Dormancy Breaking by Pre-sowing Treatment and Growth Performance of Kusum (*Schleichera oleosa* Merr.) Seedlings in Nursery and Field Condition in Chattogram

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Abstract

Seed germination percentage of Kusum (*Schleichera oleosa* Merr.) was examined with 5 pre-sowing treatments in the nursery of Bangladesh Forest Research Institute and growth performances of seedlings were determined in the nursery and field condition. The main aims of the study were to determine the effect of different pre-sowing treatments on seed germination and seedlings growth performance in nursery and field condition. The pre-sowing treatments were: i) soaking of seeds in tap water for 12 hours, ii) soaking of seeds in tap water for 24 hours, iii) soaking of seeds in tap water for 36 hours, iv) soaking of seeds in tap water for 48 hours and v) control (0 hour). The seeds after soaking were sown in the seed bed directly in the nursery. Seed germination percentage were significantly ($p \leq 0.05$) influenced by pre-sowing treatments and the highest germination (72%) was obtained when soaked for 36 hours. and the lowest (48%) was in control. With treatment (T_3), the maximum shoot length (12.8 cm), root length (11.6 cm), and vigor index (1171.2) were noted. The young seedlings were transferred after 30 days of germination having 3-4 leaves from seed bed to polybags (15×23 cm size) filled with soil and cow dung at 3:1 ratio by volume. Survival percentage of seedlings was maximum (96%) at 2.00 m × 2.00 m spacing in the field and maximum height 105.54 cm 12 months after out-planting. The results of the study suggest the pre-sowing treatment of seeds in tap water for 36 hours was most effective treatment for higher germination percentage and out-planting of one year old seedlings at 2.00 m × 2.00 m spacing in the field for better growth performance of *S. oleosa* seedlings.

সারসংক্ষেপ

বাংলাদেশ বন গবেষণা ইনস্টিটিউটের নার্সারিতে ৫টি প্রি-ট্রিটমেন্ট-এর মাধ্যমে কুসুম-এর বীজের অঙ্কুরোদগম হার পরীক্ষা করা হয় এবং নার্সারি ও মাঠ পর্যায়ে চারার বৃদ্ধি পর্যবেক্ষণ করা হয়। গবেষণার প্রধান লক্ষ্য ছিল বীজের অঙ্কুরোদগম এর উপর বিভিন্ন প্রি-ট্রিটমেন্ট-এর প্রভাব এবং চারার বৃদ্ধি ও বেঁচে থাকার হার অনুসন্ধান করা। গবেষণায় কুসুম-এর বীজগুলোকে ১২ ঘণ্টা, ২৪ ঘণ্টা, ৩৬ ঘণ্টা, ৪৮ ঘণ্টা ও ০ ঘণ্টা (কন্ট্রোল) ট্যাপের পানিতে ভিজিয়ে ট্রিটমেন্ট করা হয়। উক্ত ট্রিটমেন্টগুলোর মাধ্যমে বীজগুলো সরাসরি বীজতলায় বপন করা হয়। বীজের অঙ্কুরোদগম হার উল্লেখযোগ্যভাবে ($p \leq 0.05$) প্রি-ট্রিটমেন্ট দ্বারা প্রভাবিত হয়েছে এবং ৩৬ ঘণ্টা ট্যাপের পানিতে ভিজিয়ে বীজ বপন করলে সর্বোচ্চ ৭২% ও কন্ট্রোলে সর্বনিম্ন ৪৮% অঙ্কুরোদগম পাওয়া যায়। T_3 ট্রিটমেন্টের ক্ষেত্রে সর্বাধিক কাণ্ডের দৈর্ঘ্য (১২.৮ সে.মি.), মূলের দৈর্ঘ্য (১১.৬ সে.মি.), এবং ভিগর ইনডেক্স (১১৭১.২) লক্ষ্য করা গেছে। অঙ্কুরোদগমের ৩০ দিন পরে ৩-৪টি পাতাসমৃদ্ধ চারা বীজতলা থেকে মাটি এবং গোবর (৩ ঃ ১) ভর্তি পলিব্যাগে (১৫×২৩ সে.মি. আকারের) স্থানান্তরিত করা হয়। মাঠ পর্যায়ে ২.০ মি. × ২.০ মি. দূরত্বে চারাগুলির বেঁচে থাকার হার সর্বাধিক (৯৬%) এবং ১২ মাস পরে সর্বোচ্চ উচ্চতা হয় ১০৫.৫৪ সে.মি.। কুসুম বীজের ক্ষেত্রে ৩৬ ঘণ্টা ট্যাপের পানিতে ভিজিয়ে বপন করা সর্বোত্তম কৌশল এবং মাঠ পর্যায়ে ২.০ মি. × ২.০ মি. দূরত্বে এক বছর বয়সি চারা রোপণ করা উপযুক্ত বলে প্রতীয়মান হয়।

Key words: Growth performances, *Schleichera oleosa,* Spacing, Survival capacity, Treatments.

