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Research Article

Comparative Study on Effect of Sowing Position on Germination and Initial Seedling Growth of *Pterospermum semisagittatum*

GN Tanjina Hasnat* and Mohammed Kamal Hossain

Institute of Forestry and Environmental Sciences, University of Chittagong, Bangladesh

***Corresponding Author:** GN Tanjina Hasnat, Institute of Forestry and Environmental Sciences, University of Chittagong, Bangladesh.

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Abstract

Indigenous tree species are getting rare from nature day by day. *Pterospermum semisagittatum* Buch. -Ham. is a vulnerable native tree species of Bangladesh gradually decreased by over rating of deforestation. Despite its high medicinal and ecological value this species is carelessly destroyed. Bearing in mind the value of *P. semisagittatum*, a study was conducted at the Institute of Forestry and Environmental Sciences Chittagong University (IFESCU) during 2013 to find out effective pre-sowing method. Considering soft coated seeds, three presowing methods - seeds sown vertically in polybags in open sunlight (control), seeds sown vertically in polybags under shade (shade), and seeds sown horizontally in polybags in open sunlight (flat position) were tried. Randomized completely block design was applied and large sized uniform shaped seeds were selected for the experiment. Seeds were sown in normal polybags (6" × 4") with 3:1 soil and cowdung media. In effect, 100% germination and highest plant percent (81.3%), germination value (11.76), germination index (1.53), very good germination capacity observed in seeds sown in flat position in open sunlight. Maximum shoot length (26.4 cm) and node numbers (11.22) also calculated in seeds sown in flat position in open sunlight. The result of the study revealed that sowing seeds in flat position in polybags and keep it in open sunlight increases germination rate as well as produce comparatively vigor seedlings. The findings of the study recommend to apply the method of seeds sown in flat position in polybags to produce vigor seedlings for massive plantation.

Keywords: Vulnerable; Indigenous; Germination Percent; Plant Percent; Vigor Seedling

Introduction

Pterospermum semisagittatum Buch. -Ham. ex Roxb belongs to family Sterculiaceae is endogenous in Bangladesh [1] and commonly known as Bara assar, Lana asaar, Laona-assar, Laona assawar [2,3]. It is a medium to large tree scattered throughout in dense evergreen forests of East Asia - Bangladesh, Cambodia, India, Laos, Myanmar, Sri Lanka and Thailand. It is also found in dry forests and secondary formations at elevations from 100 - 900 metres. In Bangladesh, this plant widely used in Herbal medicine as for burning sensations, gastrointestinal disorders, heart palpitation, hepatic disorders, malaria, respiratory tract disorders, rheumatic pain cancer, skin disorders, and tumor etc. [1,4].

P. semisagittatum can be deciduous or evergreen tree based on climatic condition. The tree can grow up to 25 metres. Generally, the bole is straight and free of branches for up to 12 metres. This tree is a fairly fast-growing tree and harvested from the wild for local use as a masticatory and a source of fibre and wood. The bark fibres are used for cordage. Wood of *P. semisagittatum* is reddish-grey, heavy, fairly hard but durable. It is generally used in making axe handles and house columns in traditional buildings. Wood is

also used as fuel. Natural propagation method is seed germination. According to Red Data Book of Bangladesh [5], degree of threat of *P. semisagittatum* is vulnerable. Major threat for the plant is deforestation. The species needs more researches and field survey to assess the status for future conservation program.

P. semisagittatum has ecological, medicinal and some economic value but deforestation and improper management for long time may drive the species to be a rare one. This is the time to take some initiatives for in-situ as well as ex-situ conservation of this ecologically valuable indigenous species. In order to find out best presowing methods of different species, some studies have done nationally on *Castanopsis indica* [6], *Protium serratum* [7], *Canarium resiniferum* [8], *Acacia catechu* [9], *Albizia procera* [10], *Dalbergia sissoo* [11]; and throughout the world on *Quercus floribunda* [12], *Tectona grandis* [13], *Couroupita guianensis* [14], etc. Most of the studies are conducted on hard coated seeds. Rarely researches done on soft coated seeds for find out best methods such as *Lophopetalum wightianum* [15] and *Schleichera oleosa* [16] but no studies about presowing effects on germination and initial seedling growth of *P. semisagittatum* conducted yet.

Purpose of the Study

The main purpose of this study was to find out the appropriate presowing method that maximize total germination and produce more vigor seedlings.

