

Raising of *Calamus erectus* Roxb. Seedlings and their Performance at Nursery and Field Conditions

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Abstract

The paper deals with seed germination and seedlings growth performance of *Calamus erectus* in the nursery and field conditions. Clean seeds were sown in the seed bed filled with soil and decomposed cow dung at 3:1 ratio. Seeds started germination after 52 days of sowing and completed within 76 days with maximum 78% germination. The survival performance of the seedlings was determined by transferring the seedlings from germination bed to the polybags from 10-80 days after germination with 10 days interval. Optimum survival (100%) was found significant ($p \leq 0.05$) transferring after 30-40 days of germination from seedbed to polybag. Plantation in the field was made with one year old seedling at 2.0 m x 2.0 m spacing. Average seedlings survival was 94% after one year of plantation in the field. Mean seedling height was recorded 94.6 cm after two years of planting. Survival of seedlings and growth performance in the field were satisfactory when one year old seedlings were out-planted. Clean or decoated seeds for nursery raising and one year old seedlings were found suitable for successful plantation raising of *Calamus erectus*.

সারসংক্ষেপ

বর্ষিত প্রবন্ধে *Calamus erectus* এর বীজের অঙ্কুরোদগমের হার নির্ণয়, নার্সারি ও মাঠে চারার বৃদ্ধি পর্যবেক্ষণ করা হয়। মাটি ও গোবর ৩ঃ১ অনুপাতে মেশানো বেড়ে পরিষ্কার বীজ বপন করা হয়। বীজ বপনের ৫২ দিনের পরে অঙ্কুরোদগম শুরু হয় এবং ৭৬ দিনে সম্পূর্ণ হয় এবং সবচাইতে বেশী ৭৮% অঙ্কুরোদগম পাওয়া যায়। ১০-৮০ দিন বয়সের চারা ১০ দিন অন্তর অন্তর সীডবেড থেকে পলিব্যাগে স্থানান্তর করে বেঁচে থাকার হার নির্ণয় করা হয় এবং ৩০-৪০ দিন বয়সের চারা বীজ তলা থেকে পলিব্যাগে স্থানান্তর করলে চারার বেঁচে থাকার হার সবচেয়ে বেশী (১০০%) এবং এটি তাৎপর্যপূর্ণ ($p \leq 0.05$)। এক বছর বয়সী চারা ২.০ মি. x ২.০ মি. দূরত্বে মাঠে লাগিয়ে বৃদ্ধি পর্যবেক্ষণ করা হয়। মাঠে লাগানোর এক বছর পর চারার গড় বেঁচে থাকার হার ৯৪%। দুই বছর পর চারার গড় উচ্চতা ৯৪.৬ সে.মি. পাওয়া যায়। এক বছর বয়সের চারা মাঠে রোপণের পর চারার বেঁচে থাকার হার এবং বৃদ্ধি সন্তোষজনক। নার্সারি উত্তোলনের জন্য পরিষ্কার বা তুর্কবিহীন বীজ এবং সফল বাগান উত্তোলনের জন্য এক বছর বয়সী চারা উপযুক্ত বলে প্রতীয়মান হয়।

Key words: *Calamus erectus*, Germination percentage, Seedling growth, Survival percentage.

Introduction

Calamus erectus L. commonly known as rattan, is the largest genus of the family Arecaceae (Palmae) with about 520 species worldwide, mostly distributed in the Asia-Pacific region and Africa (Dransfield *et al.* 2008; Baker 2015; Baker and Dransfield 2016). Out of these, 15 species were recorded in Bangladesh (Wong 1984; Alam 1990, 1991; Basu 1991, 1992; Ali 2003). Recent investigation provided a list of 10 species under two genera growing in the country (Ara 2008, 2011). Rattan is the 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). The ethnic communities and the settlers heavily depend on the natural resources for their subsistence as well as for cash income (Chauhan *et al.* 2004). The rattan resource has exhausted recklessly in recent years due to over exploitation and poor management (Siddiqi 1995). To cope with ever increasing global demand, it is an imperative for sustainable management of rattan resources. To achieve this goal, immediate attention is needed for establishing rattan plantations and also management of existing rattans properly in their natural habitats.

