Hindawi Publishing Corporation
International Journal of Forestry Research
Volume 2014, Article ID 984194, 8 pages
http://dx.doi.org/10.1155/2014/984194

Research Article

The Effect of Seed Sources Variation and Presowing Treatments on the Seed Germination of *Acacia catechu* and *Elaeocarpus floribundus* Species in Bangladesh

Niamjit Das

Department of Forestry and Environmental Science, School of Agriculture and Mineral Sciences, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh

Correspondence should be addressed to Niamjit Das; niamjit.forestry@gmail.com

Received 11 December 2013; Revised 3 February 2014; Accepted 6 February 2014; Published 18 March 2014

Academic Editor: Kihachiro Kikuzawa

Copyright © 2014 Niamjit Das. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The seed germination of seed sources and presowing treatments of *Acacia catechu* and *Elaeocarpus floribundus* seeds were conducted in the nursery of Bangladesh Agricultural University. The seeds were collected from matured and healthy trees from four different locations in Bangladesh and treated with six presowing methods. The germination test was conducted in polybags with a mixture of topsoil and cow dung in a ratio of 3 : 1. The results of ANOVA showed no significant differences among seed sources but statistically significant differences among the presowing treatments for both species. Thus the presowing methods affected the germination process of seeds, and then the highest germination success was found to be 91.26% in hot water (80°C for 10 min), treatment in *Acacia catechu* and the highest germination success (89.81%) of *Elaeocarpus floribundus* was found in H_2SO_4 treatment followed by 86.35% and 78.42% in treatments with hot water (100°C for 12 min) and scarification. The study also revealed that the interactions between seed source variation and presowing methods effect significantly differed in seed germination percentages. Therefore, it is concluded that hot water treatment can be suggested on seed germination of both species for developing nurseries and rural Bangladesh.

1. Introduction

Seeds provide the most natural resources of plant reproduction, preservation of genetic variability, transportation, and propagation of flora. Though, viable seeds do not germinate even under favorable environmental conditions for many cases; this phenomenon is termed seed dormancy [1]. Several internal factors cause dormancy which includes seed coat, embryo, or inhibitors, which influence the seed germination rate [2]. To overcome these factors, different pretreatment methods have to be adjusted to individual species and seed lots depending on the type of plant species and dormancy. Physical dormancy is caused due to water-resistant seed coat or fruit enclosure which stops imbibition and sometimes also gaseous exchange. It may be overcome either by pretreatment methods of scarification of the seed coat by piercing, nicking, clipping, filing, or burning with the aid of knife, needle, hot wire burner, or abrasion paper [3]; by hot water treatment [4, 5]; or by acid treatment [4].

Acacia catechu Willd. (locally known as Khair), a member of the family Mimosaceae, is a medium sized deciduous tree which grows up to 15 m in height. The brown, beaked seed pods of *A. catechu* are 50–125 mm long on a short stalk and contain between four and seven seeds, which are dark brown, flat, and 5–8 mm in diameter [6]. *A. catechu* is the principal source of tannin, one of the most highly valuable forest products presently traded internationally [7]. It is found growing in both natural and plantation forms in Bangladesh and it is also found throughout India, Sri Lanka, Pakistan, Southeast Asia, and South China [8]. It is found in tropical savannah, dry deciduous forests, and arid steppe climates. It is a valuable bioresources and multipurpose tree species. The heartwood of the tree is mainly used for extracting Katha and Cutch (decoction obtained after filtration); Cutch is used for tanning

Table 1: Different seed sources of *Acacia catechu* and *Elaeocarpus floribundus with* latitude, longitude, and number of seeds used for germination.

Seed source	Location	Date of seed collection	Country	Latitude	Longitude	Number of seeds	
						Acacia catechu	*Elaeocarpus floribundus*
L1	Dinajpur	23.01.2013	Bangladesh	25°37′N	88°38′E	576	480
L2	Mymensingh	26.01.2013	Bangladesh	24°44′N	90°24′E	576	480
L3	Sylhet	30.01.2013	Bangladesh	24°53′N	91°52′E	576	480
L4	Chittagong	05.02.2013	Bangladesh	22°19′N	91°49′E	576	480

leather and as dye to a great extent. After that, Cutch is used as adhesive in plywood industry and it is also used in preparing polishes and paints [9]. The wood is durable and widely used by the inhabitants for house building material as poles and to prepare furniture. *A. catechu* has a great socioeconomic importance and it has tremendous ecological significance. Because of its leguminous nature and soil binding abilities, it could be a suitable species for wasteland development [7]. However, poor seed germination, due to seed dormancy of this species, restricts plantation programs. Other tree species of *Elaeocarpus floribundus* Blume belong to the family Elaeocarpaceae, which is an evergreen moderate sized tree with spreading crown and clean bole of 12 to 16 m length. The seed of *E. floribundus* is a stone-3 celled, each having a spindle shaped seed, and despite hard seed coat (stone), the seeds are recalcitrant [10]. *E. floribundus* usually grows on hill slopes and ridges with sandy to clay soils and occurs in the forests of Chittagong, Chittagong Hill Tracts, Cox's Bazar, Sylhet, and Mymensingh districts in Bangladesh, but it can also be seen in India, Indo-China, Thailand, Malaysia, Philippines, and Indonesia. Its fruits are edible, which are used for pickle and also have medicinal value for treating several diseases [11]. The wood of *E. floribundus* is used for light interior construction and plywood. It is suitable for the manufacture of particle board, fiberboard, and paper pulp [10]. But seed germination rates of this species are usually very low due to seed dormancy (personal contract with the nursery owners).