Methods and Methodology

Study site, seed source and seed morphology

The study was conducted in the Seed Research Laboratory and the nursery of Institute of Forestry and Environmental Sciences, Chittagong University (IFESCU) (22°27'41 N, 91°47'50 E), Chittagong, Bangladesh from April 2013 to July 2013. Mature fruits were collected from natural forests of Chunati, Satkania, Bangladesh during April 2013. After measuring the morphological characteristics, fruits were dried in open sun up to naturally splitting of capsules. The next, medium sized winged seeds were measured for morphological characteristics. The average fruit size was found 7.9 ± 0.6 cm × 3.9 ± 0.2 cm while seed size varied from 2.5-5.1 cm length and 1.0-1.2 cm width. About 22-32 fruits and 10,400 - 12,200 seeds found per kg each (Table 1, Figure 4a). Comparatively large sized uniform shaped seeds were selected for germination test in order to maintain homogeneity in germination and initial seedling growth performances.

	Fruit length (cm)		**Fruit width (cm)**	**Weight/ fruits (g)**	**Fruits/kg**
Average	7.9 ± 0.6		3.9 ± 0.2	38.6 ± 5.9	26 ± 4.1
Range	7-8		3.5-4	31-46.5	22-32
	Seed (with wing)		Seed (without wing)		Seeds with wing
	Seed length (cm)	Seed width (cm)	Seed length (cm)	Seed width (cm)	Seeds/kg
Average	3.92 ± 1.1	1.12 ± 0.1	0.98 ± 0.3	0.82 ± 0.01	11,467 ± 945
Range	2.5-5.1	1.0-1.2	0.7-1.3	0.8-0.9	10,400-12,200

± indicates the standard error of mean.

Table 1: Morphological characteristics of fruits and seeds of *P. semisagittatum*.

Experimental design and Presowing treatments

Seeds of the species were soft coated. Considering the seed coat, no hard presowing treatments were tried. Experiments were conducted on sowing position only. Three presowing treatments including controls were:

T_0 = Seeds sown vertically in polybags in open sunlight (control),

T_1 = Seeds sown vertically in polybags under shade (shade), and

T_2 = Seeds sown horizontally in polybags in open sunlight (flat position).

A Randomized completely block design (RCBD) [17] with three presowing treatments comprising three replications for each treatment was used in the experiment. Due to the scarcity of seeds in the natural forests, each replication consisted of ten seeds only and each seed was sown in one polybag.

Growing media

Seeds were sown in normal polybags sized 15 cm × 10 cm (6" × 4") filled with a mixture of soil and cow-dung (3:1) media. Soil was collected from the forest sites of the University of Chittagong campus. Collected soil was dried in the open sun for 3 days, sieved well (< 3 mm) and mixed with decomposed cow-dung.

Data record and analysis

The effects of different presowing treatments on germination and initial seedling growth performance was assessed. For measuring germination parameters, data of first day of germination, number to first germinate, daily germination, last day of germination, number to last germinate, plant survived from each replication of each treatment were collected in daily basis from the date of seed sowing and continued up to three months. For measuring initial seedling growth parameters, shoot height and leaf node number of three vigor seedlings from each replication of each treatment were measured after five weeks and ten weeks of seed germination.

Seed germination was considered to occur when the tip of the radicle emerged free of the seed coat, as well as sprouting [18,19]. Germination percentage calculated by counting germinated seeds per day out of 100 [20] and at the end of total seed germination, cumulative germination percent was measured by sum up daily germination. Germination energy was assessed when the daily germination percentage reached to its apex point [21]. Cumulative germination index was calculated as the sum of the percentage of seeds germinating on each day divided by the number of days since the germination test began [22]. Germination Index is also measures the speed of germination [23]. Mean time to germination (MGT) was calculated as the weighted mean of the germination time and measures the rate and time-spread of germination [24]. Mean time to germination is also expressed as speed of germination [25]. The weight is measured as the number of seeds germinated in the intervals of time established for data collection [26]. Rate of germination (R) is the maximum germination taken in a minimum time, irrespective of final germination. Rate of germination is the reciprocal of MGT [27].