Calamus erectus is a non-climbing species of rattan. It is locally known as sita bet, occurs naturally in sloppy pockets of hills, mixed with scrub vegetation, found in the Sitapahar (Chattogram), Khadimnagar (Sylhet), Ampupara (Bandarban) and BFRI (Chattogram) in Bangladesh (Alam 1990; Ara 2008). *C. erectus* is globally distributed in the region of China, Bangladesh, Bhutan, India, Laos, Myanmar, Nepal and Thailand (Flora of China 2010). It is a non climbing species with hairy young shoots. Stem with leaf sheath 3.5-4 cm in diameter; exposed part of the stem green and smooth; internodes 10-12 cm long. Leaves ecirrate, 3-5 m long; leaf sheath without

flagellum, armed with black, flattened spines; ocrea conspicuously auriculate; petiole 1.5 m long, subterete, covered with irregular, whorled spines. Leaflets linear-ensiform, equidistant, green on both sides; rachis armed below with irregular to whorled straight spines. Inflorescence 1m long, compact, non-flagelli form; primary bract elongate, tubular, lacerate in upper part; peduncle strongly armed with black, flattened comb-like spines; male rachillae slender, sterile basal part of rachillae enclosed within the basal bracts. Male flowers bifarious, narrowly oblong, obscurely 3-angled at base. Calyx campanulate, 3-lobed, lobes apiculate, corolla with 3 distinct petals. In female inflorescence rachillae without sterile basal part. Fruit ellipsoid, 3 cm x 2 cm, with distinct conical beak. Seed oblong to ovoid, terete in cross section; endosperm ruminant; embryo basal. Flowering twice in a year: April-May and August-September. Fruiting time is October to February. Fruits are about 2 cm long, roundish, with a thin scaly pattern cover which turn reddish brown when ripe. The fleshy aril covered the seed (Fig.1).

The plant has medicinal uses (Basu 1992). The fruits are edible, stems are used for making baskets, chair, etc. (Angami *et al.* 2006). It is also used for making houses for chicken, making strings of the bows for teasing cotton. *C. erectus* is mostly used for garden fencing, making animal shades, structural material for making furniture (Alam 1990). Young shoots are eaten as vegetables; the fruits are also eaten by rural people. Seeds can be used as a substitute of betel nut. *C. erectus* is an important member of the family palmae in Bangladesh with limited occurrence. The population of the species is declining gradually. To stop the declining trend it is important to know its germination pattern, seedling raising technique and also plantation technique etc. for future plantation program. Considering the facts the study has been undertaken to develop nursery and plantation techniques.