Large scale plantations in agroforestry, social forestry, and home gardens are limited due to poor seed germination and deferred nursery establishment [12–14]. Seed treatment can ensure success in both seed germination and germination speed and guarantee that germination procedures are quick and homogeneous [15, 16]. The effects of pretreatments on seed germination of some tropical forest tree species have been reported by Ahamed et al. [17], Matin and Rashid [18], Ali et al. [19], Koirala et al. [20], Khan et al. [21], Alamgir and Hossain [22, 23], Azad et al. [24, 25], and Matin et al. [26]. A good planning and profitability of forest nurseries depend on the proper techniques that gear up the germination process and attain a more dependable germination seed sown [20, 22]. Suitable presowing techniques of seed germination can enhance the germination rate and overall process [24, 25]. After that, tree species of *A. catechu* and *E. floribundus* are distributed throughout the country. Thus, variation in seed sources is very important for seed germination and seedling growth when seeds are selected for further use in afforestation, reforestation, and breeding programs in the country. Seed collection from suitable locations can enhance the germination procedure and thereby speed up plantation programs. Similar studies have been reported by Sneizko and Stewart [27] in *Acacia albida*, Vakshasya et al. [28] in *Dalbergia sissoo*, Nautiyal et al. [29] in *Quercus leucotrichophora*, Bhat and Chauhan [30] in *Albizia lebbeck*, Close and Wilson [31] in *Eucalyptus regnans*, Esen et al. [32] in *Prunus serotina*, and Shivanna et al. [33] in *Pongamia pinnata*. Therefore, the objective of the study was to recognize the effects of seed source dissimilarity on different aspects of seed germination and to determine the best presowing seed treatment that will ensure their main germination process within the shortest period of time at the nursery stage.

2. Materials and Methods

2.1. Study Area. The experiment was conducted in the nursery of Bangladesh Agricultural University, Bangladesh. The geographic position of the study area is situated between 24°44′N and 90°24′E. The climate of the study area is known as subtropical in nature, like the other part of the country. The experiment was done in January–July 2013. The air temperature ranged between 26° and 32°C and the relative humidity was 65%–80% during the experiment.

2.2. Seed Collection and Growing Media in the Experiment. The seeds were collected from 15- to 25-year-old matured and healthy trees from four different locations in Bangladesh (Table 1). All seeds were dried in the sunlight and then stored in airtight polybags till the treatments were applied. The collected seeds were checked to remove the discolored, damaged seeds. Healthy dried seeds were used for the experiment. The germination trial was carried out by sowing the seeds in 4 cm × 6 cm polybags, in a medium of topsoil and cow dung in the ratio of 3 : 1. Then the beds were laid in a systematic order and it was made with a slightly above from the ground surrounding areas so that water could not remain for a long time. Polybags were filled with soils and composts. Then the good and healthy seed was sown in each polybag after applying presowing treatment. One seed was sown in each polybag at a depth of 0.5–1.5 cm. Polybags were kept in the shade throughout the experiment and watering was carried out manually once a day.

2.3. Experimental Design and Treatments. Randomized Block Design (RBD) with four replications was used for the experiment. The treatment combination consisted of two factors,

Table 2: Variation in seed sources on different aspects of seed germination of *Acacia catechu* and *Elaeocarpus floribundus* nursery stage.

Species	Seed source	Germination starting date (d)	Germination closing date (d)	Germination period (d)	Germination percentage (%)	Rate of germination
Acacia catechu	L1	6.24 ± 0.18	15.72 ± 0.24	9.48 ± 0.43	56.15 ± 3.42	1.66 ± 0.08
	L2	5.68 ± 0.25	14.41 ± 0.16	8.73 ± 0.39	52.48 ± 4.57	1.56 ± 0.10
	L3	6.86 ± 0.37	16.08 ± 0.57	9.17 ± 0.28	53.16 ± 3.89	1.62 ± 0.07
	L4	7.13 ± 0.46	16.57 ± 0.61	9.42 ± 0.56	49.05 ± 3.96	1.45 ± 0.12
Elaeocarpus floribundus	L1	10.12 ± 0.35	31.43 ± 0.28	21.31 ± 0.34	47.43 ± 4.51	1.63 ± 0.09
	L2	9.46 ± 0.54	32.01 ± 0.57	22.54 ± 0.26	40.44 ± 3.65	1.33 ± 0.12
	L3	11.53 ± 0.28	32.64 ± 0.38	21.07 ± 0.19	44.17 ± 3.98	1.54 ± 0.10
	L4	10.49 ± 0.56	31.12 ± 0.22	20.63 ± 0.27	42.11 ± 4.09	1.46 ± 0.09

