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EVALUATING PRE-SOWING TREATMENTS TO ENHANCE GERMINATION AND EARLY GROWTH OF THE THREATENED *STERCULIA VILLOSA* ROXB. IN BANGLADESH

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Abstract

Elephant rope (*Sterculia villosa* Roxb.) is a threatened plant species in Bangladesh. To conserve this threatened tree, research should be carried out on improvement of germination and early growth. Therefore, the objective of the study was to explore the effects of pre-sowing seed treatments on germination behavior and to assess the possibility of increasing the germination rate of *Sterculia villosa*. The seeds were subjected to nine pre-sowing treatments viz., T0: Seeds with no treatment (Control), T1: Seeds scrapping with sand paper at the distal end, Seeds immersed in T2: room temp. water for 24 hours, T3: hot water for 1 minute, T4: 10% concentrated H_2SO_4 for 1 minute, T5: 10% concentrated H_2SO_4 for 3 minutes, T6: 10% concentrated HCL for 1 minute, T7: 10% concentrated HCL for 3 minutes, T8: 200ppm GA_3 for 24 hours, T9: Fungicide (Autostin 50 WDG) for 24 hours. The study conducted in the propagation house, revealed that pre-sowing treatments significantly ($p<0.05$) enhanced seed germination parameters of *Sterculia villosa*. Seed germination started within 2 days after seed sowing and continued up to 15 days. The highest germination percentage (50%) was observed in T8 and the lowest (20%) in T0, T3, and T7. The highest germination Index was found in T8 and the lowest in T0. T8 was found more effective in respect to faster germination, high germination percentage, germination index, seedling vigor index, speed, and energy of germination. In case of seedling growth parameters, the highest shoot length (62 cm) was found in T1 and the lowest (33 cm) in T3. Here, T1 was found more effective in case of shoot length, leaf number, leaf length, and leaf width.

Introduction

The Elephant Rope tree (*Sterculia villosa* Roxb.) is a near threatened tree species in Bangladesh (IUCN, 2024), primarily found in the Chittagong, Chittagong Hill Tracts and Sylhet Regions. This tree is known for its large hairy leaves and orange yellow flowers. Elephant rope tree is naturally propagated through natural seed dispersal. The poor natural seed dispersal and low germination of seeds hinder tree's ability to regenerate and expand its population leading to increased vulnerability and potentially endangered of the species. Therefore, the development of better propagation techniques is one of the best ways to conserve a threatened plant species. Many exotic species are being chosen for plantation for their high germination rate and fast-growing nature. As a result, native species are going extinct day by day as they are being harvested from their natural habitat for consumption and selling purposes but not being planted for lack of knowledge. *Sterculia villosa*, locally known as "udal'' is one of threatened plants (Hasnat *et al.*, 2019). So, it is imperative to develop efficient propagation methods to restore this species. If this

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species can be conserved in the natural habitat successfully, it can be beneficial in many ways, as it holds Economical, Ethnobotanical, Pharmaceutical and Environmental importance. For example, it is used in impotency (Khan *et al.,* 2002; Uddin *et al.,* 2015; Sajeeb *et al.,* 2022). *Sterculia villosa* is also used to prevent Jaundice, Gastric, Dysentery, Diabetes and Constipation by drinking the Petiole (Uddin *et al.,* 2017; Uddin and Hasan 2014). The strong coarse fiber obtained from the inner bark, is used for ropes, bags, cordage, elephant harness, and dragging (Dholariya *et al*., 2019) timber is used to prepare tea boxes, toys, guitars, cheap match boxes, splints and also for manufacturing of commercial plywood grade IV. It served as good quality raw material for pulp and paper industries (Barua and Rabha, 1992) Udal, fibers have good potential for exports owing to their economics, aesthetic appeal and improved overall properties (Saikia *et al.,* 2021). Ethanolic extract of the bark of *Sterculia villosa* showed antimicrobial, cytotoxicity and antioxidant properties (Haque *et al.,* 2014). Chemical profiles of the extract demonstrated that the presence of alkaloids, glycosides, tannins, flavonoids, reducing sugars and gums in the bark, and also showed moderate antimicrobial activity and anti-inflammatory effects (Tania *et al.,* 2013). Barua *et al.,* (2018) stated that it has strong sedative activity. The methanolic crude extract and other fractions of the barks of *S. villosa* have promising peripheral analgesic activity (Hossain *et al.,* 2013). *S. villosa* showed significant anthelmintic activity (Alam *et al.,* 2012). *Sterculia villosa* is an ethno medicinal plant and possesses antimicrobial, antiprotozoal properties (Das *et al.,* 2016*).* A study reported the potential antioxidant effects of methanolic bark extract of *S. villosa* (Lyzu *et al.,* 2022). The results of the study indicates that ethanol extract of *S. villosa* barks possess significant anti-inflammatory activity on both acute and chronic inflammation (Hossain *et al.,* 2012). Many chemical analyses were done on this species to use it for making sustainable medicines, but only few works have been done on the propagation of the species for its conservation. One researcher in India studied the growth and development of *Sterculia villosa* and proved it to be fast growing (Rai *et al.,* 2020). In another study in Bangladesh, carried out on the pre-sowing treatments of 14 threatened tree species where *Sterculia villosa* was one of them (Hasnat *et al.,* 2019). Very few investigations have been done and available on the mode of propagation and conservation strategies of this species. Therefore, the aims of the present study were to evaluate pre-sowing treatment effects; to observe the growth and development of the seedlings under different treatments, and to find out ways of *in-situ* conservation of the species.

