Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 13 [10] September 2024: 48-53

Online ISSN 2277-1808
Journal's URL: http://www.bepls.com
CODEN: BEPLAD

ORIGINAL ARTICLE **OPEN ACCESS**

Morphometric characterization and seed germination *of Dalbergia latifolia* Roxb.

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ABSTRACT
Dalbergia latifolia Roxb. *[Family: Fabaceae] popularly known as "Indian Rosewood" is a premier timber species used for manufacturing handicrafts and musical instruments. It is listed as "Vulnerable" in RED Data Book and also in CITES Appendix II. It is naturally distributed in moist and dry deciduous forest of Karnataka, Kerala and Tamil Nadu. It is an important flagship species and indicator of forest health. In the present study, pods and seeds of 17 population of Rosewood from Karnataka, Kerala and Tamil Nadu were studied for morphometric characterization, seed viability, seed germination and early seedling growth. There exists variability in length, width and weight of pods and seeds. Pods (length: 3.7cm-5.8cm), width (1.14cm-2.04cm) and weight (8.3g-16.1g), Seeds (length:7.1352mm-10.0208mm), width(4.0052mm-5.5112mm), thickness (1.4384mm-9.6344mm) and weight (2.7g-6.1g). Seed viability ranges from 8%-100%. Seeds do not require any pre-treatment. Mere presoaking in water for 24 hours shows good germination. The results were found to be statistically significant (One-way ANOVA at the level of significance 0.05). Seed germinates in about 5 to 7 days. Aralaguppe Coffee Estate, Bhadravati and Erode populations shows good percentage germination and higher biomass of the seedlings compared to other. Storage condition, moisture level and duration of storage affects the germination percentage and vigor of the seedling growth.*
***Key words**: Dalbergia latifolia, Seed germination, IUCN red data list, TTC test*

Received 14.07.2024 Revised 10.08.2024 Accepted 23.09.2024

INTRODUCTION

Dalbergia latifolia Roxb. [Family: Fabaceae] popularly known as "Indian Rosewood" is one of the vulnerable and most precious timber species of India. The tree is commonly called 'sitsal', 'beete', 'sisham', 'Bombay blackwood' in India, and 'sonokeling' or 'sonobrits' 'Indian palisandre', 'java palisandre', in Indonesia. The genus '*Dalbergia'*consists of around 200 species, among which 25 species are found in India. It is native to low-elevation tropical monsoon forests of South India. It is drought hardy and grows in both evergreen and deciduous monsoon forests of India. The natural range of *D. latifolia* stretches from the sub-Himalayan tracts to southern tip of India and the island of Java in Indonesia. (1). Its best growth occurs in the Western Ghats forests of Karnataka, Kerala and Tamil Nadu. It is also grown in Kenya, Malaysia, Myanmar, Nepal, Nigeria, Philippines, Sri Lanka and Vietnam. In areas with high rainfall the trees remain evergreen throughout the year while in drier habitats the leaves are shed by the end of January. New leaves appear in April-May and Flowering begins by December and normally continues to March or rarely October. Ripe fruits are available from October to April depending on locality. The fruits remain on the trees until the onset of the rainy season. When the pods turn dark brown, they are collected from the trees by lopping the branches (2and 3) Many species of *Dalbergia* are important timber trees, valued for their decorative and often fragrant wood, rich in aromatic oils (4). It has been listed in Appendix II of cites from 2016 and categorized as "Vulnerable" by the IUCN. (https://www.iucnredlist.org/, 2018) (5), (6).

Objectives of the study

- For Morphometric analyses of pods/seeds of different populations of *Dalbergia latifolia.*
- Studies on seed viability, percent germination and early growth of seedlings at nursery stage among different populations of *Dalbergia latifolia*.

MATERIAL AND METHODS

Study Area

The field survey of rosewood trees (plus trees) in Karnataka, Kerala and Tamil Nadu states which has more than two meters girth with clear bole (>5 meters) were identified and recorded geocoordinates. The

pods/seeds were collected from Bhadra Tiger Reserve, Haliyal Forest Division, Shivamogga (Karnataka State), Dharmapuri and Salem Forest Division (Tamil Nadu state), Parambikulam Tiger Reserve Palakkad (Kerala States). With the help of tree climber, the pods were collected from the marked plus trees by tapping and spreading tarpaulin. The pods were filled into polybags and brought to the laboratory. Pods/seeds were refrigerated (-4^{o}C) until further use.

