

Seed Morphology and Germination Studies of *Dalbergia sissoo* Roxb. at Nursery Stage in Bangladesh

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Abstract: *Dalbergia sissoo* Roxb. is a fast growing, nitrogen fixing, deciduous tree used in agroforestry, afforestation programs and farm forestry. It is one of the most widely used species for a variety of uses in different parts of the world and uses in rural areas of Bangladesh. Morphological characteristics of the fruits and seeds, seed germination and seedling growth performance of the species were studied in the nursery. The length, breadth, thickness and weight of the fruits and seeds were measured and were found highest in 4-seeded and lowest in 1-seeded fruit. The rate of untreated seed germination was tried in the seed tray, polybag and seedbed. The highest germination percentage was found both in cow-dung mix soil (59-68%) and without coated seeds (61-70%) in all conditions. The germination rate was poor in clear soil (55-61 %). The required germination period was very short in seeds of without coated (3-6 days) in relation to with coated seeds (14-15 days) in all conditions. So, cow-dung mixture soil is suggested for germination of the species. Seeds having no coat require less time to start and complete germination and are higher in percentage than that of with seed coat seeds. Although removing of coatings required much time and effort, it is suggested that seeds without coatings can be used to get quicker germination and better results.

Key words: *Dalbergia sissoo*, seed, seed morphology, germination

INTRODUCTION

The genus *Dalbergia sissoo* is named after the Swedish Botanist, Nicholas Dalberg. It is a Pantropical genus with 100 species distributed in different parts of tropical Asia, America and Australia^[24]. The genus *Dalbergia sissoo* is representative in Bangladesh by 14 taxa (12 species and 2 varieties) including eight trees and six woody climbers viz. *D. camienalenis* (Dennst), *D. confertiflora* Benth. Var. *listeri*^[1]. *Dalbergia sissoo* Roxb. (Shisham, Sissoo- Sisu, sisal, Shisu) is a large, fast growing, deciduous tree^[4,21,26,27,3]. A tree with light spreading crown and crooked trunk^[7]. Leaves compound, with 3 to 5 alternate leaflets^[27] in favourable conditions it grows upto 30 m in tall with a clear 10 m cylindrical stem, but in arid and other unfavorable sites it grows to about 10-15 m with crooked bole, difficult to obtain straight log^[21,27].

Sissoo belongs to family *Leguminose*, subfamily *Papilionaceae*^[7,21]. A tree with light spreading crown and crooked trunk^[7], barks 1.0 cm thick, gray, longitudinally and somewhat reticulately furrowed^[21,27]. The primary root long, at first thin, afterwards thickening considerably, terete, tapering, lateral roots

numerous distributed down main roots; nodule present^[25] and has long superficial roots, which sends upto suckers where injured and small, yellowish flowers with a pervasive fragrance^[25]. The seedlings produce a long taproot at an early stage^[21]. The stem is erect, thick, woody, somewhat round, often twisted and the butt irregularly buttressed^[9].

Morphological Features of Fruits and Seeds: The pods of Sissoo when ripe contain 1-3 seed, indurated, reniform flat, light brown, with delicate papery testa^[26]. Fruit is 5-7 x 0.08 x 1.2 cm, strap-shaped, pale brown, mostly 1-seeded, less often 3-seeded^[2]. Pods are 4.5-10 x 0.07 x 1.5 cm, linear-oblong, indecent, stipulate, glabrous, apex acute to obtuse, conspicuously reticulated against the seeds, usually 1-4 seeded. The length of pods varies from 5-10.5 cm according to the number of seeds. Pods with 1-4 seeded were observed, amongst these 2-seeded pods are common followed by 1-seeded 3-seeded and pods with 4seeded pods very rare^[14]. Seeds 8-10 x 4-S.S mm, brown to brownish black, reniform, compressed^[23]. The seeds are 6-9 cm long and number of seeds per kg. is 44000^[17], 53000^[5] and 55000 kg^[16].

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Germination Behaviour of Seeds: Seed collection starts from October to February^[5]. The flat pods which mature from December through till March are rubbed to split and reveal the flat seeds which are sown on the shaded beds immediately^[27]. The seeds enclosed in the pods are dormant in the summer months^[23]. Pods are soaked in water for 24 h^[26,27] the pod valves become soft when moistened and permits germination^[23].