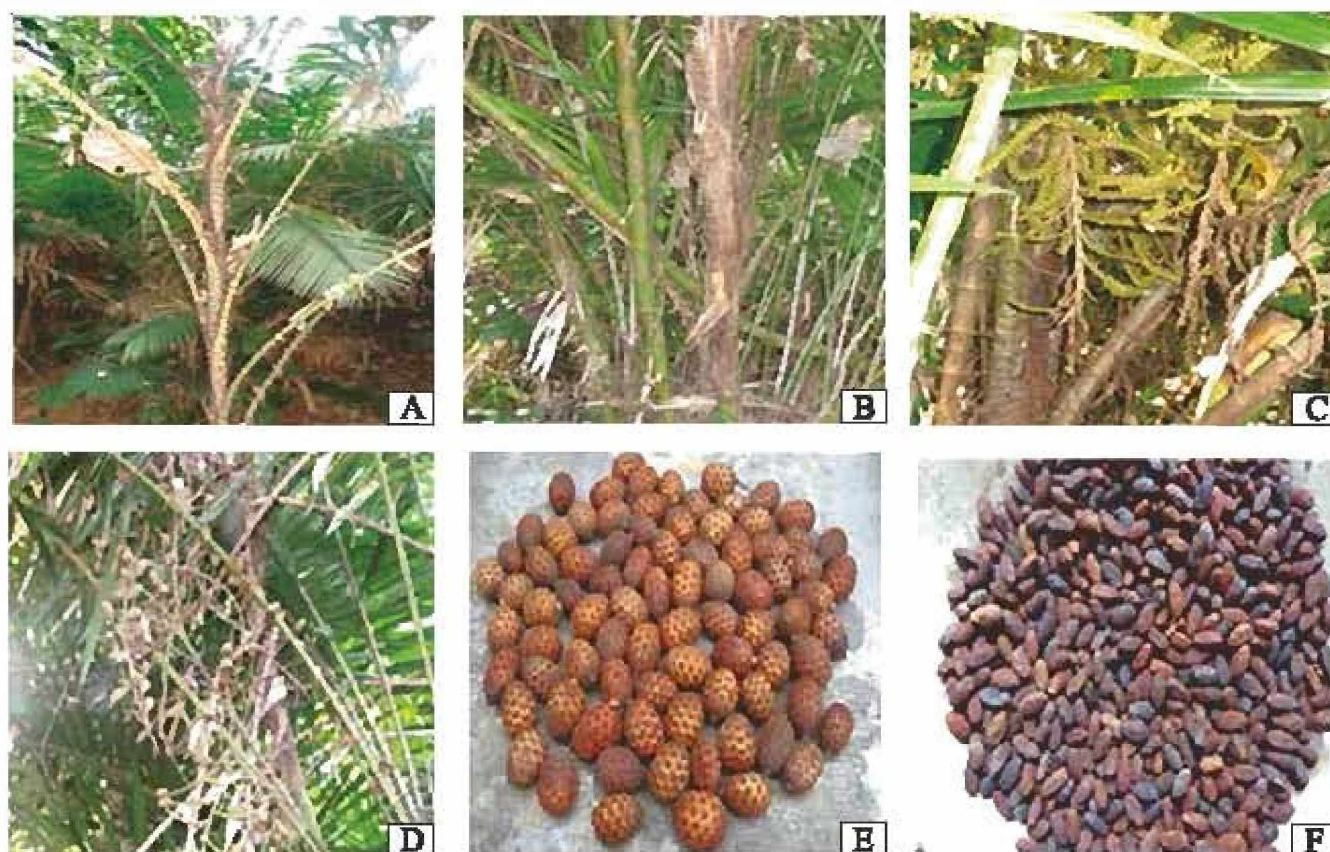


Figure 1. *Calamus erectus* clump (A), Stem (B), Inflorescence (C), Fruits in the clumps (D), Whole fruits (E) and Clean seeds (F).

Materials and Methods

The study was carried out in the nursery of Bangladesh Forest Research Institute (BFRI), Chattogram, Bangladesh over a period of three years from June 2014 to May 2017. Geographic position of the study area is situated between 22°22.27" and 22°29.0" North latitude and 91°46.30" and 91°46.30" East longitudes. The climate of the study area is tropical in nature and characterized by hot humid summer and cool dry winter. The maximum and minimum temperature in the area varies from 28.3 to 31.9° C and from 15.2 to 25.2° C (Hossain and Arefin, 2012). Mean annual rainfall is around 3000 mm mainly occurred from June to September.

Collection of seeds and germination trials

Ripen fruits of *Calamus erectus* were collected from natural forest of Sitakunda, under Chattogram district of Bangladesh in the first week of June 2014. The numbers of whole fruits and cleaned seeds per kg were 120 - 150 and 250 - 350 respectively. Clean seeds were obtained by removing the scale and pulp through rubbing. For germination trials clean seeds of *C. erectus* were sown in the seed bed filled with soil and decomposed cow dung mixture at a ratio of 3:1 by volume. Completely Randomized Design (CRD) was adopted for the experiment with three replications. Hundred seeds were sown in each replication and total of 300 seeds were sown for germination trial. Germination was recorded at 3 days interval till the end of the germinations.

Determination of optimum transplanting time of the seedlings

To determine the optimum transplanting time of seedlings from seedbed to polybag an experiment was conducted. Seedlings were transplanted to 23 cm x 15 cm size polybag filled with soil and cow-dung at 3:1 ratio. Transferring of seedlings started at 10 days of its germination and continued up to 80 days with 10 days interval. Survival percentages of the transplanted seedlings were recorded one month after transplanting.

