

# EFFECT OF PRE-SOWING TREATMENT ON SEED GERMINATION AND SEEDLINGS GROWTH ATTRIBUTES OF *ACACIA CATECHU* WILLD. IN NURSERY AND FIELD CONDITIONS

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**Abstract-** The germination percentage of *Acacia catechu* Willd. seeds were tested with four pre-sowing treatments in the nursery of Bangladesh Forest Research Institute and growth performances of seedlings were determined both in nursery and field conditions. The germination test was conducted both in germination tray and nursery bed filled with mixture of soil and decomposed cow dung at a ratio of 3:1. The growth performance of seedlings were determined by transferring the 30-45 days old young seedlings from germination bed to polybags filled with soils and cow dung, followed by out planting in the field at six months old. Germination percentage was significantly ( $p < 0.05$ ) influenced by pre-sowing treatments and highest germination percentage (80- 81) was obtained in cold water treatment for 24 hours and lowest (62%) was in control. The survival percentage of seedlings was highest (88%) at 2.0 m x 2.0 m spacing in the field and the average height was more than 2.0 m after 24 months of outplanting. Therefore, pre-sowing treatment of *Acacia catechu* seed in cold water for 24 hours is suggested for nursery raising and six months old seedlings may be planted at 2.0 m x 2.0 m spacing in the field for successful plantations of the species.

**Key words-** *Acacia catechu*, pre-sowing treatment, germination percentage, survival, seedlings growth.

## I. INTRODUCTION

*Acacia catechu* is a moderate sized deciduous tree belongs to the family Mimosaceae. The plant usually attains a height of 10-15 m with 25-30 cm diameter. Flowers small, pale yellow or white in cylindrical axillary's spikes, corolla 2-3 times the calyx. Pods strap-shaped, straight, brown [1]. The plant is distributed throughout the India, Srilanka, Pakistan, Bangladesh, Southeast Asia and South China [2, 3].

In Bangladesh *Acacia catechu* locally known as khayer, is available all over the country particularly in Rajshahi areas. Usually it occurs in the localities where normal rainfall varies from 500 to 2125 mm [4]. It is a strong light demander especially in young stage and capable of growing on the poorest soil in dry localities [4]. It is commercially important and recognized as potential medicinal plants. *Acacia catechu* bark has astringent, anti-fungal and a large number of antioxidant activities [5, 6, 7]. Extract of *A. catechu* extensively used in the management of diabetes in combination of other medicinal plants [8, 9]. It is used for sore throat and mouth infections [10].

There is a high demand for catechu which is used in pan (betel-leaf). Externally it is used as a cooling application to ulcers, boils, and eruptions of the skin [5, 11, 12]. The bark is useful in treatment of snake bites. It is also used in dyeing of cotton, silk, and calico-printing [13]. The heart wood of the tree is mainly used for extracting katha and cutch (decoction obtained after filtration) locally called khayer. There are several cottage industries developed in Chargat, Rajshahi,

Bangladesh for khayer production and a good number of people are engaged with these cottage industries. However, due to over exploitation khayer tree became scarce in the area and Khayer based cottage industries are facing problems owing to shortage of raw materials. To ensure sustainable supply of *Acacia catechu*, Forest Department initiated plantation programs in northern part of Bangladesh. For successful plantation programs, proper nursery and plantation techniques and management systems of this species is pre-requisite. Poor seed germination of khayer is one of the prime causes hinders the cultivation of khayer plants and deferred nursery establishment. Bangladesh Forest Research Institute's (BFRI) previous study also indicates the similar notion (30-35% germination) [13].

The seed viability after collection may effect the germination period and percentage. Seed treatments can influence seed germination rate and germination process [14, 15, 16]. The effect of pre-sowing treatments on seed germination of some tropical forest tree species have been reported by some authors [17, 18, 19, 20, 21, 22, 14, 23, 24]. Considering the facts the study was under taken to investigate the effects of pre-sowing treatment on seed germination and seedling growth of *Acacia catechu* in the nursery and field condition.