Note: L1: Dinajpur, L2: Mymensingh, L3: Sylhet, L4: Chittagong. Data are shown in mean ± SD.

namely, seed source/location and presowing methods. In support of each presowing method 384 ($4 \times 4 \times 24$) polybags (for *A. catechu*) and 320 ($4 \times 4 \times 20$) polybags (for *E. floribundus*) were used for four different seed sources designated as L1, L2, L3, and L4. Thus, the total number of polybags used for seed germination was 2304 ($6 \times 4 \times 4 \times 24$) for *A. catechu* and 1920 ($6 \times 4 \times 4 \times 20$) for *E. floribundus*. There were six presowing methods in the experiment as follows:

(S1) control (seeds provided no treatment);

(S2) seeds immersed in hot water (80°C) for 10 min, followed in cold water soaking for 24 h;

(S3) seeds immersed in cold water (4°C) for 24 h;

(S4) seeds immersed in hot water (100°C) for 12 min, followed by cold water soaking for 24 h;

(S5) seeds immersed in concentrated H_2SO_4 (80%) for 20 min;

(S6) scarification with sand paper.

In total, there were twenty-four treatment combinations and were denoted as follows: T1: S1L1; T2: S1L2; T3: S1L3; T4: S1L4; . . .; T24: S6L4.

2.4. Determination of Seed Germination. The number of seeds germinated in each treatment was recorded regularly. The starting and closing dates of seed germination were also recorded. At the end of the germination period, the germination percentage and rate of germination [34] were calculated using the following equations:

$$G_p = \frac{N_g}{N_t} \times 100, \qquad G_r = \sum \frac{N_g}{\text{Days of count}}, \tag{1}$$

that is,

$$G_r = \sum \frac{N_g}{\text{Days to first count}} + \cdots + \sum \frac{N_g}{\text{Days to final count}}, \tag{2}$$

where G_p is the germination percentage, N_g the number of germinated seeds, N_t the total number of seeds planted, and G_r the rate of germination.

2.5. Data Analysis. Seed germination data were statistically analyzed by using computer software SPSS version 20 to explore potential treatment variations. Analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) [35] were carried out to analyze the data. The ANOVA was carried out to determine the effect of variation in seed source (L), presowing method effect (S), and interaction (S × L) on starting and closing dates of germination, germination periods, germination percentages, and rates of germination. DMRT was conducted to compare mean germination closing dates, germination periods, and germination percentages of the effect of different presowing methods.

3. Results and Discussion

3.1. Effects of Variation of Seed Sources on Seed Germination. Germination started somewhat earlier from the seeds originating in L2 for *Acacia catechu* and *Elaeocarpus floribundus* than from other sources (Table 2). Germination closed later in L4 for *Acacia catechu* and L3 for *Elaeocarpus floribundus* than in the others. In the case of *Acacia catechu*, the highest germination success was found at 56.15% in L1 ($P > 0.05$) and the lowest was 49.05% in L4. In another case, *Elaeocarpus floribundus*, the highest germination percentage was shown at 47.43% in L1 ($P > 0.05$) and the lowest was 40.44% in L2 (Table 2). The results of ANOVA showed no significant differences ($P > 0.05$) in starting dates and closing dates in germination, germination periods, germination percentages, and rates of germination among seed sources.

3.2. Effect of Presowing Treatments on Seed Germination of Acacia catechu . Seed germination started in advance for the seeds immersed in hot water (80°C) for 10 min (S2) than other treatments, followed by cold water soaking for 24 h (S2) than other treatments. Germination closed later in the control (S1) and cold water treatment (S3) ($P < 0.05$) than in hot water (80°C) for 10 min (S2) and immersion in concentrated H_2SO_4 (80%) for 20 min (S5) treatments (Table 3). It took

Table 3: Effects of presowing treatments on different aspects of seed germination of *Acacia catechu* and *Elaeocarpus floribundus* at nursery stage.