Introduction

Schleichera oleosa Merr. is a medium sized to large deciduous tree species and belongs to the family Sapindaceae. The plant attains up to 35-40 meter height with 2-2.50 m diameter (Ahmed *et al.* 2009). *Schleichera oleosa* is locally known as kusum tree in Indian subcontinent, but is also known as Ceylon oak in Sri Lanka. This tree is noted for its growth of new leaves that are bright red and appears in March to May. The leaves are pinnate, with each leaf having 2-4 leaflets. Flowers are pale yellow or pale green. Sepals are ovate to deltoid, 1.5 mm long. Fruits are broadly ovoid to sub-globular, 15 × 13 mm long. Flowering and Fruiting occurs during March-November (Hossain and Kamaluddin 2005). About 60-64% kernel is found from the seeds (Baul *et al.* 2010). This tree grows naturally from the foothills of the Himalayas and the western Deccan Plateau, SriLanka, China and Southeast Asia. It grows in Bihar, Central and Southern parts of India. The tree occurs sporadically, seldom gregariously in dry, mixed deciduous forests. It is frost and drought tolerant species and it has good cropping power. It also grows in rocky, gravelly, or loamy, slightly acidic soil that is well drained. It is occasionally found in swampy locations, but it usually grows on rather dry soil, at low altitudes, but can be found at 900–1200 meters above mean sea level. The requirement of normal rain fall is 750–2800 mm and ambient temperature of 35-47.50°C (Ara *et al.* 2013).

In Bangladesh, the plant occasionally occurs in some gardens and forests under cultivated condition. Over exploitation is the main threat to this species. The wood is very hard and reddish brown, durable and used for the roller of oil and sugar mills, rice ponders, agricultural implements. Wood is used for making charcoal. Ripe fruit is eaten raw. Leaves and twigs are lopped for cattle fodder. Oil is also used to cure skin diseases. But the species is disappearing in an alarming rate due to forest fragmentation and deforestation (Ara *et al.* 2013; Hossain and Kamaluddin 2005). *Ex-situ* conservation measures have been proposed for this species (Ara *et al.* 2013). Seeds contain oil which is traditionally used for the cure of itch, acne, burns, other skin troubles, rheumatism (external massage), hair dressing and promoting hair growth. Powdered seeds of *Schleichera* are used for ulcers and wounds of cattle to remove maggots and bark is used for skin inflammations and ulcers. It has also been reported that oil is used as antimicrobial, antioxidant, anticancer activity, and can be used for the production of biodiesel (Meshram *et al.* 2015). The plant contains low tannin levels therefore it can be used as fodder for livestock. This species contains important phytochemicals such as terpenoids, betulin, betulinic acid etc. The literature reveals that this medicinal plant can be used as an alternative to synthetic compounds for use in preventing and treating several diseases. Considering this fact, therefore an attempt has been made to study the effect of pre-sowing treatments on seed germination in order to recommended suitable pre-sowing treatments for *S. oleosa*.

Materials and Methods

The study area

The study was carried out in the nursery of Bangladesh Forest Research Institute (BFRI), Chattogram, Bangladesh over a period of two years from August 2018 to July 2020. 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 28.30-15.20°C (Hossain *et al.* 2005). Mean annual rainfall is around 3000 mm mainly occurred from June to September.

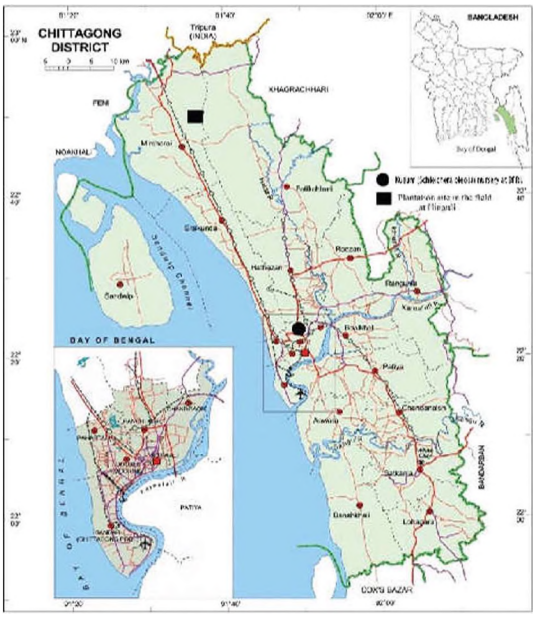

Figure 1. *Schleichera oleosa* nursery at BFRI campus and experimental plantation site at Hinguli Research Station in Chattogram district map of Bangladesh.

