Influence of Pre-sowing Treatments on Seed Germination and Seedling Growth of *Calamus latifolius* Roxb. – an Important Rattan Species of Bangladesh

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Abstract

The paper deals with seed germination behavior and seedling growth performance of *Calamus latifolius* Roxb; with 5 pre-sowing treatments in the nursery and field conditions. The pre-treatments of seeds were i) seeds soaked in tap water for 24 hours, ii) soaked in tap water for 48 hours iii) soaked in 20% H_2SO_4 for 10 minutes iv) scarification with wire net and v) control (Seeds were sown without any treatment). Pre-treated seeds were sown in the seed bed filled with soil and decomposed cow dung at 3:1 ratio. The growth performance of the seedlings were determined by transferring 30-35 days old seedlings (having 2-3 leaves) from germination bed to the polybags filled with soil and decomposed cow dung media. Plantation in the field was made with one year old seedling. Germination percentage significantly ($p \leq 0.05$) enhanced with pre-sowing treatments and maximum germination percentage (70) was recorded in seed scarified by wire net and the lowest (44%) was in control. Growth performance was also influenced by pre-sowing treatments in the nursery and highest (1008) vigor index was found in seed scarified by wire net and lowest (475) in control. Seedlings survival percentage was over 92% after one year of plantation in the field. Average height was recorded 123.1 cm after two years of planting. Thus, seeds scarified by wire net can be suggested for nursery raising and one-year old seedlings may be out planted at 2m ×2m spacing for successful plantations of the species.

mvims‡¶c

বর্ণিত প্রবন্ধে পাঁচটি প্রি- ট্রিটমেন্ট প্রয়োগে *Calamus latifolius* Roxb. এর বীজের অঙ্কুরোদগমের হার নির্ণয়, নার্সারি ও মাঠে চারার বৃদ্ধি পর্যবেক্ষণ করা হয়। ট্রিটমেন্টগুলো হলো ১) নরমাল ট্যাপের পানিতে ২৪ ঘন্টা ভেজানো ২) নরমাল ট্যাপের পানিতে ৪৮ ঘন্টা ভেজানো ৩) ২০% H_2SO_4 এ ১০ মিনিট ভেজানো ৪) তার জালি দিয়ে স্কেরিফিকেশন ও ৫) কন্ট্রোল (ট্রিটমেন্ট বিহীন)। মাটি ও গোবর ৩:১ অনুপাতে মেশানো বেডে প্রি-ট্রিটেড বীজ বপন করা হয়। ৩০-৩৫ দিন বয়সের চারা (২-৩ টি পাতাযুক্ত) সীডবেড থেকে পলিব্যাগে স্থানান্তর করে বৃদ্ধি সংক্রান্ত তথ্য সংগ্রহ করা হয় এবং এক বছর বয়সী চারা মাঠে লাগিয়ে বৃদ্ধি পর্যবেক্ষণ করা হয়। *Calamus latifolius* এর অঙ্কুরোদগমের উপর প্রি-ট্রিটমেন্টের প্রভাব ($p \leq 0.05$) তাৎপর্যপূর্ণ। প্রাপ্ত ফলাফলে দেখা যায় যে, তার জালির সাহায্যে স্কেরিফাইড (scarified) বীজের অংকুরোদগম হার সর্বোচ্চ (৭০%) এবং কন্ট্রোলের ক্ষেত্রে সর্বনিম্ন (৪৪%)। চারার বৃদ্ধির উপরও প্রি-ট্রিটমেন্টের প্রভাব দেখা যায়, তার জালি দিয়ে স্কেরিফিকেশনকৃত বীজে সবচাইতে বেশি ভিগর ইনডেকস (১০০৮) পাওয়া যায় এবং সবচাইতে কম ভিগর ইনডেকস (৪৭৫) পাওয়া যায় কন্ট্রোল বীজের ক্ষেত্রে। মাঠে লাগানোর এক বছর পর চারার বাঁচন হার ৯২% এবং দুই বছর পর গড় উচ্চতা ১২৩.১ সে.মি.। অতএব পর্যবেক্ষণ হতে প্রতীয়মান হয় যে, *Calamus latifolius* Roxb. এর নার্সারি উত্তোলনের জন্য তার জালি দ্বারা স্কেরিফাইডকৃত বীজ বপন সবচেয়ে ভাল এবং সফল বাগান উত্তোলনের জন্য এক বছর বয়সী চারা ২ মি. x ২ মি.দূরত্বে লাগানো যেতে পারে।

Keywords: *Calamus latifolius,* Scarified seeds, Germination percentage, Survival potential, Pre-sowing treatment, Seedling growth.