Species	Treatment	Germination starting date (d)	Germination closing date (d)	Germination period (d)	Germination percentage (%)	Rate of germination
Acacia catechu	S1	6.13 ± 0.21	15.86 ± 0.47^a	9.68 ± 0.34^a	69.58 ± 3.51^b	1.59 ± 0.11
	S2	5.48 ± 0.15	14.02 ± 0.23^b	8.47 ± 0.22^b	91.26 ± 2.64^a	1.87 ± 0.07
	S3	7.16 ± 0.36	16.01 ± 0.56^a	8.96 ± 0.47^a	74.22 ± 3.38^b	1.73 ± 0.10
	S4	6.05 ± 0.41	15.11 ± 0.32^a	9.09 ± 0.36^a	80.67 ± 3.43^b	1.64 ± 0.11
	S5	5.98 ± 0.24	14.34 ± 0.29^b	8.46 ± 0.31^b	73.15 ± 4.26^b	1.69 ± 0.12
	S6	6.52 ± 0.28	15.28 ± 0.34^a	8.77 ± 0.42^b	85.94 ± 3.67^a	1.81 ± 0.09
Elaeocarpus floribundus	S1	10.42 ± 0.35	32.27 ± 0.39^a	21.63 ± 0.32^a	72.16 ± 3.19^b	1.53 ± 0.11
	S2	11.48 ± 0.61	33.35 ± 0.31^a	21.96 ± 0.27^a	68.19 ± 4.59^b	1.45 ± 0.13
	S3	10.39 ± 0.36	31.54 ± 0.43^b	20.98 ± 0.30^b	74.42 ± 3.62^b	1.58 ± 0.11
	S4	10.06 ± 0.28	30.83 ± 0.37^b	20.77 ± 0.38^b	86.35 ± 2.67^a	1.73 ± 0.09
	S5	9.04 ± 0.25	29.81 ± 0.26^b	20.69 ± 0.23^b	89.81 ± 2.25^a	1.79 ± 0.06
	S6	11.87 ± 0.56	32.96 ± 0.46^a	21.05 ± 0.22^a	78.42 ± 3.92^b	1.72 ± 0.08

Note: same letter(s) in the same column indicate(s) insignificant differences and data are shown in mean ± SD at $P < 0.05$.

an average of 8 days to complete seed germination in the hot water (80°C) and germination was completed within 5–16 days after sowing the seeds collected from all sources (Table 3). The highest germination success (91.26%) in hot water (80°C) for 10 min, followed in cold water soaking for 24 h treatment (S2), differed significantly ($P < 0.01$) with the lowest germination success (69.58%) in the control treatment (S1). DMRT showed no significant difference ($P > 0.05$) of seed germination among the treatments of S1 (69.58%), S3 (74.22%), S4 (80.67%), and S5 (73.15%), but these differed significantly ($P < 0.05$) from S2 (91.26%) and S6 (85.94%) (Table 3). There was no significant difference ($P > 0.05$) between the treatments of S2 and S6 (Table 3). The cumulative germination success (%) of *A. catechu* under control (S1) and the highest germination of hot water (80°C for 10 min) treatment (S2) was shown in Figure 1. After that, ANOVAs showed no significant difference ($P > 0.05$) in germination starting dates and rates of germination among the treatments but there were significant differences ($P < 0.05$) in germination closing dates, the germination periods, and germination percentages for presowing methods effects (Table 4). The interactions between seed source variation and presowing methods showed no significant differences ($P > 0.05$) among starting dates, periods, and rates of germination, but it did show significant differences ($P < 0.05$) among germination closing dates and germination percentages (Table 4). The germination percentage of these interactions for *A. catechu* was also shown in Table 5.

That means from the consideration of germination period, germination percentage, and rate of germination the best treatment for *A. catechu* is S2 treatment. The main reason behind the successful germination of S2 is that seed of *A. catechu* might require hot water in the first time to break the dormancy and after that soaking in cold water for 24 h in second time makes the seed coat softer, which ensures the maximum successful germination of seed. Azad et al. [24] reported highest germination (52%) in hot water treatment

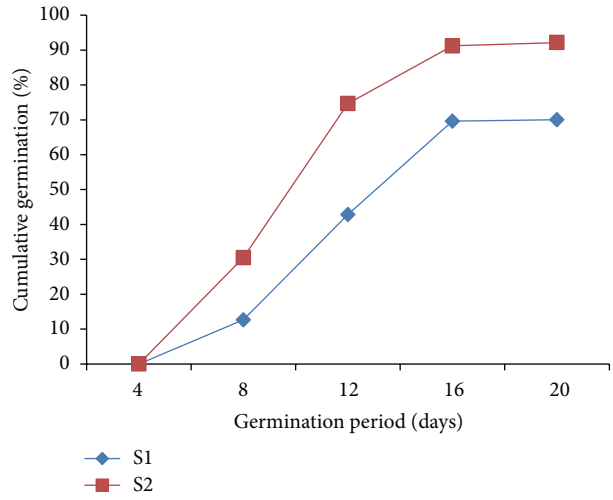


Figure 1: Cumulative germination (%) throughout the germination period of *A. catechu* under the treatments of S1 and S2 in polybag.

in *A. lebbeck* may be due to the variation of seed coat thickness. The difference of seed germination success may be due to the variation of boiling time and temperature applied. Sajeevukumar et al. [36] carried out an experiment on seed dormancy and germination on *Albizia falcataria* and *A. procera* and found that hot water treatments by 40, 60, 70, and 80°C significantly increased germination in these two Albizia species. Bowen and Eusebio [37], Koffa [38], and Diangana [39] conducted experiments on *A. falcataria* and obtained similar results. It may be due to the fact that imbibition can be almost completed at higher temperatures, although sometimes poor germination responses occurred in a hot water treatment which was sensitive to the embryo [40]. The present study clearly shows that the seed coat of *A. catechu* softens when immersed in hot water (80°C for 10 min), followed in cold water soaking for 24 h. Azad et al. [41]

Table 4: Summary of probabilities (P) of variation in seed source, presowing methods effects, and their interaction with different aspects of seed germination of *Acacia catechu* and *Elaeocarpus floribundus* at nursery stage.

