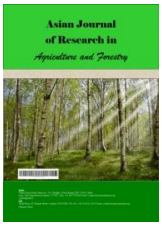

Asian Journal of Research in Agriculture and Forestry

4(4): 1-7, 2019; Article no.AJRAF.52498
ISSN: 2581-7418

Germination and Seedling Growth Response on *Lithocarpus elegans* (Fagaceae) Seeds to Pre-sowing Treatments and Fertilizer Application

Rajasree Nandi[1*], Soma Dey[1] and M. K. Hossain[1]

[1]Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong-4331, Bangladesh.

Authors' contributions

This work was carried out in collaboration among all authors. Author RN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author MKH approved the design and final draft of the study and author SD managed the analyses of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRAF/2019/v4i430067
Editor(s):
(1) Dr. Nebi Bilir Professor, Forestry Faculty, Isparta University of Applied Sciences, 32260 Isparta, Turkey.
Reviewers:
(1) Ana Maria Arambarri, La Plata National University, Argentina.
(2) Zdzisław Kaliniewicz, University of Warmia and Mazury in Olsztyn, Poland.
(3) Ali İhsan Kaya, Mehmet Akif Ersoy University, Turkey.
Complete Peer review History: http://www.sdiarticle4.com/review-history/52498

Original Research Article

Received 04 September 2019
Accepted 08 November 2019
Published 19 November 2019

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 *Lithocarpus elegans* at the nursery of Chittagong University, Bangladesh. Seeds were placed to eight pre-sowing treatments e.g. control (PT_0), treated with sand paper rubbing (PT_1), nicking (PT_2), seeds immersed in cold water for 24 hours (PT_3), seeds immersed in cold water for 48 hours (PT_4) and seeds immersed in cold water for 7 days (PT_5), seeds sown at propagator house (PT_6), seeds immersed in cold water for 7 days and then sown at propagator house (PT_7). Germination percentage was found highest (100%) in seeds sown at propagator house (PT_6) followed by seeds immersion in cold water for 24 hours (PT_3) (91.11%). 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) showed better performance in case of shoot length, collar diameter, number of leaves, shoot fresh weight, total fresh weight, total dry

**Corresponding author: E-mail: rajasree.nandi@gmail.com, rajasree@cu.ac.bd;*

weight, volume index. Finally, it can be concluded that *Lithocarpus elegans* seedlings revealed better performances under the seed pre-treatment PT_6 (seeds sown at propagator house) and fertilizer dose FT_1 (100 kg N ha^{-1}) in growth and biomass production.

Keywords: Germination value; quality index; volume index; vigor index.

1. INTRODUCTION

Lithocarpus elegans (Blume) Hatus. ex Soepadmo, is a tree in the beech family 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 [1], and the number of species is extremely variable among genera: *Castanea* Mill. (12), *Castanopsis* (100 to 200), *Chrysolepis* (2), *Fagus* (11), *Lithocarpus* Blume (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. The specific epithet *elegans* is from the Latin meaning "elegant", referring to the acorns and cupules. It grows as a tree up to 30 m tall with a trunk diameter of up to 70 cm . The greyish brown bark is fissured or lenticellate. The coriaceous leaves measure up to 17 cm long. Its edible brown acorns are ovoid to roundish and measure up to 2.5 cm across. Its habitat is dipterocarp to lower montane forests up to 1,500 m altitude. The timber is used locally as firewood and for charcoal. The genus *Lithocarpus* is closely related to the oaks (*Quercus*) and occurs in South and South-East Asia, with a single species in North America. 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. It is widely distributed, occurring from Bangladesh, Nepal to southern China and Malaysia. In Bangladesh, this tree is naturally grown in Teknaf Wildlife Sanctuary located in the southeastern corner of Bangladesh and in Lawachara National Park, Sylhet.

Moreover, forest reseources in hill forests and sal forests of Bangladesh show poor natural regeneration because of the depletion of resources due to anthropogenic interference, inappropriate methods of silviculture and a preference for exotic species over native for afforestation [2]. At the same time, plant genetic diversity is being disrupted in an alarming way [3,4]. It is observed in some cases that if somehow seeds germinate, but survival is poor [5]. If this trend continues, species under threat will become extinct in the near future. So to restore the forest with native species, regeneration through nursery and plantation programs as well as development of seed orchards are essential. However, poor germination, delayed nursery establishment and slow growth limit the cultivation of threatened species in both forestry and homestead plantation programs. Good planning and appropriate nursery techniques could speed up germination rates and assure maximum quality seedlings from minimum seed sources.