Introduction

Rattan is a spiny climbing palm belonging to the family Arecaceae (Moore 1973; Charles 2014) and comprises an integral part of the tropical forest ecosystem (Moore 1973). Rattans are second most important non timber forest products after bamboo in the tropical and sub-tropical countries of Asia and Africa (Uhl and Dransfield 1987; Sunderland 2002; Ogunwusi 2012; Haider *et al*. 2014; Wan *et al*. 2018). It has gained additional interest among the people because of increased awareness as well as their vital roles in socioeconomic development and socio-ecological research issues (Nagabatla *et al*. 2007). Rattans are important sources of income and employment for millions of people all over the world directly or indirectly (Manokaran 1990; ITTO 1997; Ogunwusi 2012; Renuka *et al*.1998).

Six hundred species of rattans under 13 genera were recorded in the world earlier (Renuka *et al*. 1998). However recent report shows existence of only 550 species (Dransfield *et al*. 2008). Out of these, 15 species were recorded so far in Bangladesh (Wong 1984; Alam 1990, 1991; Basu 1991, 1992; Ali 2003). However, recent investigation provided a list of 10 species under two genera growing in the country (Ara 2008; 2011). This rattan resource has been exhausted recklessly in recent years due to over exploitation and poor management (Siddiqi 1995). Moreover, steady loss of forest habitat due to urbanization and industrialization is also posing a serious threat to rattan supply. High demand for these resources, along with unabated harvesting and deforestation, has led the resources towards the depletion in many rattan-producing areas (Supardi *et al*. 1999). To cope up with ever increasing global demand, there is an imperative need for sustainable management of rattan resources. To achieve this goal, immediate attention is needed for establishing rattan plantations and also proper management of existing rattans in their natural habitats. Establishing rattan plantation requires appropriate knowledge about nursery development, plantation raising and stand management for sustainable development (Siddiqi 1995).

Calamus latifolius locally known as budum bet, occurs naturally in the dry hill slopes with sandy loam soil of evergreen forests of Chittagong, Chittagong Hill Tracts, Cox's Bazar, Sylhet and Gazipur district in Bangladesh (Alam 1990; Ara 2008). The species is found in robust clustering to form dense clumps, erect for climbing where support tree is available (Fig. 1). Leaves cirrate, 3 – 5 m long including petiole and cirrus; leaf sheath with prominent knee, armed with subulate, sub-regularly verticillate, dark brown, 3 cm long spines; ocrea liguliform; rachis terete in cross section, without claws on the ventral side, armed only with small spicules; leaflets not many, papery, in equidistant on rachis, broadly lanceolate or elliptic-lanceolate, slightly concavo-convex, to 50 cm long, 10 cm wide at broadest part, 5-7 nerved; nerves smooth on both sides. Fruit sessile, fruiting calyx broadly campanulate, about 12 cm. long. Seed almost half convex, grooved and regularly wrinkled. Flowering occurs in November to December and fruiting in May to June.

Figure 1. Leading shoot and spiny stem of *Calamus latifolius*

It is mainly used for making rough baskets, walking sticks, batons and furniture frames; split canes for weaving chair bottoms. With depletion of rattan resources *C. latifolius* is also depleted all over the country and hardly found in the natural condition in forests. To ensure sustainable development and continuous supply of rattans, several initiatives have already been taken to increase the rattan plantations and the overall production by involving the government, non-government and other agencies in the country. For the purpose sound knowledge on nursery raising and plantation development, updated techniques and management systems are required for the species.