Seeds collection and preparation of germination experiments

Seeds were collected from 20-25 years old mother trees from Bangladesh Agricultural University Botanical Garden, Mymensingh, Bangladesh in last week of July 2018. Collected seeds were dried in room temperature for 2-3 days. Then sound and desirable seeds were separated from discolored and damaged seeds. The number of seeds varied from 1400-1700 in one kg and selected seeds were used for the experiments.

Experimental design and pre-sowing treatments

Experiment was conducted on Completely Randomized Design with five replications. To determine the effect of pre-sowing treatments on seeds germination and seedlings growth attributes, five treatments were applied. The pre-sowing seed treatments were: i) soaking in tap water for 12 hours (T_1), ii) soaking in tap water for 24 hours (T_2), iii) soaking in tap water for 36 hours (T_3), iv) soaking in tap water for 48 hours (T_4), and V) control 0 hour (T_0) (seeds without any treatment). There were five treatments, five replications, and 50 seeds were sown in each seed bed at 1.50 to 2.50 cm depths of soil in the first week of August. Thus a total of 1250 seeds were used for the germination experiments. Regularly watering was carried out manually.

Assessment of seed germination

The number of seeds germinated in each treatment was recorded regularly. The starting and closing dates of germination and other parameters were measured with carefully. Germination percentage estimates the viability of a population of seed. The number of seeds germinated at each day in each replication of treatments was counted to calculate the germination percentage (Kumar 1999; Almodares *et al.* 2007). Cumulative germination was recorded in every alternate day of sowing and continued till ending the germination (20 days after sowing the seeds).

Seedling growth performance in the nursery

To determine the seedlings growth performance in the nursery and field, one month old seedlings (developed from T_3) were transferred in polybags (15× 23 cm) filled with soils mixed with cowdung (3:1) and allowed them to grow there. At initial stages, the polybags were kept under nursery shade for one week and then exposed to partial sunlight. Regular watering was carried out manually.

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. 10 seedlings were selected from each replication. Thus 50 seedlings were randomly uprooted and measured the total

length (root length and shoot length separately) for the assessment of growth performances in the nursery levels. These data were recorded at 3, 6, 12 and 24 months in the nursery levels. Seedlings vigor index (VI) were calculated according to Baki and Anderson (1973) as the germination percent multiplied by total length of seedling (*i.e.* sum of shoot and root length). Data on shoot length, root length and leaf number of these seedlings were also recorded at 3, 6, 12 and 24 months after transferring them in the polybags.

Assessment of seedlings growth performance in the field levels

When the seedlings were about one-year-old, 270 seedlings were out-planted in the field at the beginning of the monsoon (June-July). Equal numbers of seedlings were allowed to grow in the nursery for one year. Seedlings were planted in the field at 2.00 m × 2.00 m, 2.50 m × 2.50 m and 3.00 m × 3.00 m spacing at Hinguli Research Station, BFRI, Chattogram. For each treatment total 90 seedlings were planted in 3 replications, thus in 3 replications total 270 seedlings were planted for treatments. 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 34.70°C and 20.70°C respectively. Weeding was done at every four months in the field level of the first year. Survival percentages were determined and heights of the planted seedlings were also recorded at 6 and 12 months after planting.

Statistical analysis

Statistical analysis of data was done using the computer software package Statistical Package for the Social Sciences (SPSS) version 21. The analysis of variance (ANOVA) was studied by applying Duncan's Multiple Range Test (DMRT).

Results

Seeds germination and their percentage

The present study revealed that germination period and germination percentage of *S. oleosa* Merr. were influenced by pre-sowing treatments. The seed soaking in tap water for 36 hours showed the highest germination (72%) and occurred between 8-15 days after sowing DAS. Seeds soaked in tap water for 12 hours showed 56% germination between the periods of 8-18 DAS. Seeds soaked in tap water for 24 hours showed 64% germination between the periods of 8-18 DAS (Fig. 2A & 2B).