Materials and Methods

The red ripen fruits of *Sterculia villosa* were collected from the plants available at Mirpur Botanical Garden, Mirpur, Dhaka. The seeds were then separated from fruits manually, sundried for few hours and treated immediately as these seeds are recalcitrant and cannot be stored for long time. In some fruits, mature seeds were germinated inside the fruits indicating that the seeds were recalcitrant in nature. The experiments were conducted in the Propagation House of Department of Botany, University of Dhaka. The Propagation house was covered with insect net and an overhead polythene sheet which keeps the moisture inside the Propagation house. The temperature and humidity of the Propagation house was recorded daily.

Total nine treatments were set with control and they were indicated as T0 to T9. The treatments were replicated three times with ten seeds in each replication. A completely randomized design (CRD) was used to carry out the experiment. The treatments were as follows:

T0: Seeds with no treatment and sown in poly bag only (Control)

T1: Seeds scraping with sand paper at the distal end

T2: Seeds immersed in water at room temperature for 24 hours

T3: Seeds immersed in hot water for 1 minute

T4: Seeds immersed in 10% concentrated H_2SO_4 for 1 minute

T5: Seeds immersed in 10% concentrated H_2SO_4 for 3 minutes

T6: Seeds immersed in 10% concentrated HCL for 1 minute

T7: Seeds immersed in 10% concentrated HCL for 3 minutes

T8: Seeds immersed in 200 ppm GA_3 for 24 hours

T9: Seeds immersed in fungicide (Autostin 50 WDG) for 24 hours

These treatments were prepared following previous works. Good quality sand paper was bought for T1 and the treatment was done carefully to avoid scrapping the seed too much. For T2 the seeds were soaked in normal room temp. water for 24 hours, filter water was chosen to avoid contamination. For T3 boiling water was taken and the seeds were soaked for only 1 min. to avoid losing viability of the seeds. For T4 to T7 the seeds were treated with different concentration acid for different times. 10% acid solutions were first made by diluting the acid with distilled water. Good quality acids were chosen for the experiment. After that the seeds were soaked in 1 and 3 mints. In HCL and H_2SO_4, respectively. For T8 gibberellic acid was measured and dissolved in ethanol as it is not soluble in water then it was diluted with distilled water to make it 200ppm solution. The seeds were soaked in the solution for 24 hours. For te las treatment fungicide Autostin was made by diluting 2g fungicide in 1L solution. After that the seeds were soaked overnight.

After the treatments was performed the seeds were sown in polybags (7 × 5 cm). The polybags were filled with 1-part cow dung and 3-part garden soil which were bought from the nursery. Then the polybags were kept in the Propagation house. The germination of the seeds was recorded daily till the end of the germination and the data were taken. The seed germination criterion was visible protrusion on the surface of soil at least 0.5cm of the cotyledon and hypocotyl of the seedling. Germination percentage and cumulative germination percentage were calculated following the work of (Kumar, 1999). When the mean daily germination reached its peak, the germination percentages were also determined to find out the germination energy (Dwivedi, 1993; Islam *et al.,* 2009). Seedlings that survived at the end of the experiment were counted to determine survival percent. Germination value was found by multiplying peak value of germination (PV) and mean daily germination (MDG). Germination index (GI), Seedling vigor index (SVI), Speed of germination (SE) was calculated following the work of (Islam *et al.,* 2009; 2013). The detailed estimation procedure of all parameters is described below.