Rattan research in Bangladesh was initiated about four decades back and considerable information relating to germination and nursery techniques for selected rattan species are available (Banik and Nabi 1979, Alim and Kalimuddin 1985, Mohiuddin *et al*. 1986, Rashid *et al*. 1993, and Ara *et al*. 1994, Haider *et al*. 2014). Rattan propagation largely depends on seed germination, wildings, suckers and tissue cultured materials for plantation. Among them, seedlings from seeds are the most important propagating materials for large-scale plantations program of rattan (Tan 1942 and Mohd *et al*. 1992). Variations has been seen in germination percentage and germination period of different rattan species. The seed viability after collection may affect the germination period and percentage. Moreover, hard seed coat in association with possible seed dormancy requires longer period to germinate in most of the species of rattan (Rashid and Mohiuddin 1988). Pre-sowing treatments, especially, removal of fleshy pulp or scales from the intact fruits has been reported to influence the seed germination and seedling growth performance in many tropical tree species. For instance, depulping of fruits and soaking of the seeds in water for 48 hours enhanced the seed germination and seedling growth of Terminalia bellerica (Ara *et al.* 1997, Hossain *et al*. 2005a), *T. chebula* (Nainar *et al*. 1999, Hossain *et al*. 2013) and Grevillea robusta (Anonymous 2000). The effect of pre-sowing treatments on seed germination process of some tropical forest tree species has been reported by a number of authors (Alamgir and Hossain 2005, Matin *et al*. 2006, Azad *et al.*

2011, 2012; Haider *et al*. 2014, 2016). There are some reports on pre-sowing treatment and germination of some rattan species. For example, pre-treatment of *Daemonorops jenkinsiana* clean seeds with 10% H_2SO_4 or HCl enhanced seed germination by 68.14% with both the treatments (Ara *et al*. 1994). Haider *et al*. (2014) reported that depulped clean seed of *C. longisetus* enhanced the seed germination by 73.3%. However, information about the regeneration of *C. latifolius* with seed treatments is very scarce. Further research related to the nursery raising techniques including seed germination, pre-sowing treatments and initial seedling growth performance of this species is therefore required with an ultimate objective of raising successful rattan plantation. Therefore, the present study was undertaken to investigate the effects of pre-sowing treatments on seed germination and seedling growth performance of *C. latifolius* in nursery and field condition.

Materials and Methods

The research was carried out in the nursery of Bangladesh Forest Research Institute (BFRI), Chattogram, Bangladesh, over a period of four years from June 2014 to June 2017. The study area was located between 22°22·27′′ and 22°29·0′′ North latitude and 91°46·30′′ and 91°46·30′′ East longitude having a tropical climate, characterized by hot humid summer and cool dry winter. The maximum and minimum temperature in the area is 28.3 - 31.9°C and 15.2 - 25.2°C (Hossain and Arefin 2012). Relative humidity is usually low in winter (November - February) and high in summer (June - September). Mean annual rainfall is around 3000 mm mainly occurring from June to September.

Seed collection and pre-sowing treatments

Ripe fruits of *C. latifolius* were collected from Salna seed orchard center, under Gazipur district of Bangladesh in the first week of June 2014. To determine the effect of pre-sowing treatment on seed germination and seedling growth performance, five different treatments of seeds were applied namely; i) seeds soaked in tap water for 24 h, ii) soaked in tap water for 48 h iii) soaked in 20% H_2SO_4 for 10 minutes iv) scarification by wire net and v) control (seeds were sown without any treatment). Seeds were cleaned by removing the scale and pulp by rubbing (Fig. 2). The number of whole fruits and cleaned seeds per kg were 600 - 650 and 1200-1400, respectively. Then the seeds were sown in seed bed prepared with soil and decomposed cow dung mixed at a ratio of 3:1 by volume. Randomized Complete Block Design (RCBD) was adopted for the experiment with three replications. One hundred fifty (150) seeds were sown in each treatment at the rate of 50 seeds in each replication and a total of 750 seeds were required for five treatments of the germination trial.

(A) (B)

Figure 2. Whole fruits (A) and clean seeds (B) of *C. latifolius*

Assessment of seed germination and seedling growth performance

The effects of pre-sowing treatments on seed germination and seedling growth performance were recorded periodically by counting the germinated seeds and assessing initial growth performance of the seedlings. Cumulative germination was recorded at three days interval from the day of sowing and continued till completion of germination. Germination phase was determined by counting the number of days required for the commencement of germination and germination period is the number of days required for completion of germination from sowing the seeds. For assessing the growth performance, height of all seedlings were measured, and number of leaves counted at one month age of seedlings. Besides these ten seedlings from each replicate (30 from each treatment) were randomly uprooted and measured for total length (root length and shoot length separately). Seedling vigor index (VI) was calculated according to Abdul-Baki and Anderson (1973) through multiplying the germination percent by total length of seedlings (i.e. sum of shoot and root length).