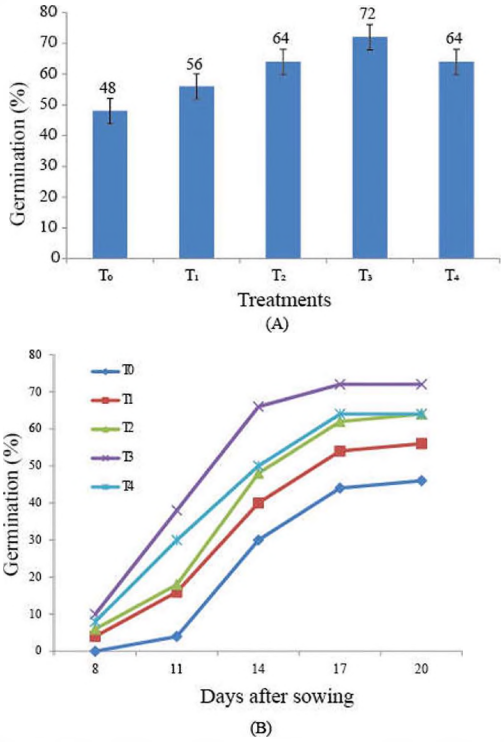

Figure 2. Germination percentage (A) and the germination pattern (B) of *S. oleosa* seeds under various treatments.

Seeds soaked in tap water for 48 hours showed 64% germination between the periods of 8-17 DAS. The lowest germination was found 46% in control and the periods of 11-20 DAS. The

germination percentage in the seeds treated with tap water for 36 hours was significantly (p<0.05) the highest than the other treatments. The germination periods were statistically similar in different treatments, but germination percentages were greatly varied in tap water treatments 12 hours, 24 hours, 48 hours and control.

Seedlings growth performance in nursery condition

The shoot length, root length and vigor index are shown in the following table (Table 1). The highest shoot length (12.80 cm), root length (11.60 cm) and vigor index (1171.20) were marked with treated in tap water for 36 hours (Table 1).

Table 1. Initial growth performance of *S. oleosa* seedlings germinated from different treatments one month after germination.

Treatments	Shoot length (cm)	Root length (cm)	Vigor index (VI)
T_0	8.60±0.67^{c}	7.80±0.87^{c}	787.20^{c}
T_1	10.80±0.37^{b}	9.40±0.51^{bc}	969.60^{b}
T_2	12.00±0.55^{ab}	10.40±0.40^{ab}	1075.20^{ab}
T_3	12.80±0.37^{a}	11.60±0.26^{a}	1171.20^{a}
T_4	10.80±0.58^{b}	9.20±0.37^{bc}	960.00^{b}

Note: Treatment values associated with same letters indicates no significance difference among the treatments at $p \leq 0.05$; ± indicates standard error of mean. T_0=Control. T_1=Seeds soaked in tap water for 12 hours. T_2=Seeds soaked in tap water for 24 hours, T_3=Seeds soaked in tap water for 36 hours, T_4=Seeds soaked in tap water for 48 hours.

The lowest length of shoot (8.60 cm), root length (7.80 cm) and vigor index (787.20) were observed in seed with control. There were significant differences observed in growth performance among the treatments at $p \leq 0.05$. Similar results were reported by several authors and mentioned that pre-sowing treatments enhance the seed germination and seedling growth performance in the nursery condition.

The vigor index mainly depends on germination percentage and seedlings length. The study reveals that there was marginal variation of seedlings length among the treatment but the germination percentage with seeds soaked in tap water for 36 hours was much higher than the other treatment which leads the vigor index considerably higher in the seeds soaked in tap water for 36 hours than other treatments.

In the experiment, only the seedlings developed from the seeds treated in tap water for 36 hours were used for assessing the seedlings growth performances in the nursery and the field (Fig. 3). One month old seedlings having 3-4 leaves were transferred in the polybags (15 × 23 cm) which was filled with soil and cow dung (3:1) and allow them to grow there. The seedlings mortality in the nursery bed, during and after transferring to the polybags was about 3-4% which is very insignificant.

The seedlings achieved a height of 21.13 cm with 20.14 cm root and 17 numbers of leaves were recorded at 3 months. The average height 30.27 cm with 27.73 cm root and 21 numbers of leaves were recorded at 6 months. The seedlings touched 44 cm height with 34.97 cm root and 38 numbers of leaves were recorded at 12 months. Finally, the seedlings attained 102.10 cm height with 69.50 cm root and 67 numbers of leaves were recorded at 24 months and their survival percentages were 96% in the nursery level (Table 2).