Germination percentage: The number of seeds out of 100 seeds from the starting of germination to the termination of germination (Dey *et al.,* 2021).

Germination % (GP) = No. of seed germinated x 100 No. of seed sow

Cumulative germination % (CGP): It assessed at the end of seed germination by summed up daily germination (Hasnat *et al.,* 2019).

CGP = Cumulative number of seeds germinated x 100

Germination energy (GE): It is measured by computing the daily germination percentage of its peak time (Dwivedi, 1993; Islam *et al.,* 2009)

Germination value (GV): It was calculated by multiplication of the peak value of germination and mean daily germination (Hasnat *et al.,* 2019)

GV = Peak value of germination × mean daily germination

Germination capacity: It is the percentage of seeds germinated in an experiment from the starting to end. It was classified as follows: a) 90-100%-very good, b)70-90%-good, c)50-70%-average, d) 30-50%-poor e)20-30%- very poor. (Hasnat and Hossain, 2012)

Seedling survival rate (%) = [Number of surviving seedlings / Number of seeds sown] x 100

Germination index: The germination index (GI) was calculated as described in the Association of official seed analysis (AOSA, 1983; Islam *et al.*, 2009) by following formula

Germination index= $\sum$ (GT/Tt) or $[\frac{No.of\ germinated\ seed}{Days\ of\ first\ count}]$ + $[\frac{No.of\ germinated\ seed}{Days\ of\ final\ or\ last\ count}]$

The vigor index was calculated according to the following formula of Islam *et al.,* (2009c):

Seedling Vigor Index (SVI) = $[\frac{Seedling\ length\ (cm)\ x\ Germination\ percentage}{100}]$

The speed of emergence was calculated according to the following formula of (Islam *et al.,* 2009):

$Speed\ of\ Emergence = (\frac{No.of\ seedlings\ emerged\ 5days\ after\ sowing}{No.of\ seedlings\ emerged\ 15\ days\ after\ sowing})$ x 100

The seedling height and leaf data were taken at three and five months to calculate the seedling growth in the timeline. Total ten plants from each treatment were chosen randomly to avoid manipulation and to take the data as effectively as possible.

The collected data was recorded and analyzed statistically by using computer package software SPSS ver. 16. Duncan's Multiple Range Test (DMRT) was employed to define the statistical significance and it was shown by different letters in the different tables. The graphs were made using Microsoft excel 2016 software.

Results and Discussion

Physical traits of seeds

The seeds of the species stay in the seed pod. There are usually 4-6 seed pods in each inflorescence. The seed pods are green when raw and turn bright red when rips. When the seeds get mature the seed pods break and release the seeds in nature. The average seed length and width were found 1.612±0.04 cm and 1.506±0.03 cm, respectively. About 5825 seeds were found per kg (Table 1, Fig. 1).

Table 1. Seed length, width and number of seeds per kg of *Sterculia villosa* seeds.

Parameters	Length (cm)	Width (cm)	Weight/seed (g)	Seeds/kg Average
Average	0.82 ±0.04	0.49 ±0.03	0.158 ±0.006	5825

± indicates the standard error of mean.

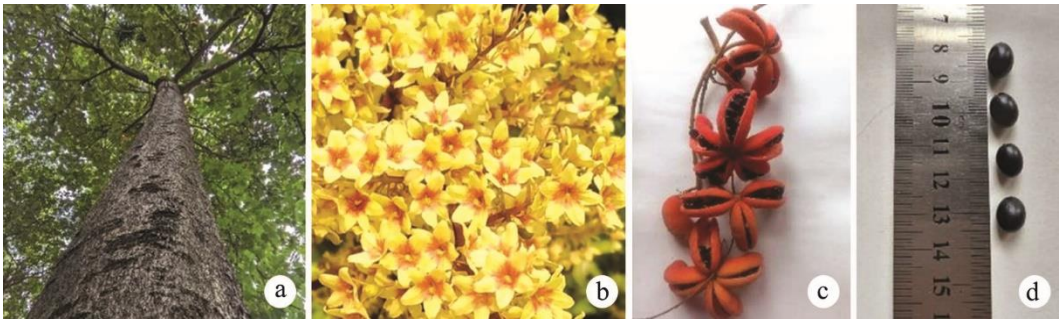

Fig. 1. Different stages of *Sterculia villosa.* (a) Mature plant, (b) Flowers, (c) Pods, (d) Seeds.