Assessment of seedling growth performance in the nursery and the field

Since, seed germination percentage and initial growth performance of seedlings was highest in the seeds scarified with wire net in the previous experiment, only the scarified *C. latifolius* seeds were sown for assessing the seedling growth performances in the nursery and field. Three thousand scarified seeds were sown in three blocks (considered as replications) in nursery bed for the purpose. When the seedlings were about one month old (with 2 - 3 leaves), they were transferred in to the polybags (23 cm x 15 cm) filled with soil and cow dung mixture. The polybags were kept under full shade for one week and then placed under direct sunlight where they were allowed to grow. When the seedlings were about one-year old, 500 seedlings were out planted in five plots in the field at the beginning of the monsoon, e.g. June. Another 500 seedlings were allowed to grow in the nursery for one more year. Data on shoot and root length and leaf number of these seedlings were recorded at 3, 6, 12 and 24 months after transferring them in polybags. Seedlings in the field were planted at 2 m × 2 m spacing at Hinguli Research Station, Chattogram, Bangladesh. The soil was sandy-loam with a pH 5.7- 6.0. Average rainfall of the area was about 3200 mm and average maximum and minimum temperature was 34.7°C and 20.7°C respectively, indicating the suitable eco-physiological conditions for rattan plantations (Xu 1985). Weeding were done at every 3 months in the field. However, no fertilizer or water was added after planting. Data on height of all plants in each plot were recorded at 6, 12 and 24 months after planting. Survival percentage of the planted seedling in the field was determined 1 year after planting.

Data analysis

Data were analyzed with Microsoft Excel to determine the significant ($p \leq 0.05$) variations among the treatments. Analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) were carried out to analyze the data.

Results

Seed germination and initial growth performance of the seedlings

Pre-sowing treatments were found to influence the germination period and germination percentage

of *C. latifolius* seeds significantly. The seeds scarified by wire net showed the maximum germination (70%) within 54-74 days after sowing (DAS). Seeds soaked in 20% H_2SO_4 for 10 minutes showed 50% germination within 60-80 DAS. Seeds soaked in tap water for 24 and 48 hours showed 46% and 48% germination within the 62-88 and 60-84 DAS respectively. The lowest (44%) germination was recorded for control within 62-90 days (Fig 3 A, B). Germination percentage in seeds scarified by wire net was found significantly ($p \leq 0.05$) higher than the other treatments. However, no significant variation was observed among the seeds treated with 20% H_2SO_4 for 10 minutes and seeds soaked in tap water for 24 and 48 hours.

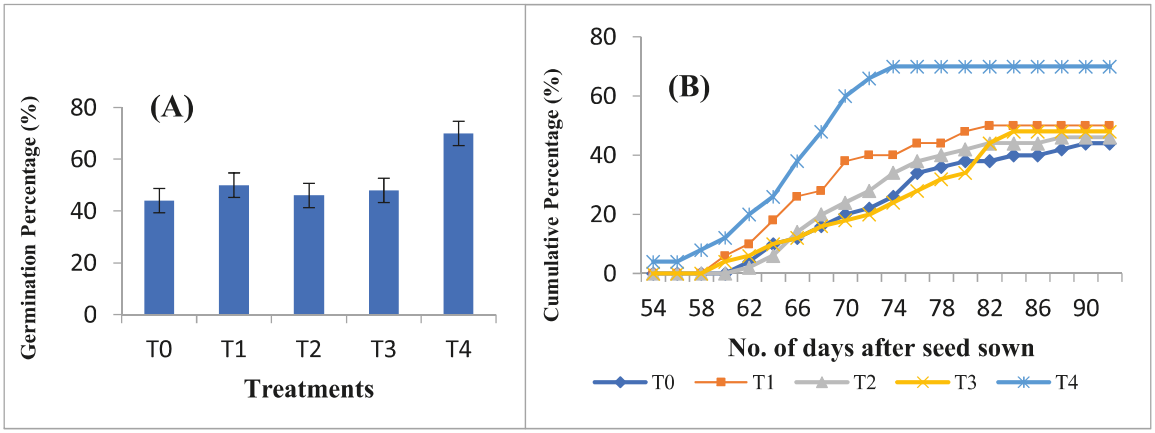

Figure 3. Germination percentage (%) of *C. latifolius* (A) and trend lines showing progress of germination under different treatments (B).

[Note: T0= control, T1= Soaked in 20% H2So4 for 10 minutes, T2= Soaked in tap water 24 h, T3= Soaked in tap water 48 hours, T4= Scarification by wire net].