Seedlings growth performance in the nursery and field condition

To determine the seedlings growth performance in the nursery and the field, the seedlings of *Calamus erectus* about 30-40 days old (with 1-2 leaves), were transferred to the polybags (23 cm x 15 cm in size) filled with soil mixed with cow dung (3:1). The polybags were kept under full shade for one week and then placed under direct sunlight and allowed them to grow there. Data on survival percentage shoot length, root length and leaf numbers of seedlings were also recorded at 3 months, 6 months, 12 months and 24 months after transferring in polybags. On the other hand, when the seedlings were about one year old, 125 seedlings were out planted in the field at the beginning of the monsoon (June-July). Seedlings were planted in the field at 2.0 m x 2.0 m spacing at Bangladesh Forest Research Institute campus, Chattogram, Bangladesh. Weeding was done at every three months in the first year and at every six months in second year in the field. Survival percentage of the planted seedlings in the field was determined one year after planting and heights of each plant were recorded at 6 months, 12 months and 24 months after planting.

Data analysis

Data were analyzed with computer software IBM SPSS ver. 21 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

Germination success

Germination of *C. erectus* seeds showed the similar trends like other members of Palmae. Germination of seeds started after 52 days from sowing and continued up to 76 days. Germination was recorded 78 % (Fig. 2).

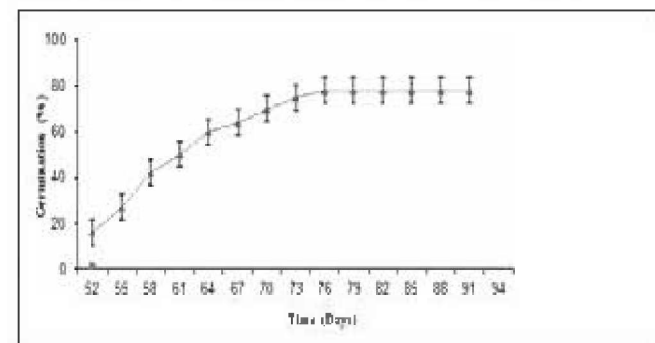


Figure 2. Germination of *Calamus erectus* over time.

Determination of optimum time for transferring of seedlings from seed bed to polybag

Ten days after germination, seedlings were transferred to polybags resulted 60% survival. Rest of the 40% seedlings were died. Seedlings transferring after 20 days of germination, survival were found 80%. Seedlings transferred after 30 days of germination, survival was recorded 100%. Similarly 100% seedlings survival was also recorded after 40 days of transferring from seed bed to polybag. Transferring of seedlings after 50 days of germination, survivality was noticed (90%). Transferring of seedlings after 80 days of germination, survivality was recorded 60% (Table 1). Survival percentage transferring after 30-40 days of germination was found significantly ($p \leq 0.05$) higher than other treatment. However, no significant variation was observed among 20, 50, 60 and 70 days after transferring.

Table 1. Seedling survival and performance of *C. erectus* after transferring to polybag over the time.

Days of transfer after germination	Survival percentage (%)	Average height of roots (cm)	Average length of shoots (cm)	Avg. no. of leaves per seedlings
10	60 ± 0.71 ^d	3.40 ± 0.18 ^g	2.75 ± 0.15 ^f	1.0 ± 0.0 ^d
20	80 ± 0.95 ^e	5.0 ± 0.14 ^f	4.15 ± 0.10 ^e	1.2 ± 0.13 ^{cd}
30	100 ± 0.0 ^a	8.10 ± 0.20 ^e	7.50 ± 0.22 ^d	1.5 ± 0.17 ^{bc}
40	100 ± 0.0 ^a	8.50 ± 0.16 ^{de}	7.70 ± 0.19 ^{cd}	1.6 ± 0.16 ^b
50	90 ± 0.45 ^b	8.90 ± 0.12 ^d	8.15 ± 0.11 ^{bc}	1.7 ± 0.15 ^{ab}
60	80 ± 1.30 ^e	10.0 ± 0.22 ^e	8.5 ± 0.15 ^{ab}	1.8 ± 0.13 ^{ab}
70	80 ± 1.41 ^e	11.20 ± 0.19 ^b	8.75 ± 0.15 ^a	2.0 ± 0.0 ^a
80	60 ± 1.14 ^d	13.15 ± 0.21 ^a	8.90 ± 0.19 ^a	2.0 ± 0.0 ^a

Seedlings growth performance in nursery condition

Based on the findings of the previous experiment 30 to 40 days old seedlings having 1-2 leaves were transferred to the polybags filled with soil - cow dung media and allowed them for growing there (Fig. 3). After one year of transferring the seedlings in the polybags, 125 seedlings were out planted in the field. Rests of the seedlings were grown in the nursery for one more year. Seedlings growth performance recorded in the nursery bed at different age shown in Table 2. Seedlings attained 15.6 cm

height (above ground) with average length of root 13.2 cm and 2.4 leaves in 3 months. After 6 months the seedlings became quite tough and attained average height of 22.4 cm with 15.6 cm root and 4.8 leaves. The average height of the seedlings was 30.2 cm with 19.6 cm root and 6.8 leaves were recorded at 12 months. The seedlings attained a height of 62.4 cm with 25.4 cm long root and 10.4 leaves at 24 months (Table 2).