## II. MATERIALS AND METHODS

### The study area

The study was carried out in the nursery of Bangladesh Forest Research Institute (BFRI), Chittagong, Bangladesh over a period of three and half years from June 2010 to

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December 2013. 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 (Fig. 1). 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 28.3-31.9°C and from 15.2-25.2°C [25]. Mean annual rainfall is around 3000 mm mainly occurred from June to September.

### Seed collection and growing media

The seeds were collected from 15-20 years old mature healthy trees from Charkhai Forest Research Center, Birampur, Dinajpur in January. Seeds were dried in the sunlight for 2-3 days and stored in air tied poly bag. The collected seeds were sorted out to remove the discolored and damaged seeds. The number of seeds per kilogram was 25000-30000. The germination trial was carried out by sowing seeds in germination trays filled up with soil mixed with decomposed cow dung at the proportion of 3:1 by volume. Seeds were sown in the tray at the depth of 0.5-1.0 cm.

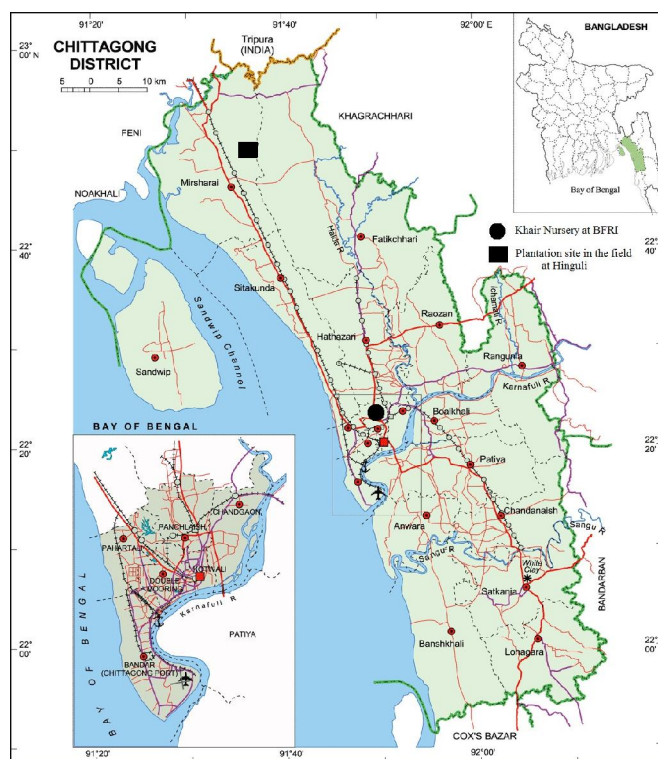


Fig. 1 *Acacia catechu* (Khayer) nursery at BTRI campus and experimental plantation site of Hinguli Research Station on Chittagong district map of Bangladesh

### Experimental Design and pre-sowing treatments

The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. To determine the effect of pre-sowing treatment on seed germination and seedling growth attributes, four different treatments were applied. The treatments were i) Soaking in cold water for 24 hours, ii) Soaking in cold water for 48 hours, iii) Soaking in hot water (100°C) for 30 second and iv) Control (seeds were sown without any treatment). In each replication 50 seeds

were sown and total of 600 seeds were used for the germination trial. The trays were kept under nursery shade for one week and then exposed to partial sunlight. Watering was carried out manually when necessary.

### Assessment of seed germination and seedling growth performance

The effects of pre-sowing treatments on germination of seeds and seedling growth were explored periodically through counting the germinated seeds and assessing initial growth performance of seedlings. Cumulative germination was recorded in every alternate day of sowing and continued till ending the germination (17 days after sowing the seeds). Germination phase like imbibitions period was determined by counting the number of days required for the commencement of germination from the day of sowing and germination period was the number of days required for completion of germination from sowing the seeds. For assessing the growth performance, all seedlings were measured for above ground height (from base to leaf tip) and number of leaves was counted when the seedlings were one month old. Besides these ten seedlings from each replication (30 from each treatment) were randomly uprooted and measured for total length (root length and shoot length separately) for the assessment. Seedling vigor index (VI) was calculated according to [26] as the germination percent multiplied by total length of seedling (*i.e.* sum of shoot and root length).