The coefficient of uniformity of germination measures the variability among seeds in relation to the mean germination time of the sample [28,29]. Plant survival percentage was determined by counting total seedlings survived at the end of the experiment divided by total number of seeds sown and the results multiplying by 100. Peak value of germination (PV) multiplying with mean daily germination (MDG) produce germination value (GV). Germination capacity denotes the percentage of seeds in a sample that actually germinate irrespective of time [20]. The following formulas were used to find out germination percentage, cumulative germination percentage, germination index, mean germination time, rate of germination, germination uniformity, plant percent, plant value and germination capacity.

Germination Percent (GP)	$\frac{Number\ of\ seeds\ germinated}{Number\ of\ seeds\ sown} \times 100$
Cumulative Germination Percent (CGP)	$\frac{Cumulative\ number\ of\ seeds\ germinated}{Number\ of\ seeds\ sown} \times 100$
Germination Index (GRI)	$\left(\frac{No.\ of\ germinated\ seeds}{Days\ of\ first\ count} + \ldots\ldots + \frac{No.\ of\ germinated\ seeds}{Days\ of\ final\ count}\right) \times 100$
Mean Germination Time/ Speed of Germination (F/ MGT/GS)	$\Sigma Dn/\Sigma n$ Here, n = the number of seeds, D = the number of days counted from the beginning of germination.
Rate of Germination (R)	$\frac{1}{MGT}$ or, $\frac{\Sigma n}{\Sigma Dn}$
Germination Uniformity (GU)	$\frac{\Sigma n}{\Sigma (Fn - t)^2 \times n}$
Plant Percent (PP)	$\frac{Number\ of\ surviving\ seedlings}{Number\ of\ seeds\ sown} \times 100$
Germination Value (GV)	$Peak\ value\ of\ germination\ (PV)$ $\times\ Mean\ daily\ germination\ (MDG)$
Germination Capacity (GC)	i) 100-90 % - very good, ii) 90-70 % – good, iii) 70-50 % – average, iv) 50-30 % - poor, v) 30-20 % - very poor, and vi) (<) 10 % - extremely poor.

Initial growth rate of seedlings at the nursery stage was estimated by analyzing recorded data from 5 weeks and 10 weeks old vigor seedlings. Shoot height measured from collar region to shoot tip with centimeter scale. Leaf node numbers recorded by counting both leaf fall scar and leaf present from 10 weeks old vigor seedlings.

Statistical analysis

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

Results and Discussion

Germination behavior of *P. semisagittatum*

Three presowing treatments T_0, T_1, and T_2 were applied on the seeds of *P. semisagittatum* and three weeks later T_1, and T_2 were compared with control (T_0) to find out the best one. The results revealed that faster starting (6th day) and ending (12th day) of germi-

nation observed in treatment T_1. 100% seeds were germinated in T_2 position, but seeds in T_0 germinated with highest energy (33.33%). All treatments showed a range of mortality but minimum observed in T_1. In T_2, highest germination value (11.76) indicates better germination percentage within shorter germination period. Highest germination index (1.53) indicates faster germination within a shorter time and it observed in T_2. The lower mean germination time (9.2) and higher R (0.11) in treatment T_1 revealed higher and faster germination of a population of seeds. A good germination uniformity (0.0117) observed in treatment T_1 (Table 2). Depending on cumulative germination percent, T_2 showed comparatively good germination capacity (Table 2 and figure 1).

Treatment	FDG	LDG	GPr (day)	GP%	GE%	GEP (day)	PP%	GV	GI	F/MGT	R	GU	GC
T_0	7	15	8	86.67a*	33.33a	8.67a	76.7a	6.11a	0.88a	10.1ab	0.1ab	0.0034a	Good
T_1	6	12	6	83.33a	23.33a	8a	76.7a	6.04a	0.93a	9.2a	0.11b	0.0117b	Good
T_2	7	15	8	100a	31.33a	10a	81.3a	11.76b	1.53b	10.73b	0.09a	0.0012a	Very good

Table 2: Germination behavior of Lana Assar (*P. semisagittatum*) seeds in sun lights, shade and flat position.

(*) Means followed by the same letter(s) in the same column are not significantly different at P<0.05, Duncan's Multiple Range Test (DMRT).

FDG = First day of germination, LDG = Last day of germination, GPr = Germination period, GE = Germination energy, GEP = Germination energy period, PP = Plant percent, GV = Germination value, GI = Germination index, MGT = Mean germination time, R = Rate of germination, GU = Germination uniformity, GC = Germination capacity.