As a general rule, seed germination commences at the beginning of the monsoon as soon as the pods have been soaked by rain^[25] and moistened seeds germinate in December to April^[26], mostly in February to March^[5]. The germination of Sissoo seed is epigynous. Seedling has a long taproot with numerous fibrous lateral roots^[22].

Seed viability period is 1-year^[6] to 4-years in sealed containers^[26]. Seed retained viability for two or more years when dry, sealed in Polythene bags^[20]. Germination capacity and plant percent in Sissoo are 90 % and 45 %, respectively. The seed stored in sealed tin containers gives higher germination percentage than stored in open baskets. Similarly, when the seed is dried in the sun for 6-12 days before storage, there is an improvement in its germination capacity^[9]. The seed do not show any marked change in germination behaviour even after 1-year, if storage conditions are good. The seed germination best at 30 °C and in July under controlled conditions. The age of the parent tree has more or less no influence on germination capacity. Tetrazolium test to compare actual germination percentage of fresh and stored seeds indicated that embryos of viable seeds are completely stained^[10].

Normally seed germination of Sissoo is 85%^[6]. About 95% germination is attained when freshly collected seeds are sown down to 40% at 4-years in sealed containers^[26,27]. Germination decreased steadily with storage from 96% at collection time, to 58-68% after 12 months storage. The highest values between container types with length of storage, but highest values after 1.2 months were found in tin containers (68%) followed by cloth bags (61.3%), polyethylene bags (59.7%) and gunny bags (58%). The viability of seeds collected from December to March was 90 %. There- was a slight but significant decrease germination rate from March to May.

Production of high quality seedlings in large-scale plantation program needs a readily available and suitable seedling growing medium^[11]. Seedlings develop profuse root system immediately after germination under full sun. Development of seedling is better in full sunlight than under partial shade^[23].

MATERIALS AND METHODS

The fruits known as pods of *Dalbergia sissoo* were collected from trees planted along the highway of Tala-

Paikgacha under Satkhira and Khulna Districts during the month of December, 2004 and January, 2005. The ripe fruits / pods were collected directly from trees by climbing the tree manually with bags or baskets and by beating with sticks or shaking the branches and collected from the ground. The trees were of about 10-15 years old with straight bales and well-formed and healthy spreading crowns. Bunches of pods were collected from each tree.

The fruits were then dried for 6-8 days in the sun and after that each pod was separated from the bunches. The pods were then dried for another 3-4 days in open air by spreading them on the floor and then stored. The pods were then grouped based on the number of seeds contained in it and were found four types namely 1-4 seeded. Measurements of each type of fruits such as fruit weight, fruit length, breadth and thickness etc. were taken. Measurements of the same were also taken for seeds. An electronic balance was used for weight and a slide calipers was used for measuring dimensions of fruits and seeds.

For germination trails, three types of treatments were used namely poly bags, plastic seive as seed tray and nursery seedbeds. White color poly bags of size 15 x 10 cm x 0.006 mm, round plastic sieve of 24.5 cm diameter as seed tray and open nursery plot of 1m x 1 m area as seed beds were used at the Forestry and Wood Technology (FWT) nursery in Khulna University (KU), Khulna during the experiment. The rooting media used for germination purpose were clear dry soil and decomposed cow-dung in 3: 1 ratio by volume and were thoroughly mixed with each other arid clear soil. The seeds used were of with seed coat and without seed coat.

The relative humidity, air temperature and rainfall recorded during the experiment period. For these purposes Hygrometer / Humidity meter, Thermometer; and Rain gauge were, respectively used. The average relative humidity, rainfall, air temperature and soil moisture were 76%-80%o, 196 cm - 200 cm and 28-32 °C, respectively.

The pods were then segmented into parts containing 1 seed in each part. In all the three treatments / conditions (viz. seed tray, poly bag and seed beds) rooting media is placed properly and 100 seeds with seed coat collected randomly were sown directly in May, 2005 without any pre-treatment having three replications. The seeds sowed uniformly at a depth of 0.5 -1.5 cm in all the three treatments. Watering was done at every alternate day.

The number of seeds germinated was recorded every day in each condition by counting the number of seedlings germinated. The starting and finishing date of germination were also recorded and total length of period in days was also calculated. The percentage of germination of the species was calculated. The percent

Germinative Energy (GE) was calculated by using the following formula:

GE (%) =

$$\frac{\text{Number of germinating seeds during the germinative energy period}}{\text{Total number of seeds in the sample}} \times 100$$

(N.B. the Germinative energy period starts from sowing of seeds and terminates with rapid constant falling off in daily germination).