The initial growth performance of the *C. latifolius* seedlings was also significantly influenced by the pre-sowing treatment of the seeds. The shoot length (from base to leaf tip), root length, leaves number and vigor index are shown in Table 1. The highest length of shoot (8.40 cm) and root (6.0 cm) and vigor index (1008) was found in the seeds scarified by wire net, which values were much higher than that of other treatment. However, there was no significant variation in the leaf number among the treatments.

Table 1. Growth performance of *C. latifolius* seedlings germinated from various treatment one months after germination

Treatments	**Growth parameters**			
	Ave. shoot length (cm)	**Ave. root length (cm)**	**Ave. no. of leaves per seedlings**	**Vigor index**
Soaked in tap water for 24 h	6.80± 0.20 ^{bc}	4.60± 0.24 ^{b}	2.00± 0. 00 ^{a}	524.4 ^{cd}
Soaked in tap water for 48 h	7.20± 0.20 ^{bc}	4.60± 0.24 ^{b}	2.00± 0. 00 ^{a}	566.4 ^{c}
Soaked in 20% H_2So_4 for 10 minutes	7.80± 0.37 ^{ab}	5.40± 0. 24^{ab}	2.00± 0.00 ^{a}	660 ^{b}
Scarification by wire net	8.40± 0.51 ^{a}	6.00± 0. 32^{a}	2.20± 0. 20 ^{a}	1008^{a}
Control	6.20± 0.37 ^{c}	4.60± 0. 24 ^{b}	1.800± 0. 20 ^{a}	475.2 ^{d}

Note: Treatment values associated with same letters indicates no significance difference among the treatments at $p \leq 0.05$; ± indicates standard error of means

Seedlings growth performance in polybag

The study reveals that the germination percentage of *C. latifolius* was higher in scarified seeds than other treatments (Fig. 3). The initial growth performance of seedlings in terms of shoot and root length and vigor index was also found significantly higher than other treatments (Table 1). Therefore, we sowed only the scarified seeds in the seed beds for assessing the seedling growth performances in polybag and field condition. Three thousand scarified seeds were sown in three blocks (considered as replications) in nursery bed for this purpose. The germination percentage (71 ± 2.3) was almost similar of the previous experiment (Fig. 3). One-month old seedlings having 2-3 leaves were transferred to the polybags filled with soil - cow dung media and allowed to grow there.

(A) (B)

Figure 4. One-month old seedlings of *C. latifolius* in nursery bed (A) and one-year old seedlings in polybag (B).

After one year of transferring the seedlings in the polybags, 500 seedlings were out planted in the field. Rest of the seedlings (500) was grown in the nursery for another one year. The seedling mortality in the nursery bed and after transplanting the seedlings to the polybags is around 1-2 % which is very negligible. Seedlings growth performance was recorded in polybag at different age is shown in Table 2. The seedlings attained 15.4 cm height with average length of root 8.4 cm and 3.2 leaves in three months. Seedlings were found to become quite tough and attained a height of 21.6 cm with 12 cm root and 7.2 leaves at six months. The average height (28.4 cm) with 14.8 cm root and 8.2 number leaves was recorded at 12 months. The seedlings attained a height of 65.8 cm with 22 cm long root and 11 leaves at 24 months (Table 2 and Fig 4 B).

Table 2. Seedlings growth performance of *C. latifolius* at different age in the nursery (polybag)

Age of seedlings (months)	Ave. height (shoot) (cm)	Ave. length of roots (cm)	Ave. No. of leaves Per seedlings
3	15.4± 0.51	8.4± 0.68	3.2± 0.37
6	21.6± 0.68	12± 0.55	7.2± 0.37
12	28.4± 1.17	14.8± 0.86	8.2± 0.37
24	65.8± 3.12	22± 0.71	11± 0.71

Note: The figure in each column mean followed by standard error (SE) of means.

Seedling survival and growth performance in the field

One year old seedlings of *C. latifolius* developed from scarified seeds grown in polybags were planted in the field. Survival and seedlings growth performances were determined at 6, 12 and 24 months after planting in the field (Table 3). Survival percentage varied from 90 - 96 with an average of 92.4 among the plots. The seedling height varied from 51.4 - 65.44 cm at six months, 67.7 - 80.7 cm in one year and 116 . 3 - 130.1 cm in two years after planting in the field (Table 3).