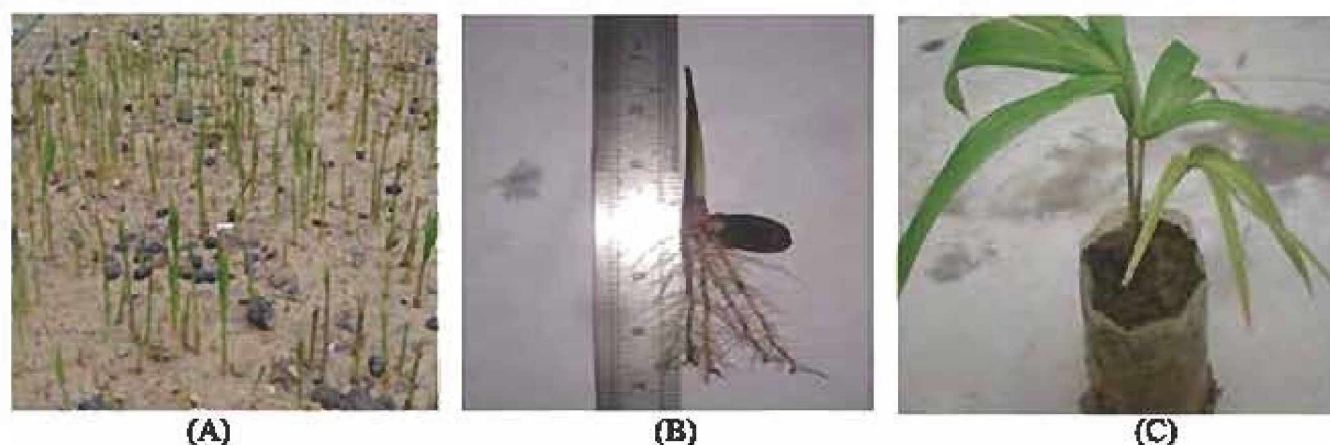


Figure 3. Different stages of seedlings of *C. erectus*. One-month old seedlings of *C. erectus* in nursery bed (A) an individual seedling prior to transfer into the polybag (B) and six-months old seedlings in the nursery (C).

Table 2. Seedling growth and survival performance of *Calamus erectus* at different age (up to 24 months) in the nursery.

Age of seedlings (months)	Survival (%)	Average height (cm)	Average length of roots (cm)	Average no. of leaves per seedlings
3	100 ± 0.0 ^a	15.6 ± 0.51 ^d	13.2 ± 0.37 ^d	2.4 ± 0.24 ^d
6	100 ± 0.0 ^a	22.4 ± 0.74 ^c	15.6 ± 0.50 ^c	4.8 ± 0.37 ^c
12	98 ± 1.58 ^b	30.2 ± 1.01 ^b	19.6 ± 0.67 ^b	6.8 ± 0.49 ^b
24	98 ± 1.0 ^b	62.4 ± 1.28 ^a	25.4 ± 0.74 ^a	10.4 ± 0.50 ^a

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

Seedlings survival and growth performance in the field

One-year old seedlings of *C. erectus* were planted in the field. Survival was recorded after one year of out planting and seedlings growth performance was recorded at 6, 12 and 24 months after planting in the field (Table 3). Survival percentage varied from 92 - 96 with an

average of 94 among the plots. The seedlings height varied from 44.1 - 48.5 cm at six months; 61.0 - 70.3 cm in one year and 90.0 to 102.2 cm in two years after planting in the field (Table 3).

Table 3. Survival percentage and seedling growth performance of *Calamus erectus* after out planting.