RESULTS AND DISCUSSIONS

Fruits: The fruit of the species were reniform, indecent legumes and light brown in color. The seeds contained in each fruit were varied in numbers. Pods with 1-4 seeded were found, amongst these 2-seeded fruits were common followed by 1 and 3 seeded and of 4seeded were few. Kanak and Sahai^[14] also described similar instances. The length and weight of the pods were varied according to the number of seeds contained in it. The average length of pods was highest in 4-seeded and lowest in 1-seeded pods. The average thickness and breadth were more or less similar in all and were 0.097-0.105 cm and 1.01-1.19 cm respectively. The average length, breadth and thickness of fruits of 1, 2 and 3-seeded were summarized in Table 1, Table 2 and Table-3 respectively. Four seeded fruits were of rare in number so that its measurement was not taken.

Seeds: The seeds of the species were reddish brown in color. Some of them were brownish black, reniform and compressed. The seeds were measured and average lengths, breadth and thickness were found out and were of 0.59 – 0.62 cm, 0.0324 – 0.336 cm and 0.056 – 0.54 cm respectively. The number of seeds per kilogram (Kg) was 54,000 (with seed coat) and 86000 (without seed coat). Benewial and Singh (1998) also found similar results. The detailed information about seed morphology was shown in Table-4.

Seed Germination: In case of clear soil, seed germination started within 10 days in seed tray, within 11 days in poly bag and within 12 days in seed bed (fig. 1). In cow-dung mix soil medium seed germination started within 9 days in seed tray and 10 days both in poly bag and seed bed (fig. 1) showed in Table - 5. On the other hand, seed without coat germination started within 3 days in poly bag and 4 days both in seed tray and seed bed (fig. 2), shown in Table 5.

Germination percentage was found the highest in pure soil (61%) and cow-dung mix soil (68%) both in poly bag condition and in seeds without coating (70%) in seed tray (fig. 1), showed in Table -6. The higher germination percentage in seed tray may be due to the

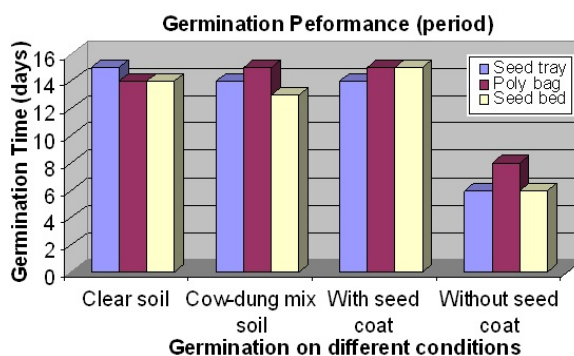


Fig. 1: Seed Germination performance of *Dalbergia sissoo* on different conditions using clear soil & cow dung mix soil and with seed coat & without see coat.

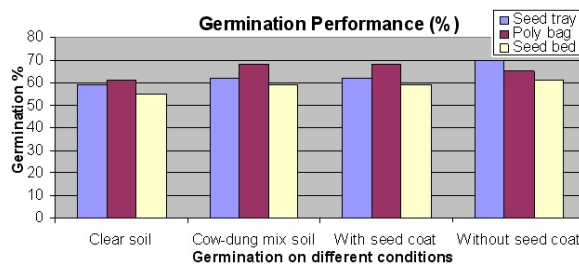


Fig. 2: Seed Germination percentage of *Dalbergia sissoo* on different conditions using clear soil & cow dung mix soil and with seed coat & without see coat.

fact that the seeds in tray were not washed out at the time of watering during germination. Because water was given to the perforated tray as and when necessary to maintain optimum moisture condition by dipping perforated portion of the tray in water through. Similar techniques of watering also followed, by Benewial and Singh^[6], Matin and Rashid^[18] during germination of some forest species.

In the same way, the better germination percentage in poly bag might be due to the fact that each poly bag had 1-seed during the germination test. The poly bags were duly perforated to drain out excess water in time and perforation helped proper aeration, which is also very important for germination. Moreover, each poly bag contained-higher volume of rooting medium, which is favorable for seed germination. On the other hand, germination percentage of the species was very poor in open bed condition. It might be the cause that some seeds might be washed away or buried deep in soil due to heavy rain in May-June of the year^[5,6,18].