L. elegans was once abundant in hill forests but are becoming very rare because of habitat destruction Considering the importance of native and rare species to the ecological and environmental balance of the forest ecosystems, this research has been designed to assess the effects on seed germination by different pre-sowing treatments and the initial seedling growth attributes of *Lithocarpus elegans.* Good planning and appropriate nursery techniques could speed up germination rates and assure maximum quality seedlings from minimum seed sources. There is, however, little information on germination ecology of native threatened species [6] especially those of the hill forests. Although much research has been conducted on common plantation species, germination behavior and initial seedling growth of threatened native species has been largely ignored. This research investigates the germination rate and growth performance under different pre-sowing treatments at the nursery level and as well as biomass growth under different doses of urea fertilizers at the nursery level for better plantation level growth.

2. 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 *Lithocarpus elegans* 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 eight pre-sowing treatments with three replications (15 seeds per replication) in a randomized design. For each treatment, 45 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 24 hours,
PT_4 :Seeds immersed in cold water for 48 hours,
PT_5 :Seeds immersed in cold water for 7 days,
PT_6 :Seeds sown at propagator house,
PT_7 :Seeds immersed in cold water for 7 days and then sown at propagator house,

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) was recorded. In addition, germination value (GV) was also calculated using the formula of [7] below:

$$GV = (DDGs/N) \times GP/10$$

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 (VI) = [root collar diameter (mm^2) x shoot height (cm)] [8]

Seedling Vigor index (SVI) = [seedling length (cm) × germination percentage] [9].

Fig. 1. *Lithocarpus elegans* seeds

The quality index (QI) [10] 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

2.1 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 *Lithocarpus elegans* at the nursery for selecting the best fertilizer dose for field level plantation of this species. In second experiment, 90 best seedlings were chosen before fertilizer application from the first experiment which showed shoot length range within 30-39 cm and collar dia within 3-5 mm. So a range for shoot length and collar dia was maintained for the fertilizer experiment to show reliability of evaluation of result.

A randomized complete block design with three 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 among 90 seedlings 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/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 three treatments were taken at the IFESCU laboratory by using weight machine for measuring fresh weight and then using oven to make the fresh sample dry and then took dry weight again by weight machine. Data were statistically analyzed by using SPSS© and data were subjected to analysis of variance and Duncan's Multiple Range Test (DMRT).

3. RESULTS

3.1 Germination Period and Germination Percentage

Germination behavior of *Lithocarpus elegans* seeds was affected by different pre-sowing treatments under this experiment. Germination percentage was found highest (100%) in seeds sown at propagator house (PT_6) followed by seeds immersion in cold water for 24 hours (PT_3) (91.11%) (Table 1). Moreover, germination was started earlier in all treatments except in PT_5 in seeds immersed with cold water for 7 days where as it took 74 days for initiation of germination (Table 1).

Moreover, germination was started just after 34 days in seeds soaked in cold water for 24 hours and 48 hours respectively. Germination of seeds continued up to 205 and 208 days in those two treatments. In addition, it is found that seeds sown in propagator house (PT_6) and seeds immersed in cold water for 7 days plus sown in propagator house (PT_7) took 38 days to start germination. Therefore, it is evident from the study that all the treatments except PT_5 reduced the seed dormancy period (Table 1).

The highest germination percentage (100%) was observed in PT_6 (Seeds sown at propagator house) followed by 91.11% in PT_3 (seeds immersed with cold water for 24 hours), 88.88% in PT_4 (seeds immersed in cold water for 48 hours) and 82.22% in PT_1 (sand paper rubbing), 73.33% in PT_2 (sand paper nicking) (Table 1). Germination percentage was least (8.88%) and started later (74 days) in PT_5 (seeds immersed with cold water for 7 days).