Table 3. Survival percentage and seedling growth performance of *C. latifolius* after out planting

Plots	Survival % at 12 months	Average Height (cm)		
		6 months	12 months	24 months
Plot-1	93	$53.8\pm.9391^{cd}$	72.5 ± 2.1331^{bc}	118.5 ± 1.7292^{b}
Plot-2	96	65.44 ± 2.1248^{a}	80.7 ± 1.3903^{a}	130.1 ± 1.2830^{a}
Plot-3	91	61.3 ± 1.0416^{ab}	78.88 ± 3.2914^{ab}	128.58 ± 3.1026^{a}
Plot-4	92	58.4 ± 2.3611^{bc}	69.2 ± 1.1904^{c}	122.16 ± 1.4194^{b}
Plot-5	90	$51.4\pm.6943^{d}$	67.7 ± 2.5020^{c}	116.3 ± 1.4866^{b}

Note: Means followed by the same letter (s) are not significantly different at $p \leq 0.05$, according to Duncan's Multiple Range Test (DMRT). ± indicates the standard error of the mean.

Discussion

Resembling to the other members of the family Palmeae, the species *Calamus latifolius* required long time to germinate. Generalao (1980) reported that cane seeds take weeks to six months to germinate depending on the species and method of treatment. Sumantakul (1989) reported that *C. longisetus* seed in different media starts to germinate from 30 days and continues till 60 days. Banik and Nabi (1979) mentioned that the seeds sown with intact sarcotesta require two to three months to start germination and give poor germination percentage (10- 26% only). Haider *et al*. (2014) reported that clean seeds of *C. longisetus* showed 60% germination within 70-80 days. The findings of the present research are also alike to those previous studies mentioned here.

The initial growth performance of the *C. latifolius* seedlings was also found to affect significantly by the pre-sowing treatment of the seeds. The highest length of shoot and root and vigor index was noticed in the scarified seeds than other treatments. However, there was no significant variation in the leaf number among the treatments. Hossain *et al*. (2013) mentioned that the seedling growth including root, shoot and total length of *T. chebula* was significantly increased with pre-sowing treatment specially by depulping the fruits. Haider *et al*. (2014) reported that root, shoot and total length was significantly enhanced by pre-sowing treatment in *C. longisetus*. Findings of present study also agree with those of previous studies mentioned here.

The vigor index of the seedlings in this study was increased from 475.2 in the control to 1008 in the scarified seeds (Table 1). The vigor index depends on the germination percentage and the seedling length. The study reveals that there was marginal variation in seedlings length among the treatments. However, the germination percentage with scarified seed was much higher than the other treatment which leads the vigor index considerably higher in the scarified seeds than other treatments. The findings almost similar to the findings of Haider *et al*. (2014b, 2016).

The height growth of seedlings in the field was always significantly higher in plot 2 than in the other plots and lowest in plot 5. This variation of the seedlings height growth was probably due to the microclimate of the plots. Since the survival percentage of the seedlings in the field was quite satisfactory, one-year old seedlings may be considered for planting the species in the field. The finding is similar to the report made by Haider *et al*. (2014b) in case of *C. longisetus* in Bangladesh. Kerala Forest Research Institute, India also noticed similar report and mentioned that rattan seedlings were out planted at the age of one year (Fewa 1994).

Conclusion

Due to scaly seed coat and stony nature of seed, germination behavior of *Calamus latifolius* is similar to other members of the family Palmeae and needs longer time to germinate. *C. latifolius* seeds start germination after 54 days of sowing and complete within 90 days. Maximum seed germination and highest initial growth performance of the seedlings was observed in scarified seeds which was much higher than the other treatments. Pricking of the seedlings after 30-35 days of germination from nursery bed to polybags ensures negligible mortality. Survival of seedlings and growth performance in the field was satisfactory when one year old seedlings were out planted at 2 m × 2 m spacing. Thus, clean scarified seeds are suitable for nursery raising and one-year old seedlings might be recommended for plantation program of the species.

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References

Abdul-Baki, A. and Anderson, J. D. 1973. Vigor determination in soybean seed by multiple criteria. *Crop Science* 13:630-633.

Alam, M. K. 1990. Rattans of Bangladesh. Bulletin 7. Plant Taxonomy Series. Bangladesh Forest Research Institute, 33 p.

Alam, M. K. 1991. Rattan resources of Bangladesh and their status. *RIC Bulletin* 10(1):2-5.

Alamgir, M. and Hossain, M. K. 2005. Effect of pre-sowing treatments on *Albizia procera* (Roxb.) Benth. Seeds and initial development of seedlings in the nursery. *Journal of Forestry and Environment* 3: 53–60.