The higher germination percentage was found in cow-dung mixture soil medium and requires less time than in clear soil medium in all the three conditions (fig. 2), as shown in Table-5. It might be due to the hot that the former one was looser than the later as

Table 1: Morphological characteristics of 1-seeded fruits of *Dalbergia sissoo* (mean of 30 fruits \pm t.SE).

Color	Average length (cm)	Average breadth (cm)	Average thickness (cm)	Average weight (gm)
Light brown	5.30 \pm 0.20	1.03 \pm 0.02	0.098 \pm 0.007	0.04 \pm 0.002

\pm showed 95% confidence interval

Table 2: Morphological characteristics of 2-seeded fruits of *Dalbergia sissoo* (mean of 30 fruits \pm t.SE).

Color	Average length (cm)	Average breadth (cm)	Average thickness (cm)	Average weight (gm)
Light brown	6.33 \pm 0.208	1.09 \pm 0.016	0.098 \pm 0.007	0.78 \pm 0.003

\pm showed 95% confidence interval

Table 3: Morphological characteristics of 3-seeded fruits of *Dalbergia sissoo* (mean of 30 fruits \pm t.SE).

Color	Average length (cm)	Average breadth (cm)	Average thickness (cm)	Average weight (gm)
Light brown	7.61 \pm 0.28	1.17 \pm 0.022	0.114 \pm 0.002	0.114 \pm 0.003

\pm showed 95% confidence interval

Table 4: Morphological characteristics of *Dalbergia sissoo* seeds (mean of 30 seeds \pm t.SE).

Color	Average length (cm)	Average breadth (cm)	Average thickness (cm)	Average weight of seeds per Kg	
				With seed coat	Without seed coat
Reddish brown	0.61 \pm 0.013	0.33 \pm 0.006	0.011 \pm 0.001	54000	86000

\pm showed 95% confidence interval

Table 5: Seed germination percentage (mean of 100 seeds) of *Dalbergia sissoo* both in clear soil and cow-dung mix soil.

	Seed tray				polybag				Seed bed			
	cease	total	%	start	cease	total	%	start	cease	total	%	start
Clear soil	10	25	15	59	10	25	61	61	12	26	14	55
Cow-dung mix soil	9	23	14	62	10	25	68	68	10	24	13	59

Table 6: Seed germination percentage (mean of 100 seeds) of *Dalbergia sissoo* both in clear soil and cow-dung mix soil.

	Seed tray				polybag				Seed bed			
	cease	total	%	start	cease	total	%	start	cease	total	%	start
With seed coat	9	14	14	62	10	25	15	68	11	26	15	59
Without seed coat	4	10	6	70	3	8	5	65	4	10	6	61

some organic matter (cow-dung) were thoroughly mixed and thus requires less time. In addition, it helps to develop and maintain good soil structure and porosity, water holding capacity, aeration, permeability and contribute in raising Cation Exchange Capacity (CEC) of the soil. Similar instances were also found by Quantin^[19], Jones^[13], Jenkinson^[13].

In the same way, higher germination percentage was found in seed, without coat than with seed coat and requires less time in all the conditions (fig. 2), as shown in Table-6. It was probably due to seed coat impermeability to water or oxygen or both that prevents seed from, germination. Besides, it might be due to the fact that seeds need to rot the coat and required much time, which reduced germinating energy. As a result, lower/poorer germination percentage was found in seeds having coatings. Similar results of poor germination percentage were also found by Kozlowski^[15, 16].

Recommendations and Conclusions: In case of seed germination, seeds in the clear soil medium and cow-

dung mixture soil medium (3: 1) showed the best performance in seed tray condition but seeds having no coatings performed better in poly bag conditions. Germination period required less in cow-dung mixture soil medium and is higher in percentage than that of clear soil medium. So, cow-dung mixture soil is suggested for germination of the species. Again, seeds having no coat require less time to start and complete germination and are higher in percentage than that of with seed coat. Hence it is suggested that seeds without coatings can be used to get quicker germination and better results though removing of coatings required much time and effort. Although removing of coatings required much time and effort, it is suggested that seeds without coatings can be used to get quicker germination and better results.

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