Temperature and humidity monitoring in the propagation house

In the propagation house where the experiments took place the daily temperature and humidity was recorded. The highest temperature was recorded in April where the humidity was lowest and the lowest temperature was recorded in July where the humidity was highest (Table 2). By analyzing the average temperature and humidity it can be concluded that mean temperature across the six months is approximately 34.2°C and 72.3% which indicates a hot and humid weather condition in the propagation house.

Table 2. Mean temperature and humidity in the propagation house.

Parameters	Months					
	April	May	June	July	August	September
Mean Temperature	37.95^0C±0.20	34.76^0C±0.40	34^0C±0.40	31.7^0C±0.82	31.8^0C±0.90	34.6^0C±0.60
Mean Humidity	66.25%	68.8%	65%	78%	79%	77%

± indicates the standard error of mean.

Germination

Germination behaviors of *Sterculia villosa* were differently affected by applying different pre-sowing treatments (Fig. 2). Germination started at first (3rd day) in seeds treated with 200 ppm GA_3 for 24 hours (T8) and maximum days (5 days) was taken by these seeds in control (T0). The germination ended within only 8 days in case of three treatments viz., seeds scrapping with sand paper at the distal end (T1), immersed in water at room temp. for 24 hours (T2), and immersed in 10% concentrated H_2SO_4 for 3 minutes (T5). Seeds took the longest time to germinate in case of seeds treated with 200 ppm GA3 for 24 hours and the germination percentage was also the highest (50%) in the same treatment. The germination percentage of seeds varied significantly in different treatments (Table 3, Fig. 2). The lowest germination rate (20%) was found in case of seeds with no treatment, immersed in hot water for 1 minute and immersed in 10% concentrated HCL for 3 minutes. As the germination percentage increased in hormonal treatment from the control it indicates physiological dormancy of the seeds. The second highest germination percentage (40%) (Table 3) was found in seeds soaking in water which also indicates physical dormancy of the seed. The seeds have both physical and physiological dormancies.

Germination index increased in the pre-sowing treatment compared to control. Germination index was found to be the highest (2.99) in case of 200 ppm GA3 treatment and lowest (.81) in case of immersion in hot water for 1 minute and immersed in 10% concentrated HCL for 3 minutes, from this result it can be concluded that the hot water may harm the seed health thus more care should be taken in case of hot water treatment. The seedling vigor index was also increased in pre-sowing treatments compared to control. The highest seedling vigor index (6.05) was found in Seeds immersed in 10% concentrated H_2SO_4 for 3 minutes and the lowest (1.63) was in Seeds immersed in 10% concentrated HCL for 3 minutes which indicate the treatment with acid is quit tricky as in one acid the seed performs the best and in another the worst. Pre-sowing treatments increased the speed of emergence compared to control. The speed of emergence was highest (66.69) in case of 200 ppm GA3 for 24 hours' treatment and the lowest (20) in control. Plant percent was also higher compared to control. The highest (36.67) was in seeds immersed in water for 24 hours and lowest (10) was in seeds immersed in 10%concentrated HCL for 3 minutes. Compared to control seeds treated with different treatments showed better germination capacity (Table 3).