Seedlings survival and growth performance in the field

One year old seedlings of *S. oleosa* raised in the polybags were out planted in the field. Survival

(A) (B) (C)

Figure 3. Seeds and seedlings of Kusum (*S. oleosa*) at nursery. (A) *S. oleosa* seeds (B) Germination stage (C) 12 months seedlings after germination.

Table 2. Seedlings growth performance of *Schleichera oleosa* at different ages up to 24 months in the nursery condition.

Age of seedlings (month)	Survival (%)	Average length of shoots (cm)	Average length of roots (cm)	Average number of leaves per seedling (cm)
3	98	21.13±2.89	20.14±1.45	17.00±1.24
6	96	30.27±2.69	27.73±1.21	21.00±1.68
12	96	44.98±2.58	34.97±1.39	38.00±1.33
24	96	102.10±2.82	69.50±2.21	67.00±1.15

was recorded at 12 months and seedlings growth performances were determined at 6 and 12 months after planting in the field and shown in Table 3. Survival percentage varied from 92-96 with an average of 94 % in the field level. The seedlings height varied from 74.79 – 83.12 cm at six months and 93.23 – 105.54 cm in one year old seedlings in the field level. (Table 3).

Table 3. Survival percentage and seedlings growth performance of *S. oleosa* in different spacing at Hinguli Research Station after one year planting in field condition.

Spacing used	Survival (%)	Average height (cm)	
		6 months	12 months
1.50 m×1.50 m	92^{c}	74.79±1.11^{c}	93.23±1.10^{c}
2.00 m×2.00 m	96^{a}	83.12 ±1.13^{a}	105.54.10±1.13^{a}
2.50 m×2.50 m	94^{b}	78.30±1.01^{b}	96.20±1.16^{b}

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

The heights of seedlings were significantly affected by distances in the field level. (Table 3). The variation of the height growth in the seedlings may be due to the microclimatic condition between the spacing. The survival percentage and height growth of the seedlings in the field were satisfactory at 2.00 m × 2.00 m spacing. The average survivals of seedlings were 94% in the field level. Considering the above mentioned facts and comparatively less land requirement, 2.00 m × 2.00 m spacing may be considered for planting of one year old seedlings in the field.

Discussion

Several scientists suggested that seed germination was influenced by environmental factors (Mukarati *et al.* 2013; Soleymani and Sharajabian 2018). Soaking of the seeds in water helps in softening the seeds coat, removal of inhibitors and reduces required time for germination and enhances germination percentage (Hartman *et al.* 2007). The present study also revealed that soaking the seeds in water helps to increase the germination rate and reduces require time for germination. Gupta (2003) observed that overnight soaking of *Rauwolfia serpentina* seeds in cold water offered increased germination (86%) against control (48%). *Acacia catechu* seeds showed better germination (80%) against control (62%) when the seeds are soaked in cold water for 24 hours (Haider *et al.* 2014). The finding of the present study is similar to the previous findings.

Azad *et al.* (2012) mentioned that germination percentage and seedling growth including shoot, root and total length of *Acacia auriculiformis* increased significantly with pre-sowing treatment especially by hot water treatment. The vigor index of the seedling in the study was increased remarkably from 787.20 in control to 1171.20 in the treated seeds soaked in tap water for 36 hours.

Similarly report was made by Haider *et al.* (2014) and mentioned that *Acacia catechu* seedlings showed satisfactory growth performance when they were planted at 2.00 m× 2.00 m spacing at the age of 6 months, in the field. On the other hand, seedlings height was low in the nursery level (102.10 cm) in comparison to the field level (105.54 cm) at 2 years age. The present study indicated that seedlings growth influenced by silvicultural practices such as weeding, watering and edaphic characteristics. The study revealed that the survival capacity was higher in the nursery level than the field level.

Conclusion

Pre-sowing treatments of seeds influence the germination percentage under nursery condition. Seeds start germination after 8 days of sowing and complete within 20 days. Maximum germination and highest initial growth performance was perceived in seeds treated with tap water for 36 hours which was much higher than other treatments. Pricking of the seedlings at 30 days after germination from nursery seed bed to polybag ensure minimum mortality. Survival of the seedlings (96%) and growth performance of the seedlings in the field was satisfactory after out planting one year old seedlings planting at 2.00 m × 2.00 m spacing. Therefore, pre-sowing treatment of seeds with tap water for 36 hours is suitable for seedling raising in the nursery and one year old seedlings planting at 2.00 m × 2.00 m spacing may be suggested for plantation program.

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