### Assessment of seedling growth performance in the nursery and field

To determine the seedlings growth performance in the nursery and field, healthy seeds were first sown in the nursery bed with cold water treatment for 24 hours. When the seedlings were about 30-40 days old (with 2-4 leaves), they 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. When the seedlings were about six months old, 225 seedlings were out planted in the field at the beginning of the monsoon (June- July). Equal number of seedlings (225), were allowed to grow in the nursery for one and half year more.

Data on shoot length, root length and leaf number of these seedlings were also recorded at three months, six months, twelve months and twenty four months after transferring them in polybags. Seedlings in the field were planted at 1.5 m x 1.5 m, 2.0 m x 2.0 m and 2.5 m x 2.5 m spacing at Hinguli Research Station, Chittagong, Bangladesh. For each treatment total 75 seedlings were planted in 3 replications, in each replication 25 seedlings were planted. 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. Weeding was done at every six months in the field but no fertilizer or water was added after planting. Data on the height of each plant were recorded at six months, twelve months and twenty four months after planting. Survival percentage of the planted seedling in the field was determined one year after planting the seedlings.

### Data Analysis

All 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.

### III. RESULTS AND DISCUSSION

#### Seed germination and initial growth performance of seedlings

Pre-sowing treatment influence the germination period and germination percentage of *A. catechu* seeds. Germination for all the treatments started 05 days after sowing (DAS) and continues up to 14 DAS, except control in which germination was started after 7 days of sowing and continues up to 17 days. The seed soaking in cold water for 24 hours, showed highest germination (80%) and occurred between 05-15 DAS. Seeds soaked for 48 hours in cold water showed 70% germination between the periods of 05-15 DAS. Seeds soaking in hot water for 30 second showed 66% germination between 05-13 DAS. The lowest 62 % germination was recorded for control between 7-17 DAS (Fig. 2). Although the germination percentage in the seeds treated in cold water for 24 hours is significantly ( $p < 0.05$ ) higher than the other treatments, but there was no variation between seeds treated in cold water treatment 48 hours and seeds treated in hot water (100°C) for the 30 seconds.

Seeds pre-soaked in cold water for 24 hours also recorded highest germination percentage (80%) which was significantly higher than control (62%). Seeds pre-soaked in cold water for 48 hours also recorded higher germination (70%) which was significantly higher than control (62%). Soaking the seeds in water at room temperature helps in softening the seed coats, removal of inhibitors and reduces the time required for germination and increases germination percentage [27]. The imbibitions of water by seed help to enlarge the embryo which leads to increase in fresh weight of seed. Better germination (79-81%) was observed when seeds were soaked in water for six days or placed in running water against control (17%) in *Pterocarpus santalinus* seeds [28]. Overnight soaking of *Rauwolfia serpentina* seeds in cold water gave better germination (86%) against control (40%) [29]. The findings of the present study is almost similar to those reported in the earlier studies mentioned here.

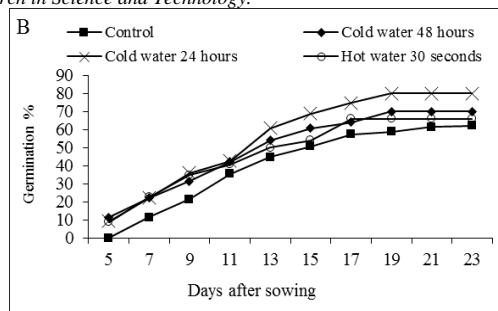
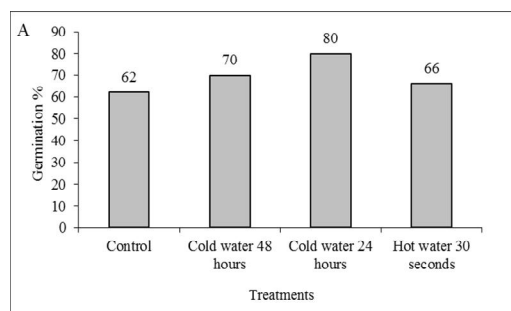


Fig. 2 Germination percentage (A) and the germination pattern (B) of *Acacia catechu* wild. for cold water treatment for 24 hours, 48 hours, treatment for 30 seconds with hot water (100°C) and control.