Table:1. Seed source location

Tree Number	Date Of Collection	State	Location	Forest Division	Gps Location
TREE 1	17-03-2023	Karnataka	Ropeline to Dhoopad khan Road, Kemmannugundi	Bhadravati	N 13.57342^{0} E 075.74852^{0}
TREE 2	18-03-2023	Karnataka	Nagenahalli (Ubrani-Kukwada forest), Tarikere	Bhadravati	N 13.76288^{0} E 075.85167^{0}
TREE 3	27-03-2023	Karnataka	Pradhani Village	Haliyal	N 15 12 26.6 E 74 34 22.2
TREE 4	27-03-2023	Karnataka	Pradhani Village	Haliyal	N 15 12 27.5 E 74 34 23.8
TREE 5	27-03-2023	Karnataka	Haliyal	Haliyal	N 15 11 23.3 E 74 45 02.
TREE 6	27-03-2023	Karnataka	Haliyal	Haliyal	N 15 11 23.3 E 74 45 02.0
TREE 7	27-03-2023	Karnataka	Shivamogga		
TREE 8	28-03-2023	Karnataka	Aralaguppe Coffee Estate	Chikmagalur	N 13.35172^{0} E 075.74343
TREE 9	28-03-2023	Karnataka	Aralaguppe Coffee Estate	Chikmagalur	N 13.35205^{0} E 075.74339^{0}
TREE 10	28-03-2023	Karnataka	Aralaguppe Coffee Estate	Chikmagalur	N 13.35205^{0} E 075.74339^{0}
TREE 11	23-03-2023	Karnataka	Dandeli	Haliyal	N 15^{0}18'8.40" E 74^{0}36'31.03"
TREE 12	26-03-2023	Tamil Nadu	Tamil Nadu	Dharmapuri	N 11^{0}55'35.213" E 78^{0}31'17.141
TREE 13	26-03-2023	Tamil Nadu	Tamil Nadu	Salem	N 11.829457 E 78.278674
TREE 14	25-03-2023	Tamil Nadu	Tamil Nadu	Salem	N 11.43'37.26624" E 78^{0}206050
TREE 15	23-03-2023	Tamil Nadu	Erode	Sathyamangalam	N 11^{0} 36' 20.7" E 77^{0} 35' 17.3"
TREE 16	23-03-2023	Tamil Nadu	Erode	Sathyamangalam	N 11^{0} 39' 05.9" E 77^{0} 07' 55.3"
TREE 17	23-03-2023	Kerala	Parambikulam Tiger Reserve Sungam range	Palakkad	N 10^{0} 26' 45.5" E 76^{0} 49' 03.6"

(Note: For the present study, pods/seeds were secured from IWST, Bengaluru and further studies and analysis were carried out).

The seeds were authenticated by, Dr T. N. Manohara, Scientist F, SFM Division, IWST, Bangalore.

PODS/SEEDS MORPHOMETRY

The variation of morphometric analyses of pods/seeds were carried out. Measurements were made by using Vernier caliper and weight of the pods and seeds were recorded using four decimal electronic weighing balance.

SEED VIABILTY STUDIES

CHEMICAL METHOD: TRIPHENYL TETRAZOLIUM CHOLORIDE (TTC TEST)

2,3,5, - Triphenyl Tetrazolium Chloride (TTC) salt is a cream or light-yellow colored and water-soluble. To prepare a 1.0% solution, one gram of tetrazolium salt is dissolved in the distilled water to make 100ml. The pH of the solution should be 7.0 for the proper staining to occur. The Preparation of buffer solutions: Solution A- 9.078 g of Potassium dihydrogen phosphate (KH_2PO_4) was dissolved in 1000 ml of distilled water. Solution B- 11.876 g of Disodium hydrogen phosphate (Na_2I-$IPO_4.2H_20$) was dissolved in 1000 ml of distilled water. 400 ml of Solution-A and 600 ml of Solution-B were mixed together. In the prepared buffer solution 10g of tetrazolium salt was dissolved. This gives 1.0% tetrazolium solution of pH 7.0. The solution was stored in dark or amber colored bottle to prevent the light reaction.

SEED GERMINATION TEST

Seeds were soaked in distilled water overnight were sowed in the sand-bed. Seeds were spread evenly and placed 2 cm depth in the sand.

NURSERY BED PREPARATION

The sand beds of 3 ft x 7 ft x ½ ft were prepared in the nursery. Seeds of seventeen populations pre-soaked in water for 24 h were sown. Seeds were monitored regularly for germination. First signs of germination were observed on day-five. The percentage germination of seeds was recorded at regular intervals of two days and were photographed.30 days-old seedlings were transferred to 4x6'' poly bags with Sand: Soil: Farmyard Manure mixture in the ratio of 30:60:10. The seedlings were watered regularly and weeding was done at 15 days intervals.

Estimation of biomass

The estimation of biomass was carried out for one-month seedlings by taking fresh weight and dry weight by using four-digit electronic weighing balance.

Statistical analysis

The results were statistically analyzed by considering one variable and performed using One-way ANOVA.

RESULTS AND DISCUSSION

A total 17 populations were selected for the morphometric and germination studies. Morphometric studies gave a diverse output along with that of the germination studies.