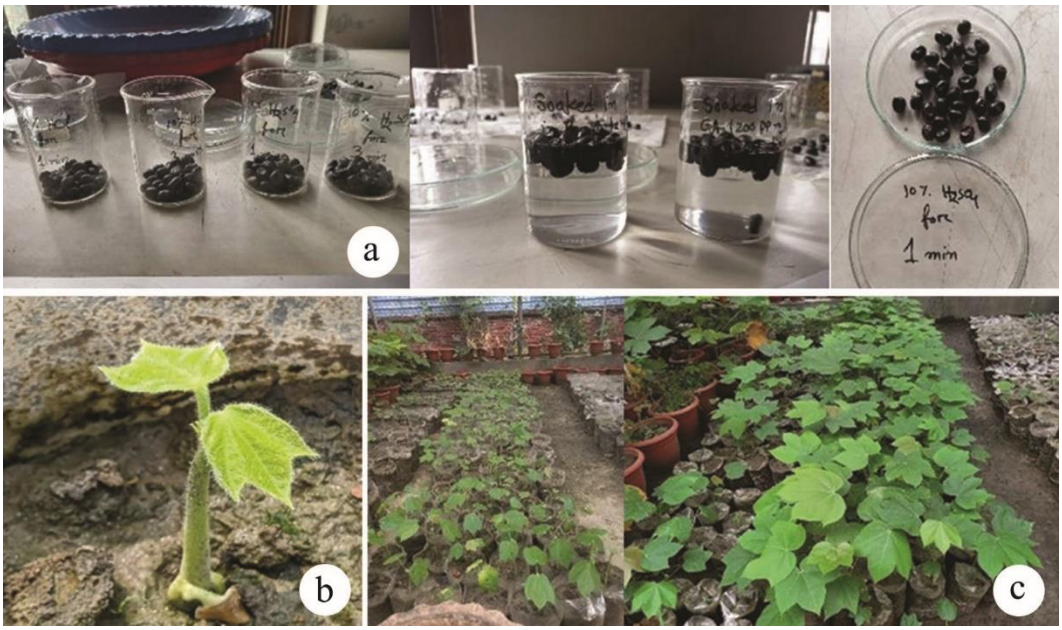

Fig. 2. Germination experiment of *Sterculia villosa.* (a) Different stages of pre-sowing treatments, (b) germinations and (c) seedling establishment.

Table 3. Effects on germination behavior of *Sterculia villosa* seeds in different pre-sowing treatments.

Treatments	No of days to first germinate (days)	No of days to end germination (days)	Cumulative germination %	Germination index	Seedling vigor index	Speed of emergence	Seedling survival rate %	Germination capacity
T0	5.67^{e}	15^{bc}	20^{a}	0.653^{a}	1.63^{a}	20.00^{a}	16.67b	Very Poor
T1	3.33^{abc}	8^{a}	30^{ab}	1.83^{c}	4.00^{c}	66.67^{e}	23.33c	Very Poor
T2	2.67^{a}	8^{a}	40^{ab}	2.63^{e}	5.00^{d}	60.00^{d}	36.67e	Poor
T3	5.33^{de}	15^{bc}	20^{a}	0.81^{a}	1.80^{ab}	33.33^{b}	13.33b	Very Poor
T4	4.00^{bc}	18^{c}	23.33^{a}	0.87^{a}	1.63^{a}	16.67^{b}	16.67b	Very Poor
T5	2.67^{a}	8^{a}	36.67^{ab}	2.13^{d}	6.05^{e}	54.54^{c}	30.00d	Poor
T6	3.67^{abc}	9^{a}	30^{ab}	1.47^{b}	2.40^{ab}	33.33^{b}	23.33c	Very Poor
T7	4.33^{cd}	15^{bc}	20^{a}	0.81^{a}	1.60^{a}	33.33^{b}	10.00a	Very Poor
T8	3.00^{ab}	13.67^{b}	50^{b}	2.99^{f}	5.83^{de}	66.69^{de}	26.67c	Poor
T9	3.33^{abc}	13^{b}	33.33^{ab}	2.57^{e}	2.67^{b}	60.00^{d}	16.67b	Poor

*Means followed by the same letter (s) in the same column do not vary significantly at $P<0.05$, according to Duncan's Multiple Range Test (DMRT).**T0: Seeds with no treatment and sown in polybag (Control), T1: Seeds scrapping with sand paper at the distal end, T2: Seeds immersed in room temp. water for 24 hours,T3: Seeds immersed in hot water for 1 minute, T4: Seeds immersed in 10% concentrated H_2SO_4 for 1 minute,T5: Seeds immersed in 10% concentrated H_2SO_4 for 3 minutes,T6: Seeds immersed in 10% concentrated HCL for 1 minute, T7: Seeds immersed in 10% concentrated HCL for 3 minutes, T8: Seeds immersed in 200 ppm GA_3 for 24 hours,T9: Seeds immersed in Fungicide (Autostin 50 WDG) for 24 hours.

To obtain cumulative germination percentage for each treatment, daily germination percentages were summed. Cumulative germination of T8 starts after 4 days after seed sown which rose rapidly and continued up to 50% within 14 days. After 6 days of seed sown, seeds in the control treatment (T0) started germination and achieved 20% germination (Fig. 3).