Source	Aspect	*Acacia catechu*	*Elaeocarpus floribundus*
		P value	P value
Seed source effects (L)	Germination starting date (d)	0.5173	0.8162
	Germination closing date (d)	0.4291	0.6381
	Total germination period (d)	0.9062	0.5327
	Germination percentage (%)	0.5389	0.9402
	Rate of germination	0.7614	0.6183
Presowing methods effects (S)	Germination starting date (d)	0.1683	0.0843
	Germination closing date (d)	0.0027***	0.0015***
	Total germination period (d)	0.0392***	0.2361
	Germination percentage (%)	0.0001***	0.0001***
	Rate of germination	0.3562	0.0217***
Interaction (S × L)	Germination starting date (d)	0.0935	0.0005***
	Germination closing date (d)	0.0252***	0.0618
	Total germination period (d)	0.1083	0.3816
	Germination percentage (%)	0.0001***	0.0001***
	Rate of germination	0.2681	0.0495***

***$P < 0.05$.

Table 5: Effects of interaction between seed source and presowing methods on the germination of *Acacia catechu* and *Elaeocarpus floribundus*.

Species	Seed source	S1	S2	S3	S4	S5	S6
Acacia catechu	L1	76.53 ± 2.75^{b}	95.53 ± 1.63^{a}	75.44 ± 1.85^{b}	82.41 ± 2.72^{a}	81.65 ± 2.74^{a}	87.04 ± 4.92^{a}
	L2	70.07 ± 3.41^{b}	93.77 ± 2.21^{a}	85.00 ± 3.95^{a}	73.57 ± 1.90^{b}	69.81 ± 3.84^{b}	91.21 ± 2.33^{a}
	L3	68.58 ± 2.51^{b}	77.42 ± 1.68^{b}	63.69 ± 2.86^{c}	87.91 ± 2.98^{a}	76.15 ± 2.94^{b}	86.55 ± 3.70^{a}
	L4	61.52 ± 1.98^{c}	91.93 ± 2.17^{a}	73.63 ± 3.02^{b}	77.86 ± 2.08^{b}	64.10 ± 1.77^{c}	75.49 ± 1.86^{b}
Elaeocarpus floribundus	L1	81.79 ± 2.96^{a}	78.81 ± 1.96^{a}	73.95 ± 2.08^{b}	92.89 ± 2.87^{a}	89.62 ± 3.83^{a}	85.92 ± 1.74^{a}
	L2	73.32 ± 3.90^{b}	64.35 ± 2.44^{b}	58.43 ± 3.55^{c}	73.39 ± 3.81^{b}	93.12 ± 2.77^{a}	69.43 ± 2.78^{b}
	L3	58.15 ± 2.58^{c}	56.18 ± 3.75^{c}	79.29 ± 2.89^{a}	87.26 ± 2.94^{a}	92.99 ± 1.96^{a}	87.00 ± 3.83^{a}
	L4	74.13 ± 3.88^{b}	73.15 ± 2.42^{b}	80.26 ± 3.88^{a}	91.23 ± 4.02^{a}	74.73 ± 2.71^{b}	71.265 ± 2.51^{b}

Note: same letter(s) in the same column or row indicate(s) insignificant differences and data are shown in mean ± SD at $P < 0.05$.

found 69% germination success in hot water (80°C for 10 min) treatment on *Melia azedarach*. It may be due to the difference of seed coat thickness. Ali et al. [19] carried out an experiment on hot water treatment (50°C and boiling for 3 min) on *A. procera* and found 43% seed germination.

3.3. Effect of Presowing Treatments on Seed Germination of Elaeocarpus Floribundus . Seed germination started earlier for the seeds immersed in concentrated H_2SO_4 (80%) for 20 min (S5) than other treatments. Germination closed later in hot water treatment (80°C) for 10 min (S2) and scarification with sand paper treatment (S6) ($P < 0.05$) than other treatments of immersed in hot water (100°C) for 12 min (S4) and immersed in concentrated H_2SO_4 (80%) for 20 min (S5) (Table 3). The shortest period required for germination was observed in S4 (10–31 days) and S5 (9–30 days), and the longest period of germination was observed in S2 (11–33 days). The highest germination percentage was found in S5 (89.81%) followed by S4 (86.35%) and S6 (78.42%) and the shortest germination percentage was found in S2 (68.19%). From DMRT, it was also found that seed germination percentages were significant differences ($P < 0.05$) of H_2SO_4 treatment with other treatments (S1 (72.16%), S2 (68.19%), S3 (74.42%), and S6 (78.42%)), but no significant difference ($P > 0.05$) was found between hot water (100°C) for 12 min (S4) and concentrated H_2SO_4 (80%) for 20 min (S5) treatment (Table 3). The cumulative germination success (%) of *E. floribundus* under control (S1) and the highest germination of H_2SO_4 treatment (S5) and hot water (100°C for 12 min) treatment (S4) were shown in Figure 2. After that, ANOVAs showed no significant difference ($P > 0.05$) in germination starting dates and periods among the treatments but there were significant differences ($P < 0.05$) in germination closing dates, percentages, and rates of germination for presowing methods effects (Table 4). The interactions between seed source variation and presowing methods showed no significant differences ($P > 0.05$) among germination closing dates and periods, but it did

