and lowest in FT_0 (28.46 cm). There was no significant variation among FT_1, FT_2 and FT_3 but FT_0 was significantly different ($p < 0.05$) from other treatments (Table 2). Collar diameter (mm) of seedlings was maximum (6.74 mm) in FT_1 (100 kg/ha=0.33679 g urea/pot/seedling) and lowest in FT_3 (300 kg/ha=1.01037 g urea/pot/seedling) but there was no significant difference among FT_0, FT_1, FT_2, and FT_3 treatments. Maximum leaf number was recorded in FT_1 (34.20) and minimum

Table 2. Effect of fertilizer treatment on shoot length, root length, total length, collar diameter, number of leaves, fresh weight of *Quercus gomeziana* seedlings at the nursery

Treatment	Shoot length (cm)	Root length (cm)	Total length (cm)	Collar diameter (mm)	No of leaves (no.)	Root fresh wt (g)	Shoot fresh wt (g)	Total fresh wt (g)
FT_0	58.40[b]*	28.46[a]	86.86[b]	6.57[a]	26.60[a]	17.94[a]	39.10[ab]	57.04[ab]
FT_1	84.70[a]	29.36[a]	114.06[a]	6.74[a]	34.20[a]	18.44[a]	49.52[a]	67.96[a]
FT_2	85.30[a]	27.84[a]	113.14[a]	6.00[a]	6.00[b]	17.28[a]	38.96[ab]	56.24[ab]
FT_3	81.00[a]	21.98[a]	102.98[ab]	5.62[a]	33.00[a]	15.34[a]	31.24[b]	46.58[b]

*Figures followed by the same letter(s) are not statistically significant at $p < 0.05$, DMRT test.

Table 3. Effect of fertilizer treatment on dry weight, quality index, volume index, root-shoot ratio and sturdiness of *Quercus gomeziana* seedlings in the nursery

Treatment	Root dry wt (g)	Shoot dry wt (g)	Total dry wt (g)	Quality index	Volume index	Root-shoot ratio	Sturdiness
FT_0	9.80[a]*	17.00[a]	26.80[a]	2.6644[a]	2536.09[a]	0.5879[a]	89.06[b]
FT_1	8.42[a]	19.74[a]	28.16[a]	1.9855[ab]	3904.82[a]	0.4262[a]	127.69[a]
FT_2	6.58[a]	16.84[a]	23.42[a]	1.3892[b]	3073.97[a]	0.4170[a]	143.78[a]
FT3	5.94[a]	13.94[a]	19.88[a]	1.2077[b]	2825.82[a]	0.4677[a]	144.14[a]

*Figures followed by the same letter(s) are not statistically significant at $p < 0.05$, DMRT test.

Fig. 3. *Quercus gomeziana* in field condition.

was in FT_2 (6). Highest shoot fresh weight (49.52 gm) and highest total fresh weight (67.96 gm) was found in FT_1 treatment which showed slightly different from FT_0 and FT_2 (Table 2).

Total dry weight (g) was found maximum in treatment FT_1 (28.16 g). The highest quality index was recorded in FT_1 (2.66) and it was slightly different from FT_1 (1.98). In case of quality index, FT_0 was significantly ($p < 0.05$) different from other treatments (Table 3). Besides, highest volume index (3904.82) was recorded in treatment FT_1 and no significant difference was observed among FT_0, FT_1, FT_2, and FT_3 treatments. Sturdiness was found maximum (144.14) in FT_3 and minimum (89.06) in FT_0. Greatest root-shoot ratio was found in FT_0 (0.5879) (Table 3).

The results of the present study demonstrate that *Quercus gomeziana* seeds, when treated with sand paper rubbing (PT_1) showed better in germination and other growth parameters and at the same time, with the fertilizer application dose of 100 kg/ha (0.33679 g urea/pot/seedling) , this species showed better biomass production. But it is also evident that with the increased dose of fertilizers, growth parameters of this seedling were reduced (Fig. 3).

Discussion

Findings from the study reveals that *Quercus gomeziana* seedlings, when treated with FT_1 (100 kg N ha^{-1}) shows better performances in growth and biomass production. These findings relate with the findings of Hoque et al. (2004) where it was observed that there was significant increase in height of seedlings of *Michelia champaca* after N

and P fertilization. Moreover, another study from Afa et al. (2011) demonstrates that Khaya ivorensis showed better growth parameter on application of organic and inorganic fertilizers and it was found that growth attributes were increased with the application of 75 mg urea that is added to the seedlings. This study is also related with the present study. In addition, another study on the effect of NPK fertilizer on growth of *Hopea odorata* (Telsur) seedlings found that N has significantly increased the seedling height, leaf and shoot dry matter production (Hossain and Hossain 2006). Moreover, further study on the response of four species of tropical timber seedlings to Urea and Folivert fertilizers in nursery revealed that plants treated with 3 g of urea produced the highest number of leaves in *Albizia zygia* seedlings (Andrew et al. 2018).

Moreover, there are several studies on improvement of growth performances of seedlings through application of organic fertilizers which is reported by Awang and Katim (1986), Zwierink (1984), Onuwaje and Uzu (1982), and Van den Driessche (1977) earlier. Furthermore, it is observed from the study that with the increased doses of fertilizers, growth parameters e.g. collar diameter (mm), total fresh wt (g), quality index, volume index was reduced. It means, FT_2 (200 kg/ha) and FT_3 (300 kg/ha) treatments reduced growth performance of *Quercus gomeziana* seedlings. It can be concluded from this study that 100 kg urea/ha is recommended for better growth perform ance of *Quercus gomeziana* seedlings.

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