Pod/Seed morphometry

Morphometric analyses of pods and seeds indicated that there was variation in terms of length, width, thickness and in weight of pods and seeds. Length and width of pods varied from 3.7cm- 5.8cm and 1.14cm – 2.04cm respectively.

Minimum length of pod was observed in population number-13 collected from Salem, Tamil Nadu, whereas maximum length was observed in population number-15 collected from Erode, Tamil Nadu. Minimum width of pod was observed in population number-16 (Erode, Tamil Nadu) and maximum width was observed in population number-17 (Palakkad, Kerala). Weight of pods varied from 8.3g to 16.1g respectively. The minimum weight of the pod was 8.3g in the population number-16 (Erode, Tamil Nadu) and maximum weight of pod was observed in population number-8 (Aralaguppe Coffee Estate, Karnataka). Seed length and width varied from 7.1352mm-10.0208mm and 4.0052mm-5.5112mm respectively. Highest seed length was observed in population number-16 (Erode, Tamil Nadu), lowest seed length was seen in population number-7 (Shivamogga, Karnataka). Maximum seed width was seen in population number-16 (Erode, Tamil Nadu) and minimum width in population number-8 (Aralaguppe Coffee Estate, Karnataka). The thickness of seeds varied from 1.4384mm to 9.6344mm. Maximum thickness was observed in seeds of population number-13 (Salem, Tamil Nadu), whereas minimum thickness was observed in seeds of population number-16 (Erode, Tamil Nadu). Weight of seeds varies from 2.7g to 6.1g respectively. Minimum weight of seeds was 2.7g, in population number-16 (Erode, Tamil Nadu) and maximum weight of seed was 6.1g in population number- 7 (Shivamogga, Karnataka) (Table 2).

Table 2. Morphometric studies of pod/seeds of *Dalbergia latifolia* Roxb

Population Number	Mean of pod in cm		Mean of seed in mm			Weight in Grams	
	Length of pod	Width of pod	Length of seed	Width of seed	Thickness of pod	Weight of pods	Weight of seeds
1	5.705	1.62	8.6508	4.974	1.8168	15.1	4.7
2	4.82	1.43	7.7148	4.54	1.88	11.6	4.9
3	4.09	1.53	8.0276	4.932	1.7852	10.8	4.9
4	3.73	1.47	8.1336	5.1628	1.6892	11.6	4.8
5	4.74	1.69	8.1196	5.0924	1.792	10.1	5.2
6	3.97	1.43	8.0552	4.9112	1.7504	9.4	4.7
7	5.02	1.685	10.0208	5.1184	1.7688	12.5	6.1
8	5.825	1.93	8.5352	5.5112	1.6436	16.1	5.2
9	5.345	1.65	7.2496	4.8752	7.9388	12.6	3.7
10	5.155	1.58	7.3128	4.8824	7.782	11.8	4
11	4.24	1.41	8.1844	5.2068	1.816	9.8	4.7
12	4.18	1.43	8.124	5.1376	1.8472	10.5	5.2
13	3.7	1.46	8.0748	5.2224	9.6344	10.2	5.1
14	4.14	1.53	8.07	4.968	1.8804	10.1	4.5
15	5.85	1.38	8.2836	4.4308	1.5316	12.5	4
16	4.23	1.14	7.1352	4.0052	1.4384	8.3	2.7
17	5.3	2.04	8.7052	5.2396	1.7684	5.3	4