Ali, S. S. 2003. Forest and Forestry. In: Islam, S. and Miah, S. (eds). *Banglapedia*. Asiatic Society of Bangladesh, Dhaka. 4:248-250.

Alim, A. and Kalimuddin, M. 1985. Development of nursery procedure of three cane species. *Bano Biggyan Patrika* 14(1&2):26-29.

Anonymous 2000. *Grevillea robusta* Seed. Danida Forest Seed Centre, Leaflet 14: 2.

Ara, R. 2008. An Overview of Rattan Resources in Bangladesh. Document no.2. Market Development of Bamboo and Rattan Products with Potential. CFC INBAR-01 Project, 9p.

Ara, R. 2011. Assessment of reproductive features and propagation potential in rattans of Bangladesh. *Indian Forester* 137(12):1445-1450.

Ara, R.; Merry, S. R. and Siddiqi, N. A. 1997. Cultivation and uses of twelve medicinal plants of Bangladesh. Minor Forest Products Series, Bangladesh Forest Research Institute, Chittagong, Bulletin 7:727-731.

Azad, M. S.; Manik, M. R., Hasan, M. S. and Matin, M. A. 2011. Effect of different pre-sowing treatments on seed germination percentage and growth performance of *Acacia auriculiformis. Journal of Forestry Research* 22 (2): 183–188.

Banik, R. L. and Nabi, M. N. 1979. A note on the flowering periodicity and the seed germination in bara bet. *Bano Biggyan Patrika 8* (1&2):52-56.

Basu, S. K. 1991. Living rattan collection in the Forest Research Institute, Chittagong. *RIC Bulletin* 10(2):5-6.

Basu, S. K. 1992. Rattans (Canes) in India: A Monographic Revision. Rattan Information Centre, Forest Research Institute, Keopong, Malaysia. 141 p.

Charles, M. P.; Henderson, A.; Dung, N.Q. and Ledecq, T. 2014. Systematics, Ecology, and Management of Rattan in Cambodia, Laos and Vietnam. 236 p.

Dransfield, J.; Uhl, N. W.; Asmussen-Lange, C. B.; Baker, W. J.; Harley, M. M. and Lewis, C. E. 2008. Genera Palmarum: The Evolution and Classification of Palms. Kew Publishing, UK. 732 p.

Fewa, T. C. 1994. Nursery techniques. *In*: Mohd, W.R.W., Dansfield, J. and Monakaran, N. (eds). Nursery Techniques for Rattan. INBAR Technical Report 2: 1-21.

Generalao, M. L. 1980. How to grow rattan. FOR HOW-To Series no.1. *Pub. For Res. Inst*. College, Laguna, Philippines. 24 p.

Haider, M. R.; Alam, M. S. and Shutrodhar, A. R. 2016. Effect of pre-sowing treatment on seed germination and seedlings growth attributes of *Sapindus mukorossi* Gaertn.- an important medicinal plants in Bangladesh. *Journal of Bioscience and Agriculture Research* 6(2): 570-577.

Haider, M.R.; Alam, M.S. and Hossain, M.A. 2014b. Effect of pre-sowing treatment on germination and seedlings growth attributes of Acacia catechu Willd. in nursery and field conditions. *International Journal of Latest Research in Science and Technology* 3(4): 214-219.

Haider, M.R.; Alam, M.S.; Hossain, M.A. and Shukor, N. A. 2014. Impact of pre-sowing treatment on seed germination and seedlings growth attributes of *Calamas longisetus* Griff. at nursery and field conditions. *Journal of Food, Agriculture and Environment* 12 (3 &4):395-399.

Hossain, M. A. and Arefin, G. 2012. Mass clonal propagation of *Bambusa balcooa* and *B. nutans* by branch cutting in non-mist propagation system. *International Journal of Forest Usufruct Management* 13(2):13-25.

Hossain, M. A.; Arefin, M. K.; Khan, B. M. and Rahman, M. A. 2005a. Effects of different seed treatments on germination and seedling growth attributes of a medicinal plant bohera (*Terminalia belerica* Roxb.) in nursery. *International Journal of Forest Usufruct Management* 6:28-37.

Hossain, M. A.; Uddin, M. S.; Rahman, M. M. and Shukor, N.A.A. 2013. Enhancing seed germination and seedling growth attributes of a tropical medicinal tree species *Terminalia chebula* through depulping of fruits and soaking the seeds in water. *Journal of Food, Agriculture and Environment* 11(3&4): 2573-2578.