Table 1. Germination parameters of talbatna (*Lithocarpus elegans*) seeds under different pre-sowing treatments

Treatments	Germination start (day)	Germination end (day)	Germination percentage (%)	Germination value
PT_0 (Control)	33	150	88.88	4.57
PT_1 (Sand paper)	30	105	82.22	12.60
PT_2 (Nicking)	30	106	73.33	9.29
PT_3 (Cold water, 24 hrs.)	34	205	91.11	10.82
PT_4 (Cold water, 48 hrs.)	34	208	88.88	6.04
PT_5 (Cold water, 7 days)	74	189	8.88	0.057
PT_6 (Seeds sown at propagator house)	38	188	100	9.15
PT_7 (Cold water, 7 days + seeds sown at propagator house)	38	125	66.66	6.19

3.2 Growth Performance of the Seedlings under Different Doses of Fertilizer Application

In case of the total length of seedlings, the value was highest (121.00 cm) in FT_1 (100 kg/ha=0.33679 g urea/pot/seedling) and lowest in FT_2 (90.50 cm). There was significant variation ($p<0.05$) among FT_0, FT_1, and FT_2 (Table 2). Collar diameter (mm) of seedlings was maximum (7.96 mm) in FT_1 (100 kg/ha=0.33679 g urea/pot/seedling) and lowest in FT_2 (200 kg/ha=0.67358 g urea/pot/seedling). There was significant difference between FT_1 and FT_2 treatments and slightly significance difference between FT_0 and FT_1. Maximum leaf number was recorded in FT_1 (32.40) and minimum was in FT_2 (21.80). Highest shoot fresh weight (50.10 gm) and highest total fresh weight (67.90 gm) was found in FT_1 treatment which showed significant variation from FT_0 and FT_2 (Table 2).

Total dry weight (g) was found maximum in treatment FT_1 (37.10 g). The highest quality index was recorded in FT_2 (2.69) and there is no significance difference among FT_0, FT_1, and FT_2 (Table 3). Besides, highest volume index (5861.49) was recorded in treatment FT_1 and there was significant difference between FT_1 and other treatments. Sturdiness was found maximum (116.61) in FT_1 and minimum (93.87) in FT_2. Greatest root-shoot ratio was found in FT_2 (0.5565) (Table 3).

The results of the present study demonstrate that *Lithocarpus elegans* seeds, when seeds sown at propagator house showed better in germination and at the same time, with the fertilizer application dose of 100 kg/ha (0.33679 g urea/pot/seedling) , this species shows better biomass production. But it is also evident that with the increased dose of fertilizers, growth parameters of this seedling were reduced.

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

Treatment	Shoot length (cm)	Root length (cm)	Total length (cm)	Collar diameter (mm)	No of leaves	Root fresh wt	Shoot fresh wt	Total fresh wt
FT_0	71.40^b	35.10^a	106.50^b	7.29^{ab}	26.00^a	12.30^a	30.70^b	43.00^b
FT_1	92.40^a	28.60^a	121.00^a	7.96^a	32.40^a	17.80^a	50.10^a	67.90^a
FT_2	64.20^b	26.30^a	90.50^c	6.90^b	21.80^a	20.50^a	29.70^b	50.20^b

"a, 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 *Lithocarpus elegans* 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	8.00^a	16.30^b	24.30^b	2.1082^a	3780.58^b	0.4783^a	99.44^a
FT_1	11.50^a	25.60^a	37.10^a	2.2268^a	5861.49^a	0.4474^a	116.61^a
FT_2	8.40^a	15.80^b	24.20^b	2.6953^a	3098.27^b	0.5565^a	93.87^a

"a, b", - Figures followed by the same letter(s) are not statistically significant at $p<0.05$, DMRT test

4. DISCUSSION

Findings from the study reveals that *Lithocarpus elegans* 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 [11] where it was observed that there was significant increase in height of seedlings of *Michelia champaca* L., after N and P fertilization. Moreover, another study from [12] demonstrates that *Khaya ivorensis* A. Chev., 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* Roxb. (Telsur) seedlings found that N has significantly increased the seedling height, leaf and shoot dry matter production [13]. 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* (DC.) J.F. Macbr., seedlings [14] .

Moreover, there are several studies on improvement of growth performances of seedlings through application of organic fertilizers which is reported by [15,16,17,18] earlier. However,it is observed from the study that with the increased doses of fertilizers, seedlings growth parameters e.g. collar diameter (mm), total shoot length (cm), total dry weight (gm), volume index, sturdiness was reduced. It means, FT_2 (200 kg/ha) treatment reduced growth performance of *Lithocarpus elegans* seedlings.

5. CONCLUSION

It can be concluded from this study that 100 kg urea/ha is recommended for better growth performance of *Lithocarpus elegans* seedlings. Moreover, seeds sown at propagator house can be suggested for best germination of this species.