Plots	Survival % at 12 month	Average Height (cm)		
		6 months	12 months	24 months
Plot-1	94 ± 0.71 ^{ab}	44.1 ± 1.49 ^b	63.6 ± 1.36 ^{bc}	93 ± 1.0 ^{bc}
Plot-2	92 ± 0.45 ^b	46.9 ± 1.0 ^{ab}	68.2 ± 1.56 ^{ab}	97.4 ± 2.18 ^{ab}
Plot-3	96 ± 0.95 ^a	48.5 ± 0.92 ^a	70.3 ± 1.70 ^a	102.2 ± 1.96 ^a
Plot-4	96 ± 1.58 ^a	44.1 ± 1.46 ^b	61.4 ± 2.01 ^c	90.2 ± 1.85 ^c
Plot-5	92 ± 1.26 ^b	44.0 ± 1.29 ^b	61.0 ± 1.52 ^c	90.0 ± 1.58 ^c

Discussion

Similar to other members of the family Palmae, the species *Calamus* 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 starts to germinate from 30 days and continues till 60 days in different media. Banik and Nabi (1979) mentioned that the

seeds sown with intact sarcotesta require two or three months to start germination and give poor germination percentage (10-26 only). Haider *et al.* (2014) reported that clean seeds of *Calamus longisetus* started germination after 56 days of sowing (DAS) and continued up to 106 DAS, and showed 60% germination. Alam *et al.* (2020) also reported that *Calamus latifolius* seeds started germination after 54 days of

sowing and continued until 74 days and showed maximum germination (70%) with scarified seeds by wire net. Ara (2008) reported that *Calamus erectus* showed 55% germination from seeds collected during May. The study revealed that *C. erectus* started germination after 52 days of sowing and continued up to 76 days with maximum 78% germination. Germination trends showed the resemblance to other findings mentioned here. However, germination percentage of present study was recorded higher (78%) in comparison to Ara (2008), which may be due to seed collection time.

Age of seedlings is an important factor for its survival after transferring from seed bed to polybag. It was noticed from the experiment that 30 - 40 days after germination pricking of seedlings showed 100% survival. It means that 30-40 days after germination is optimum time for pricking out the seedlings from seed bed and transferring to polybag. After 50 days gradually mortality of the seedlings was noticed. Eighty days after germination and transfer of the germinated seeds to polybag 40% seedling mortality was noticed. Feaw (1994) reported that when the first leaves are fully expanded, rattans seedlings are generally ready for transferring in the polybags which is similar to the present study findings. Mohiuddin *et al.* (1986) reported that gradual increase in survival with delayed transferring after sprouting for *Calamus tenuis*. Siddiqi *et al.* (1998) reported that seedlings of *Calamus viminalis* transfer to polybag in 90 days after germination, seedlings mortality was noticed. Haider *et al.* (2014) reported that delayed pricking, 100-120 days after sowing the seeds from nursery bed to polybag ensures least or no mortality. The variation among the rattan species may be due to nature of the species. Initial growth performance of the seedlings in the nursery showed that progressive growth in

root and shoot length and number of leaves with the age of seedlings. Outcomes of the present study are analogous to findings of Haider *et al.* (2014) in case of *Calamus longisetus* and Alam *et al.* (2020) in case of *Calamus latifolius*.

The height growth of seedlings in the field was found higher in plot 4 than the other plots and lowest in plot 5. This variation of the seedlings height growth was probably due to the microclimatic conditions of the plots. Since the survival percentage of the seedlings in the field was quite satisfactory (92-96%), outplanting of one-year old seedlings may be considered for the planting of the species in the field. The finding is like to the report of Alam *et al.* (2020) in case of *Calamus latifolius* and report made by Siddiqi *et al.* (1998) for *Calamus viminalis* in Bangladesh. Kerala Forest Research Institute, India also made similar report and mentioned that rattan seedlings were outplanted at the age of one year.

Conclusion

Germination behavior of *Calamus erectus* is similar to other members of the family Palmae and needs longer time to germinate. *C. erectus* seeds started to germination after 52 days of sowing and completed within 76 days. Pricking of seedlings at 30-40 days old from nursery bed to polybags ensures least or no mortality of the seedling. Survival of seedlings and growth performance in the field was satisfactory when one year old seedlings were out-planted at 2.0 m x 2.0 m spacing. Therefore, clean seeds are suitable for nursery raising and one year old seedlings of *Calamus erectus* may be recommended for plantation program.

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