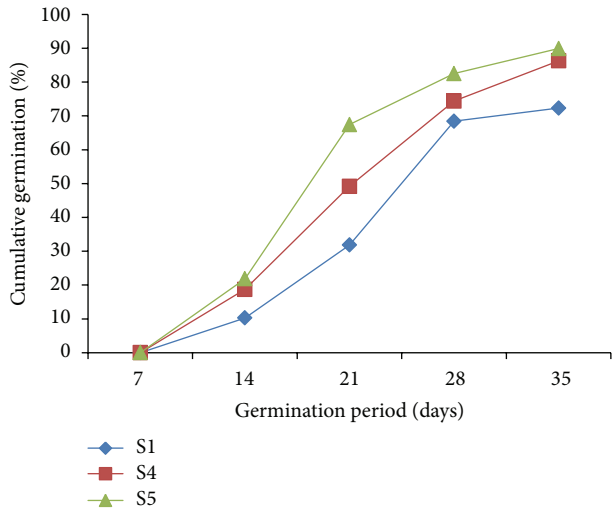


FIGURE 2: Cumulative germination (%) throughout the germination period of *E. floribundus* under the treatments of S1, S4, and S5 in polybag.

show significant differences ($P < 0.05$) among germination starting dates, percentages, and rates of germination (Table 4). The germination percentage of these interactions for *E. floribundus* was also shown in Table 5. Azad et al. [25] found a similar result in 80% concentrated H_2SO_4 treatment for 20 minutes (84%) on presowing treatment effect on the seed germination of *Xylia kerrii* in Bangladesh. Pipinis et al. [42] noted that concentrated sulphuric acid treatment proved more effective in breaking dormancy. Consequently, Ren and Tao [43] reported that concentrated sulphuric acid treatment recorded superior germination rate in *Calligonum* species compared to scarification treatment. We also showed that several authors have argued that different methods of presowing treatments to break the seed dormancy increase the germination rate and speed up the germination process [22–25, 40, 41, 44].

The present study revealed that there were differences in seed germination starting dates, closing dates, germination period, germination percentages, and rates of germination among the different seed sources, but variation in seed sources did not affect significantly ($P > 0.05$) different aspects in the seed germination of *A. catechu* and *E. floribundus*. This may be due to variation in the microclimate among the seed sources which was very similar. Besides these factors, the subtropical climate conditions throughout the country help to adopt this species in Bangladesh. Azad et al. [14] carried out a similar study on seed germination of *Albizia procera* in Bangladesh and found no significant difference of seed germination among the seed sources. For establishing a nursery of particular species for predicting the maximum number of quality seedling with minimum cost, time, and labor, presowing treatments of seeds are essential. As a result, the forest department, nursery owners, farmers, NGOs, and researchers to know the effect of presowing treatments on germination and thereby they can apply these treatments to get best quality seedlings within the shortest period of time for large scale production of seedling.

4. Conclusions

Presowing seed treatments play a key role to enhance the seed germination under nursery condition. Among the presowing treatments, hot water immersion (80°C for 10 min and 100°C for 12 min) and acid treatment performed very well for both species. The best treatment of *A. catechu* was found by seeds immersed in hot water (80°C) for 10 min, followed in cold water soaking for 24 h. Effective presowing treatments of *E. floribundus* were shown by soaking in concentrated H_2SO_4 (80%) for 20 min and hot water (100°C) for 12 min that has no significant difference appeared. Though, the use of sulfuric acid techniques is somewhat risky and troublesome. Therefore, it is suggested to apply hot water treatment at 80°C for a period of 10 min for *A. catechu* and 100°C for a period of 12 min for *E. floribundus* in Bangladesh to get high seed germination success rates.

Conflict of Interests

The author declares that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

I would like to thank Bangladesh Agricultural University for their permission of field works. I also thank the support staff of the forest nursery of Mymensingh, Bangladesh for providing help and cooperation during the experiment.

References

[1] L. Taiz and E. Zeiger, *Plant Physiology*, vol. 10, Sinauer Associates, Sunderland, Mass, USA, 3rd edition, 2002.

[2] P. K. Agrawal and M. Dadlani, *Techniques in Seed Science and Technology*, South Asian Publishers, New Delhi, India, 2nd edition, 1995.

[3] L. A. Catalan and R. E. Macchiavelli, "Improving germination in Prosopis flexuosa D.C. and *P. alba Grise* B. with hot water treatments and scarification," *Seed Science and Technology*, vol. 19, pp. 253–262, 1991.