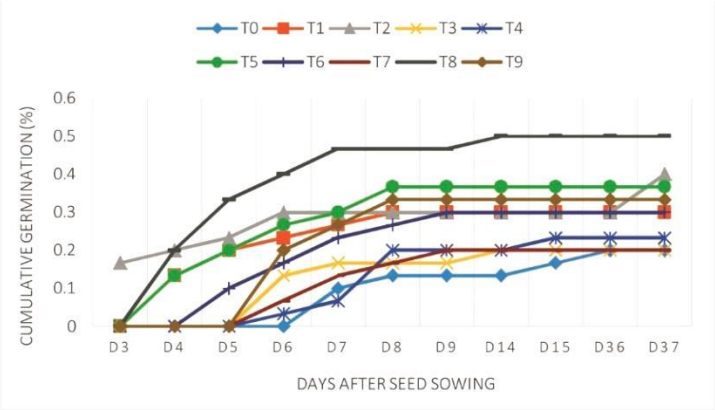

Fig. 3. Cumulative germination percentage of *Sterculia villosa* under different pre-sowing treatments [T0: Seeds with no treatment and sown in polybag (Control), T1: Seeds scrapping with sand paper at the distal end, T2: Seeds immersed in room temp. water for 24 hours,T3: Seeds immersed in hot water for 1 minute, T4: Seeds immersed in 10% concentrated H_2SO_4 for 1 minute,T5: Seeds immersed in 10% concentrated H_2SO_4 for 3 minutes,T6: Seeds immersed in 10% concentrated HCL for 1 minute, T7: Seeds immersed in 10% concentrated HCL for 3 minutes, T8: Seeds immersed in 200 ppm GA_3 for 24 hrs,T9: Seeds immersed in Fungicide (Autostin 50 WDG) for 24 hrs].

Seedling growth

Shoot length, leaf number, leaf length and leaf width were recorded at 1-, 3- and 5-months old seedlings. The highest mean shoot length (62 cm) attained in T1(seeds scraping with sand paper at the distal end) and the lowest (33.67 cm) in T3(seeds immersed in hot water for 1 min). Mean maximum number of leaves (6) were produced in T1 and minimum (4.33) in T5 (seeds immersed in 10% concentrated H_2SO_4 for 3 minutes. Mean maximum leaf length (19.33cm) was observed in T1 and the lowest (13cm) in T3. Mean maximum leaf width (22.67cm) was found in T1 and the lowest (16.67cm) in T7 (seeds immersed in 10% concentrated HCL for 3 minutes) (Table 4).

Seeds scrapping with sand paper at the distal end (T1) produced vigorous straight seedlings with shoot height of 10.1, 34 and 62 cm at the end of 1, 3 and 5 months, respectively (Fig. 4). The shoot length of T1, T2, T5, T6 were higher than other treatments. Shoot length of T3 is the lowest among all the treatments.

The science of seed biology encompasses development and physiology of seeds until they finally germinate or fail to do so (Dey *et al.*, 2021). Hard coated seeds are sometimes impermeable to required nutrition for producing vigor seedlings, these seeds need proper pre -sowing treatments for producing potential seedlings for plantation and for restoration of land (Hasnat and Hossain, 2018).

The present study showed significant difference ($p<0.05$) within the germination percentages among control seeds and treated seeds. Seeds treated with 200 ppm GA3 showed maximum germination percentage (50%) compared to control (20%) which indicates physiological dormancy of the seeds. A high percentage of seed germination (80%) was reported by Hasnat *et al.* (2019) form the study conducted in the propagation house (a bed made of Sylhet sand) under temperature and humidity control system. On the other hand, Vahabinia *et al.* (2019) reported lower seed germination and that was due to the effects of environmental factors like temperature, water stress,

salinity and burial depth. They proved that all studied traits including germination percentage (GP), germination rate (GR), germination uniformity (GU), normal seedling percentage (NSP),

Table 4. Mean shoot length, leaf number, leaf length and leaf width of *Sterculia villosa* seeds in different pre-sowing treatments.