#### Seedlings growth performance in nursery condition

The initial growth performance of *A. catechu* seedlings influenced to some extent with pre-sowing treatment (Table 1). The highest length of root 4 cm and shoot 6 cm was noticed with seeds treated in cold water for 24 hours and followed by seeds treated in cold water for 48 hours and seeds treated in hot water for 30 seconds. The lowest length of root 3.7 cm and shoot 5.7 cm was noticed seeds with control. However, there was no significant variation in growth performance among the treatments at  $p \leq 0.05$ . Similar results were reported by several authors. It was also mentioned that seedling growth including root length, shoot length, total length and vigor index in *T. chebula* was increased by pre-sowing treatment in cold water [30]. In another experiment, [31, 32] showed maximum growth including shoot length, root length, total length and vigor index in *T. belerica* seedlings when fruits were depulped and soaked in cold water. However, similar to the present study, there was no remarkable difference in average number of leaf per seedlings of *T. belerica* seedlings [33].

TABLE 1 INITIAL GROWTH PERFORMANCE OF KHAIR SEEDLINGS PRODUCED APPLYING DIFFERENT TREATMENTS UP TO 1 MONTH AGE

Growth parameters	Root length (cm)	Shoot length (cm)	Leaf number (Nos.)	Vigor index
Treatments				
Soaked in cold water (24 hours)	4 ± 0.26	6 ± 0.26	3 ± 0.27	800
Soaked in cold water (48 hours)	3.9 ± 0.23	5.8 ± 0.79	2.9 ± 0.23	679
Soaked in hot water (30 sec.)	3.7 ± 0.26	5.9 ± 0.27	2.9 ± 0.23	633.6
Control	3.7 ± 0.21	5.7 ± 0.21	2.8 ± 0.13	582.8

(No significance difference was found among the treatments at  $p \leq 0.05$ )

The vigor index of the seedlings in the present study was increased from 582.8 in the control seeds to 800 in pre-sowing treated seeds of *A. catechu* in cold water for 24 hours (Table 1). The vigor index usually depends on germination percentage and seedlings length. In the study we noticed that seedlings length was marginally higher among the treatments but the germination percentage in seeds treated in cold water for 24 hours was significantly higher than other pre-sowing treatments of seed which lead the higher vigor index in seeds treated with cold water for 24 hours than seeds without any treatment.

### Seedlings growth performance in nursery condition

In our experiment, it was noticed that the germination percentage of *A. catechu* seeds treated in cold water for 24 hours was higher than that of other treatments (Fig. 1). The initial growth performance of these seedlings including seedling length and vigor index were also higher than those in the other treatments (Table 1). Therefore we sowed only the seeds treated in cold water for 24 hours in seed beds for assessing the seedlings growth performances in the nursery and in the field. Nine hundred seeds were sown in three blocks considering as replication of the nursery bed for the purpose. The germination percentage ( $81.7 \pm 1.2$ ) was almost similar to the previous experiments. One and half months old seedlings having 3 - 4 leaves were transferred in the 15 cm x 23 cm sized polybags filled with soils mixed with cow dung (3:1) and allowed them to grow there. After six months of transferring the seedlings in the polybags, 225 seedlings were outplanted in the field (Hinguli Research Station). Rests of the seedlings were grown in the nursery for one and half year more. The seedlings mortality in the nursery bed, during and after transferring the seedlings to the polybag was about 1-2 percent which is very negligible. Growth variation of seedlings was observed in the nursery in relation to age and the results are presented in the Table 2.