Figure 1: Effect of sun, shade and flat sowing position on cumulative germination percentage of *P. semisagittatum* seeds.

Mean cumulative germination percentage of *P. semisagittatum*

Suitable presowing techniques can enhance germination rate [8,11,15,16,30,31]. Among the applied presowing methods, germination started at first and ended fast in seeds sown vertically in polybags and kept under shade (T_1). Germination started in shade on 6th day of seed sown and continued up to 12th day. Seed germination in seeds sown horizontally in polybags and kept in open sunlight (flat position/ T_2) started on 7th day of seed sowing and on 12th day, mean cumulative germination percentage curve shown an upward trend by crossing the curves of seeds sown under sun (T_0) and shade (T_1), then remained highest up to the end of the experiment. Seeds sown in sun (T_0) started germination on 7th day, showed a gradual increase and crossed the curve of seeds sown in the shade (Figure 1). By analysing the mean cumulative germination percentage of *P. semisagittatum*, it is found that though germination started in shade at earliest and need less time for complete germination but seeds sown in flat position (T_2) was the best as it showed a regular increase in germination and revealed 100% germination finally (Figure 1).

Shoot increment and nodal variation of *P. semisagittatum* seedlings

At age five weeks (after germination), shoot height of vigor seedlings were measured and it was quite similar among all seedlings grown under sun (10.4 cm), shade (10.6 cm) and flat position (10.3 cm). After 10 weeks shoot height was measured again and a variation observed. Seedlings grown from seeds of flat position performed best in height growth and obtained highest height (26.4 cm) followed by shade (25.9 cm) and sun (23.8 cm) (Figure 2). The error bars show that the data are around the mean value and mean value of data is more accurate in all cases. Figure 2 also represents that the error bars overlap each other, that reveals there is no significance differences in shoot length among the applied presowing methods. In case of nodal increment, highest node counted in seedlings germinated from seeds sown in flat position (T_2) followed by seedlings growth under sun (T_0). Lowest nodes were found under shade (Figure 3).

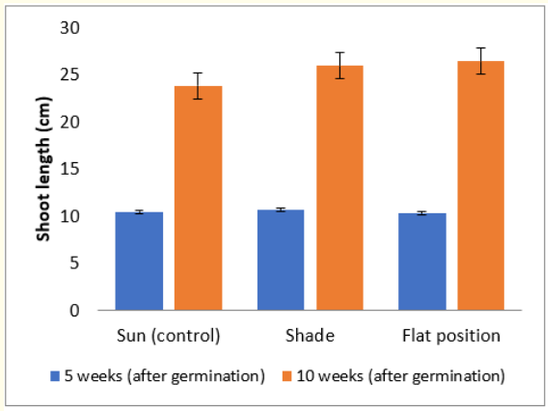

Figure 2: Shoot increment of *P. semisagittatum* seedlings in sun light, shade and flat position in nursery.

Figure 3: Nodes in ten weeks old seedlings of *P. semisagittatum* germinated in open sunlight, shade and flat position.

Figure 4: a) Fruits and seeds of P. semisagittatum, b) 30 days old seedling after germination, c) 90 days old seedlings, d) 90 days old seedlings in polybags.

Soft coated seeds are generally set aside from researches for presowing techniques as the seed coat do not require especial treatment for breaking dormancy to accelerate germination. But sometimes especial care in nursery with some improved method may induce germination of seeds than that in natural environment. In order to find out the best method for better germination and vigor seedlings the study was carried out (Figure 3). For raising improved seedlings in nursery for plantation, seeds must be collected immediate before or after fruit splitting and sown as soon as possible after seed collection. Storing more time effect on seed viability. More the days storage, less the viability.

Conclusion

Present study explored germination behaviors and initial growth performance of seedlings of *Pterospermum semisagittatum*, an ecologically valuable but vulnerable indigenous species. The findings of the study revealed that seeds of *P. semisagittatum* responded differently in different sowing methods. Among three presowing methods, seeds sown horizontally in polybags in open sunlight (flat position) exhibited cent percent germination with best germination behaviors and produced comparatively vigor seedlings. The present study suggests to raise seedlings by sowing seeds in flat position in polybags in open sunlight with soil and cow-dung media for best germination and seedlings growth performances. Further researches are recommended on seed viability and tissue culture of the species.

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Conflict of Interest

None.

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