Treat-ments	Shoot length (cm)			Leaf number			Leaf length (cm)			Leaf width (cm)		
	1 month	3 months	5 months	1 Month	3 months	5 months	1 month	3 months	5 Months	1 month	3 months	5 months
T0	7.3± 0.38	21.2± 1.39	39± 1.39	4.2± 0.2	4.6± 0.4	5± 0.32	7.1± 0.33	15± 0.71	16± 1.05	8.9± 0.33	15± 0.77	18± 1.05
T1	10.16± 0.4	34± 0.57	62± 1.53	4.33± 0.33	5.33± 0.33	6± 0	9.675± 0.33	16.67± 1.45	19.33± 0.67	10.33± 0.67	19.33± 0.67	22.67± 1.20
T2	11.33± 0.88	34.33± 0.88	57.67± 1.85	4.33± 0.33	6±0	5.33± 0.33	8.67± 0.67	14.67± 0.88	18.67± 0.67	10.67± 0.33	16.67± 1.20	19.67± 0.67
T3	8.12± 0.43	24.67± 1.85	33.67± 4.5	4.5±. 0.29	6.67± 0.33	4.67± 0.33	9.12± 0.43	17±1.5	13± 3.78	9±0.4	15.33± 2.03	19.67± 1.76
T4	7.16± 0.16	21.67± 2.90	52± 4.16	3± 0.57	54± 0.57	4±0.5	6.67± 0.33	10.67± 0.67	19.67± 4.37	7.67± 0.33	12±1.15	19.33± 3.28
T5	16.67± 1.45	36.67± 1.76	61.67± 2.90	3.67± 0.33	5.0± 0.57	4.33± 0.33	9.67± 0.88	15.33± 0.88	17.33± 0.33	8.16± 0.16	17±1	18.33± 0.33
T6	6.93± 0.38	30± 2.08	56± 2.30	4± 0.31	6.33± 0.33	5.33± 0.67	6.86± 0.45	16.33± 1.20	16.67± 1.20	9.43± 0.60	18.67± 0.67	19± 1.15
T7	7.5± 0.23	20.33± 0.33	42.67± 4.05	4.33± 0.33	5.33± 0.67	5±0.5	8.83± 0.44	13± 0.57	14.67± 1.85	10± 0.28	15.33± 0.33	16.67± 1.45
T8	10.67± 0.33	24.67± 2.73	43± 1.52	4±0	5.33± 0.33	5±0.57	6.83± 0.44	15.67± 2.60	16±1.15	9.16± 0.167	17.33± 3.17	18± 2.08
T9	10.33± 0.33	24± 0.57	43.16± 2.40	4±0	4.67± 0.33	4.67± 0.33	9±0.57	11.33± 0.88	14.67± 0.33	9±0.57	13.67± 0.88	18.67± 0.88

±Indicates the standard error of mean

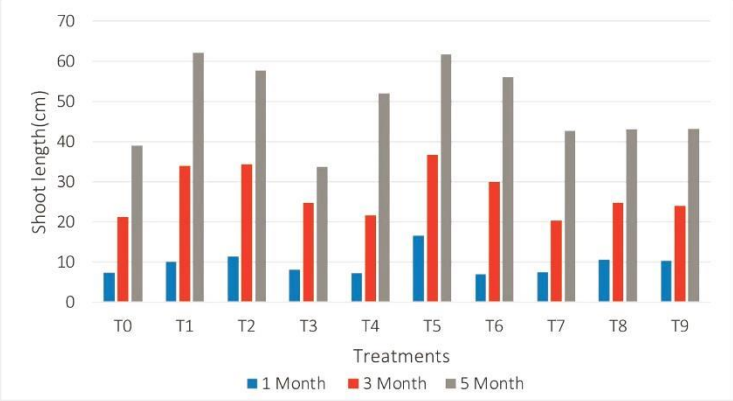

Fig. 4. *Sterculia villosa* shoot growth pattern under different pre-sowing treatments [T0: Seeds with no treatment and sown in polybag (Control), T1: Seeds scrapping with sand paper at the distal end, T2: Seeds immersed in room temp. water for 24 hrs,T3: Seeds immersed in hot water for 1 minute, T4: Seeds immersed in 10% concentrated H_2SO_4 for 1 minute,T5: Seeds immersed in 10% concentrated H_2SO_4 for 3 minutes,T6: Seeds immersed in 10% concentrated HCL for 1 minute, T7: Seeds immersed in 10% concentrated HCL for 3 minutes, T8: Seeds immersed in 200 ppm GA_3 for 24 hrs,T9: Seeds immersed in Fungicide (Autostin 50 WDG) for 24 hrs].