**TABLE 2 SEEDLINGS GROWTH PERFORMANCE OF ACACIA CATECHU AT DIFFERENT AGE (UP TO 24 MONTHS) IN THE NURSERY.**

Age of seedlings (month)	Survival %	Average length of shoot (cm)	Average length of roots (cm)	Average number of leaves per seedling
3	98	20 ± 1.76	9 ± 0.82	6.9 ± 0.88
6	98	42 ± 2.75	12 ± 1.05	9 ± 0.82
12	95	64 ± 5.77	19 ± 1.41	13.6 ± 1.58
24	95	98 ± 3.60	26 ± 1.41	26.5 ± 1.35

The seedlings attained 20 cm height (above ground) with average root length 9 cm and 6.9 number of leaf in three months. The seedlings became hard and attained a height of 42 cm with 12 cm root and number of leaf 9.0 at six months. The average height 64 cm with 19 cm root and 13.6 number of leaf was recorded at 12 months. The seedlings reached 98 cm height with 26 cm root and 26.5 number of leaf at twenty four months (Table 2).

### Seedling survival and growth performance in the field

Six months old seedlings of *A. catechu* raised in the polybags were out planted in the field. Survival was recorded at 12 months and seedlings growth performances were determined at 6, 12 and 24 months after planting in the field and shown in Table 3. Survival percentage varied from 85-88 with an average of 87 among the treatments at 12 months after planting. The seedlings height varied from 78.9 to 81.5 cm at six months, 139.2 to 150.1 cm at one year and 193.2 to 229.5 cm at two years among the treatments.

The height growth of the seedlings was higher (229.5 cm) in 2.5 m x 2.5 m spacing at two years, and almost similar in 2.0 m x 2.0 m spacing (213.2 cm) and lowest (193.2 cm) in 1.5 m x 1.5 m spacing (Table 3). The variation of the height growth in the seedling may be due to the microclimatic condition between the spacing or some other unknown reasons. The survival percentage and height growth of the seedlings in the field was satisfactory (87-88 %) in both 2.0 m x 2.0 m and 2.5 m x 2.5 m spacing. Considering the above mentioned facts and comparatively less land requirement, 2.0 m x 2.0 m. spacing may be considered for planting at six months old seedlings in the field. However, it was reported that 3-4 months old seedlings of *A. catechu* may be out planted in the field [13]. On the other hand, seedlings height in the nursery was very low (98 cm) in comparison to the field condition (more than 2.0 m) at two years age. Again it was not possible to maintain the seedlings in the nursery after two years of transferring in polybags due to some unavoidable circumstances.

**TABLE 3 GROWTH PERFORMANCE OF A. CATECHU SEEDLINGS IN DIFFERENT SPACING (TREATMENTS) AT HINGULI RESEARCH STATION (AFTER OUT PANTING).**

Age of seedling / Spacing used	Survival % at 12 months	6 months	12 months	24 months
1.5 m × 1.5 m	85.33 ± 2.31	78.94 ± 0.46 <sup>c</sup>	139.25 ± 1.21	193.22 ± 17.07
2.0 m × 2.0 m	88 ± 4.00	81.50 ± 0.23 <sup>a</sup>	144.19 ± 2.74	213.26 ± 10.16
2.5 m × 2.5 m	86.67 ± 2.31	80.22 ± 0.25 <sup>b</sup>	150.19 ± 2.10	229.53 ± 6.89

### IV. CONCLUSIONS

Pre-sowing treatment of seed plays vital role to enhance the seed germination under nursery conditions. Among the pre-sowing treatments, the best treatment of *A. catechu* was found cold water treatment for 24 hours. Pricking of seedlings at the age of 30-45 days after sowing of seeds from nursery bed to polybags ensures least mortality of seedlings. Survival of seedlings and growth performance in the field

was satisfactory when six months old seedlings were out planted at 2.0 m x 2.0 m spacing.

Therefore, pre-sowing treatments of seeds in cold water for 24 hours is suitable for seedlings rising in the nursery and six months old seedlings at 2.0 m x 2.0 m spacing may be recommended for plantation programme.

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