[4] B. Kobmoo and A. K. Hellum, "Hot water and acid improve the germination of *Cassia siamea* Britt. Seeds," *The Embryan*, vol. 1, no. 1, pp. 27–33, 1984.

[5] P. D. Khasa, "Scarification of limba seeds with hot water, bleach and acid," *Tree Planters Note*, vol. 43, no. 4, pp. 150–152, 1992.

[6] N. S. Bisht and S. P. Ahlawat, *Seed Technology*, State Forestry Research Institute, Government of Arunachal Pradesh, Itanagar, India, 1999.

[7] K. N. Singh and B. Lal, "Notes on traditional uses of khair (*Acacia catechu* Willd.) by inhabitants of shivalik range in Western Himalaya," *Ethnobotanical Leaflets*, vol. 10, pp. 109–112, 2006.

[8] T. Chakrabarty and M. Gangopadhyay, "The genus Acacia P. Miller, (Leguminosae: Mimosoideae) in India," *Journal of Economic and Taxonomic Botany*, vol. 20, pp. 599–633, 1996.

[9] K. N. Singh, *Variation studies on katha content in relation to different forms of khair (Acacia catechu Willd.) trees [M.S. thesis]*, Dr. Y. S. Parmar University of Horticulture and Forestry, Solan, India, 2000.

[10] U. V. Singh, S. P. Ahlawat, and N. S. Bisht, *Nursery Technique of Local Tree Species II*, SFRI Information Bulletin No. 11, State Forest Research Institute, Jabalpur, India, 2003.

[11] H. B. Joshi, M. A. Rashid, and P. Venkataramany, *The Silviculture OfIndian Trees*, Controller of Publication, New Delhi, India, 1981.

[12] M. S. Azad, M. W. Islam, M. A. Matin, and M. A. Bari, "Effect of pre-sowing treatment on seed germination of *Albizia lebbeck* (L.) Benth," *South Asian Journal of Agriculture*, vol. 1, no. 2, pp. 32–34, 2006.

[13] M. S. Azad, M. A. Matin, M. W. Islam, and M. Z. A. Musa, "Effect of pre-sowing treatment on seed germination of Lohakath (*Xylia kerrii* Craib & Hutch.)," *Khulna University Study*, vol. 7, no. 2, pp. 33–36, 2006.

[14] M. S. Azad, R. K. Biswas, and M. A. Matin, "Seed germination of *Albizia procera*(Roxb.) Benth. in Bangladesh: a basis for seed source variation and pre sowing treatment effect," *Forestry Study in China*, vol. 12, no. 2, pp. 124–130, 2012.

[15] M. S. Azad, M. R. Manik, M. S. Hasan, and M. A. Matin, "Effect of different pre-sowing treatments on seed germination percentage and growth performance of *Acacia auriculiformis*," *Journal of Forestry Research*, vol. 22, no. 2, pp. 183–188, 2011.

[16] M. S. Azad, M. T. Rahman, and M. A. Matin, "Seed germination techniques of *Phoenix dactylifera*: a new experience from Bangladesh," *Frontiers of Agriculture in China*, vol. 5, no. 2, pp. 241–246, 2011.

[17] F. D. Ahamed, S. Das, and M. A. Hossain, "Effect of seed treatment on the germination of *rakta kombal* seeds," *Bano Biggyan Patrica*, vol. 12, no. 1, pp. 62–65, 1983.

[18] M. A. Matin and M. H. Rashid, "Seed morphology, germination and seedling survival of Albizia trees in the Nursery," *Bangladesh Journal of Forest Science*, vol. 21, no. 1, pp. 40–45, 1992.

[19] M. Ali, S. Akhter, and M. Kamaluddin, "Study on the bearing of hot water treatment on seed germination and seedling growth of *Albizia procera* benth," *Indian Forester*, vol. 123, no. 8, pp. 764–768, 1997.

[20] B. Koirala, M. K. Hossain, and M. S. Hossain, "Effects of different pre-sowing treatments on *Adenanthera pavonia* L. seeds and initial seedling development in the nursery," *Malaysian Forester*, vol. 63, no. 2, pp. 82–91, 2000.

[21] B. M. Khan, B. Koirala, and M. K. Hossian, "Effect of different pre-sowing treatments on germination and seedling growth attributes in Ghora Neem (*Melia azedarach* L.)," *Malaysian Forester*, vol. 64, no. 1, pp. 14–21, 2001.

[22] M. Alamgir and M. K. Hossain, "Effect of pre-sowing treatments on *Albizia procera* (Roxb.) Benth seeds and initials development of seedlings in the nursery," *Journal of Forestry and Environment*, vol. 3, pp. 53–60, 2005.

[23] M. Alamgir and M. K. Hossain, "Effect of pre-sowing treatments on germination and initials seedling development of *Albizia saman* in the nursery," *Journal of Forestry Research*, vol. 16, no. 3, pp. 200–204, 2005.