root length (RL), shoot length (SL) and seedling dry weight (SDW) were significantly influenced by the environmental factors. So, more research should be done on the effects of environmental

and other factors on seed germination. Another study from India showed that the total seed germination was 80% in the month of May-June within 21 days in *Sterculia villosa* Linn (Rai *et al.,* 2020), which was different from the present study; it might be due to different species as the species in the present study was *Sterculia villosa* Roxb. The second highest germination percentage (40%) (Table 3) was found in seeds soaking in water which indicates physical dormancy of the seed. The germination percentage can be increased by increasing the soaking time. Dey *et al.,* (2021) reported that the germination percentage increased from 57% to 71% by increasing the soaking time from 24 to 48 hrs. Germination percentage of seeds treated with sand paper (30%) was higher from the control (20%), and was different from the works of Hasnat *et al.,* (2016), they found similar germination percentage with the control. This also proved that the seeds of *Sterculia villosa* Roxb. have physical dormancy. In case of hot water treatment for 1 min the germination percentage was observed 20% which was equal to control. This result was similar to the results reported by Dey *et al.* (2021) but different from the results reported by Hasnat *et al.,* (2019) and Hasnat *et al.,* (2018), as the germination percentage decreased at a significant rate in the control compared to the hot water treatment. So hot water treatment may not suitable for the cotyledon all species, some species may be harmed by hot water treatment. Soaking in concentrated acid sometimes enhances germination rate. Seeds soaked sufficiently in acid may boost germination rate in some hard-coated seeds (Hasnat and Hossain, 2018). But insufficient soaking may not effective enough. Moreover, concentration of acid and time of exposure are very critical and varies from species to species. In this study only one concentration (10% solution) and two time of exposures (1 and 3 minutes) to HCl and H_2SO_4 was used. In case of H_2SO_4 treatment, 5min immersion showed better results and in case of HCl immersion of 1min showed better results which is similar to the findings of Hasnat and Hossain (2018). But more research is needed in case of acid treatment to standardize the concentrations of acids and the duration of immersion time requirements. In case of fungicide treatment, the result was similar to the findings of Mohammad *et al.* (2016).

In case of seedling performance, the seedlings from the T1 (treated with sand paper at the distal end) showed good results in every parameter and the germination percentage was 30%. So, it can be said that the sand paper treatment can break the physical dormancy of seed as a result nutrients and water could enter in to the seed, making the seedlings more vigor. In case of T2 (immersed in water for 24 hours), the seedling performance was also good as imbibition could happen. On the contrary the seedling performance of T3 (treated with hot water for 1 min) was poor as hot water may harm the cotyledon (Hasnat and Hossain, 2018). The seedling performance from acid treatments was also good as acid may soften the seed coat and nutrients can enter but the concentrations and time of acid immersion should be considered more carefully. And more research is necessary. Though the 200ppm gibberellic acid treatment could increase the germination percentage but the seedling performance was not satisfactory, if the reason can be found out it will be very useful in other researches. The fungicide treatment is same as gibberellic acid treatment. From the result the second highest germination percentage and seedling vigor was found in seeds immersed in water for 24 hrs. If the immersion time of water can be increased this treatment can be the best. More research is necessary in this matter.

Conclusion

Pre-sowing treatment of the seeds of *Sterculia villosa* showed significant difference in germination percentage and seedling performances from the control seeds. In case of germination percentage seeds treated with 200 ppm GA3 showed the highest result (50%). And in case of seedling performance, seeds treated with sand paper at the distal end showed better results. In this experiment it can be concluded that the sand paper treatment is a bit tricky as if scrapped

vigorously the viability may be lost also if used properly the seeds may germinate more and the seedlings also grow quit viperously. The hot water treatment is also difficult as it may harm the seeds if kept for too long. In case of water treatment, the duration may be increased to get better result again it may also increase the chances of rotting of the seeds. In case of acid treatment H2SO4 performed better than HCL. Different concentration of GA3 can be used as it increased the germination percentage the most. In case of fungicide the concentration may be increased also. So, more research is needed to evaluate the results of pre-sowing treatment effect of *Sterculia villosa*. This result can be useful in future research to improve seed germination, seedling performance as well as conservation strategies of this species.

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