ACKNOWLEDGEMENTS

The author would like to provide thanks to the whole IFESCU nursery management team for providing support during the study. The authors gratefully acknowledge the supports of the team members of the Seed Research Laboratory, IFESCU and also the forest staff of the Ukhia-Teknaf reserve forest, Bangladesh for providing support during seed collection from the forest.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Govaerts R, Frodin DG. World checklist and bibliography of Fagales (Betulaceae, Fagaceae and Ticodendraceae). Royal Botanical Garden, Kew, UK; 1998.
2. Ahmed ZU, Begum ZNT, Hasan MA, Khodker M, Kabir SMH,Ahmad M, Ahmed ATA, Rahaman AKA, Haque EU. Encyclopedia of flora and fauna of Bangladesh. Angiosperms: Dicotyledons (Acanthaceae-Asteraceae). Asiatic Society of Bangladesh. Dhaka; 2008b.
3. Khan MS, Rahman MM, Ali MA. Red data book of vascular plants of Bangladesh. Bangladesh National Herbarium. BinimoiPrinters, Dhaka; 2001.
4. Hossain MA, Hossain MK, Salam MA, Rahman R. Composition and diversity of tree species in dudhpukuria-dhopachori wildlife sanctuary of Chittagong (South) forest division,Bangladesh. Res J Pharm Biol Chem Sci. 2013;4(2):1447–1457.
5. Ahmed ZU, Begum NT, Hasan MA, Khodker M, Abir SMH, Ahmad M, Ahmed ATA, Rahaman AKA, Haque EU. Encyclopedia of flora and fauna of Bangladesh. Angiosperms: Mono-cotyledons (Orchidiaceae-Zingiberaceae), Asiatic Society of Bangladesh. Dhaka. 2008a;6:408.
6. Dayamba SD, Savadogo P, Diawara S, Sawadogo L. Perspectives in restoration: Storage and pretreatments of seeds for better germination of Sudanian savanna-woodland species. J For Res. 2016; 27(4):773–778.
7. Djavanshir K, Pourbeik H. Germination value: A new formula. Silvae Genet. 1976; 25, 79-83.
8. Manavalan A. Seedling Vigour and Bioproductivity in Woody Biomass Species. Ph.D. thesis. Madurai: Madurai Kamarajar University; 1990.
9. Abdul-Baki A, Anderson JD. Vigor determination in Soybean seed by multiple Criteria. Crop Sci. 1973;13:630-633.

10. Dickson A, Leaf AL, Hosner JF. Quality Appraisal of White Spruce and White Pine Seedling Stock in Nurseries. The Forestry Chronicle. 1960;36(1):10–13.
11. Hoque ATM R, Hossain MK, Mohiuddin M, Hoque MM. Effect of Inorganic Fertilizers on the Initial Growth Performance of Michelia champaca Linn. Seedlings in the Nursery. J of Bio. Sci. 2004;4(4):489-497.12.
12. Afa FD, E Bechem E, Andrew FA, Genla FB, Ambo Ndah NR. Effects of organic and inorganic fertilizers on early growth characteristics of *Khaya ivorensis* Chev (African mahogany) in nursery. African Journal of Plant Science. 2011;5(12):722 729.
13. Hossain MS, Hossain MK. Effect of NPK fertilizers on the growth of Telsur seedlings. Bangladesh J Agric and Environ. 2006;2(1):17-24.
14. Andrew EE, Limbi TB, Ayamoh EE, Response of Four Species of Tropical Timber Seedlings to Urea and Folivert Fertilisers in Nursery. Journal of Advances in Agriculture. 2018;9:1579-1593.
15. Awang K, Katim I. Growth response of Gmelina arborea Roxb. Seedlings to N, P and K fertilizers on Bungor Soil. Malay For. 1986;9:358-370.
16. Zwierink M. Growth response of potted seedlings of Gmelina arborea roxb. to an omission trial of nitrogen, phosphorus potassium and lime. For Res Rep SR. Sarawak For. Dept. 1984;25.
17. Onuwaje O, Uzu F. Growth response of rubber seedlings to N, P and K fertilizer in Nigerai. Fert Res. 1982;3:169-175.
18. Van den Driessche R. Fertilizer experiments in conifer nurseries of British Columbia. B C For Ser Res. 1977;79: 32.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/52498