[24] M. S. Azad, M. W. Islam, M. A. Matin, and M. A. Bari, "Effect of pre-sowing treatment on seed germination of *Albizia lebbeck* (L.) Benth," *South Asian Journal Agriculture*, vol. 1, no. 2, pp. 32–34, 2006.

[25] M. S. Azad, M. A. Matin, M. W. Islam, and Z. A. Musa, "Effect of pre-sowing treatment on seed germination of Lohakath (*Xylia kerrii* Craib & Hutch.)," *Khulna University Studies*, vol. 7, no. 2, pp. 33–36, 2006.

[26] M. A. Matin, M. S. Islam, and M. S. Azad, "Seed germination, seedling growth and rooting of branch cuttings of *Dalbergia sissoo* Roxb," *Khulna University Studies*, pp. 83–87, 2006, Proceedings of the 1st Research Cell Conference.

[27] R. A. Sniezko and H. T. L. Stewart, "Range-wide provenance variation in growth and nutrition of *Acacia albida* seedlings propagated in Zimbabwe," *Forest Ecology and Management*, vol. 27, no. 3-4, pp. 179–197, 1989.

[28] R. K. Vakshasya, O. P. Rajora, and M. S. Rawat, "Seed and seedling traits of *Dalbergia sissoo* Roxb.: seed source variation studies among ten sources in India," *Forest Ecology and Management*, vol. 48, no. 3-4, pp. 265–275, 1992.

[29] A. R. Nautiyal, D. C. S. Rawat, and P. Prasad, "Physiological aspects of seed source variation in seed germination of *Quercus leucotrichophora* A. Camus," *Indian Forester*, vol. 126, no. 3, pp. 269–273, 2000.

[30] G. S. Bhat and P. S. Chauhan, "Provenance variation in seed and seedling traits of *Albizzia lebbek* Benth," *Journal of Tree Science*, vol. 21, pp. 52–57, 2002.

[31] D. C. Close and S. J. Wilson, "Provenance effects on pre-germination treatments for *Eucalyptus regnans* and *E. delegatensis* seed," *Forest Ecology and Management*, vol. 170, no. 1–3, pp. 299–305, 2002.

[32] D. Esen, O. Yildiz, M. Sarginci, and K. Isik, "Effects of different pretreatments on germination of *Prunus serotina* seed sources," *Journal of Environmental Biology*, vol. 28, no. 1, pp. 99–104, 2007.

[33] H. Shivanna, H. C. Balachandra, and N. L. Suresh, "Source variation in seed and seedling traits of *Pongamia pinnata*," *Karnataka Journal of Agricultural Science*, vol. 20, no. 2, pp. 438–439, 2007.

[34] J. D. Maguire, "Speed of germination aid in selection and evaluation for seedling emergence and vigor," *Crop Science*, vol. 2, no. 2, pp. 176–177, 1962.

[35] D. B. Duncan, "Multiple ranges and multiple F-tests," *Biometrics*, vol. 11, no. 1, pp. 1–42, 1955.

[36] B. Sajeevukumar, K. Sudhakara, P. K. Ashokan, and K. Gopikumar, "Seed dormancy and germination in *Albizia falcataria* and *Albizia procera*," *Journal of Tropical Forest Science*, vol. 7, no. 3, pp. 371–382, 1995.

[37] M. R. Bowen and T. V. Eusebio, *Albizia Falcataria. Information on Seed Collection, Handling and Germination Testing*, Occasional Technical and Scientific Notes, Seed Series No. 4, Forest Research Centre, Sabah, Malaysia, 1981.

[38] S. N. Koffa, "Temperature: its effect on the pre-germination of *Albizia falcataria*," *Canopy International*, vol. 9, p. 5, 1983.

[39] D. Diangana, "Treatment to accelerate germination of *Acacia mangium*, *Albizia falcataria*, *Calliandra calothyrsus* and *Leucaena leucocephala*," *Nitrogen Fixing Trees Research Report*, vol. 3, pp. 2–3, 1985.

[40] S. Kandya, "Enhancing germination in *Cassia siamea* seeds," *Journal of Tropical Forest Science*, vol. 6, pp. 28–35, 1990.

[41] M. S. Azad, N. K. Paul, and M. A. Matin, "Do pre-sowing treatments affect seed germination in *Albizia richardiana* and *Lagerstroemia speciosa*?" *Frontiers of Agriculture in China*, vol. 4, no. 2, pp. 181–184, 2010.

[42] E. Pipinis, E. Milios, P. Smiris, and C. Gioumousidis, "Effect of acid scarification and cold moist stratification on the germination of *Cercis siliquastrum* L. seeds," *Turkish Journal of Agriculture and Forestry*, vol. 35, no. 3, pp. 259–264, 2011.

[43] J. Ren and L. Tao, "Effects of different pre-sowing seed treatments on germination of 10 *Calligonum* species," *Forest Ecology and Management*, vol. 195, no. 3, pp. 291–300, 2004.

[44] J. P. Yadav, "Pretreatment of teak seed to enhance germination," *Indian Forester*, vol. 11, no. 2, pp. 260–264, 1992.