International Tropical Timber Organization. 1997. Bamboo and Rattan: Resources for the 21st Century. *Tropical Forest update* 7:13 pp.

Manokaran, N. 1990. The State of Bamboo and Rattan Trade. Rattan Information Centre Occasional Paper No. 7. RIC, Forest Research Institute, Kepong, Malaysia, 39 p.

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

Mohd, W. R. W.; Dransfield, J. and Manokaran, N. 1992. A Guide to the Cultivation of Rattan. *Malayan Forest Record* 35:293 pp.

Mohiuddin, M.; Rashid, M. H. and Rahman, M. A. 1986. Seed germination and optimal time of transfer of seedlings of *Calamus* sp. from seed bed to polythene bag. *Bano Biggyan Patrika* 15(1&2): 21-24.

Moore, H. E. Jr. 1973. The major groups of palms and their distribution. *Gentes Herbarum* 11(2): 27-141.

Nagabhatla, N.; Roy, P. S. and Jagdale, R. 2007. Monitoring spatial distribution of commercial rattans and palms in the tropical forest of Baratang Islands (Andaman and Nicobar Islands). *Indian Journal Traditional Knowledge* 6(4):630-635.

Nainar, P.; Sundharaiya, K. and Ponnuswamy, V. 1999. Germination studies in Kadukkai *(Terminalia chebula). South Indian Horticulture* 47:1- 6.

Ogunwusi, A. A. 2012. Challenge of Industrial Production and Processing of Rattans in Nigeria. *Journal of Research in National Development* 10:50-59.

Rashid, M. H. and Mohiuddin, M. 1988. Canes of Bangladesh and Their Cultivation. *Krishikatha,* Ashin, pp. 287-289 (in Bengali).

Rashid, M. H.; Merry, S. R.; Ara, R.; Mohiuddin, M. and Alam, M. J. 1993. How to Cultivate Rattan and Patipata. Bulletin 6. Minor Forest Products Series. Bangladesh Forest Research Institute, 12 p. (in Bengali).

Renuka,C.; Indira, E. P. and Muralidharan, E. M. 1998. Genetic Diversity and Conservation of Certain Species of Rattan in Andaman and Nicobar Islands and Southern India. KFRI Research Report 157, Kerala Forest Research Institute, Peechi, Thrissur, 38 p.

Siddiqi, N. A. 1995. Rattan research in Bangladesh. *INBAR Newsletter*, India. 3(2): 8.

Sumantakul, V. 1989. Preliminary studies on the germination of *Calamus latifolius* Roxb. and *Calamus longisetus* Griff. In Rao, A. N. and Vongkaluang, I. (eds). Recent Research on Rattans: Proceedings of the international Rattan Seminar. Nov. 12-14, 1987. Chiangmai, Kasetsart University, Thailand and IDRC, Canada.116-121 pp.

Sunderland, T. C. H. 2002. Recent research into African Rattans (*Palmae*): A valuable non wood forest products from the forests of central Africa. FAO document repository.

Supardi, M. N. N.; Khali Aziz, H. and Wan Razali, M. 1999. Considerations in rattan inventory practices in the tropics. *INBAR Technical Report* 14. International Network for Bamboo and Rattan, Beijing, China. 57 p.

Tan, C. F. 1982. Selection of rattan species, planting sites and planting materials.

Uhl, W. and Dransfield, J.1987. Genera Palmarum, a classification of palms based on the work of H. E. Moore Jr. L.H. Bailey Hortorium and International Palm Society, Lawrence, Kausas. 603 p.

Wan, T.W.A.; Kaam, R.; Muralidharan, E.M.; Sreekumar, V.B.; Chowdhary, C.; Sheng, R.; Viet, Le.; Sunderland, T.; Haider, M.R.; Tekpety, S.; Olorunnisola, A.O.; Achdiawan, R. and Hourt, K.E. 2018. Rattan Terminologies. A publication of INBAR Taskforce on Rattan Uses and Development 29 p.

Wong, K. M.1984. On the Feasibility of an Export oriented Rattan Furniture Industry in Bangladesh. Occasional Paper No. 1. Rattan Information Center, Forest Research Institute, Malaysia (FRIM), Keopong. 15 p.

Xu, H. 1985. Country Report: China. Proceedings of the Rattan Seminar, Kuala Lumpur, Malaysia. The Rattan Information Centre, Forest Research Institute, Kepong, Malaysia. 209-211pp.