Figure 1. Pod morphometry

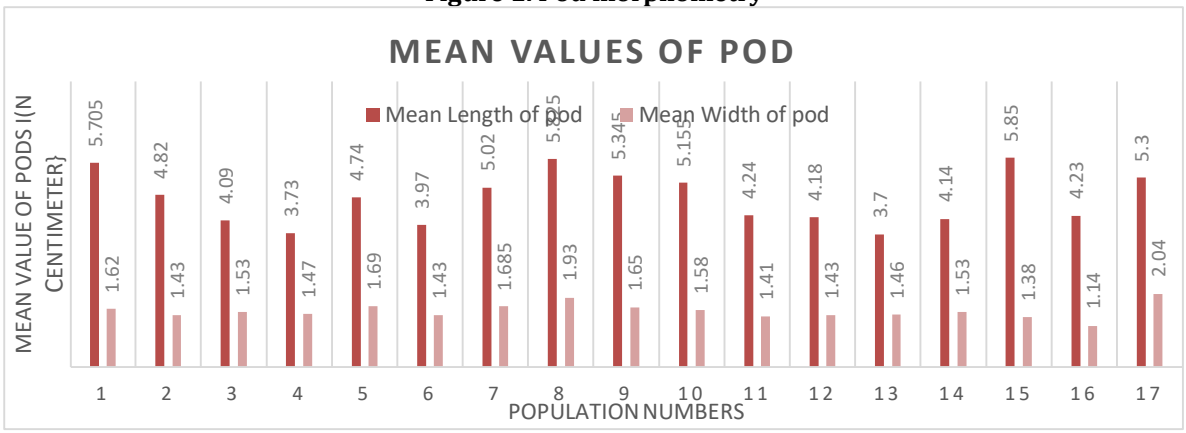
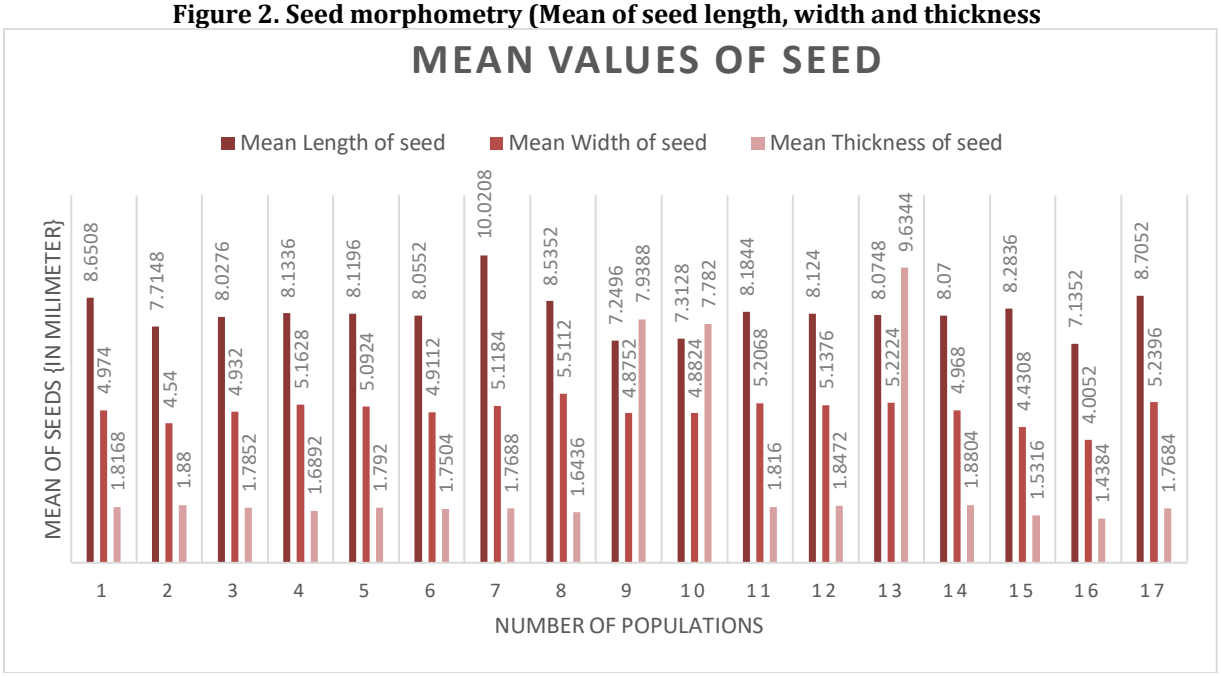


Figure 2. Seed morphometry (Mean of seed length, width and thickness



Seed Viability

In TTC test, out of the 17-populations, population No- 14 (Salem, Tamil Nadu) did not show any change in colour indicating that seeds are non-viable. On the contrary, seeds from population number 9 and 10 collected from Aralaguppe Coffee Estate, Karnataka showed 100% red indicating their viability.

The rest of the population showed a varying percentage of viability. Seeds of population number 1 and 2 collected from Bhadravati, Karnataka showed 68% and 64% viability respectively. Seeds of population number 3, 4, 5, 6 and 11 (Haliyal, Karnataka) showed 8%, 8%, 16%, 8% and 32%viability respectively. Seeds of population number 7 (Shivamogga, Karnataka) showed 12% viability. Seeds of population number 8 (Aralaguppe Coffee Estate; Karnataka) showed 72% viability. Population number 12 (Dharmapuri, Tamil Nadu) showed 20% viability, Population number 15 and 16 (Erode, Tamil Nadu) showed 20% and 24% viability respectively. Population number 17 collected from Palakkad; Kerala showed 70% viability (Table 3).

Sl.No.	Name of Populations	Total Number of Seeds	Number of Viable Seeds	Viability Percentage (%)
1	Tree 1	25	17	68
2	Tree 2	25	16	64
3	Tree 3	25	2	8
4	Tree 4	25	2	8
5	Tree 5	25	4	16
6	Tree 6	25	2	8
7	Tree 7	25	3	12
8	Tree 8	25	18	72
9	Tree 9	25	25	100
10	Tree 10	25	25	100
11	Tree 11	25	8	32
12	Tree 12	25	5	20
13	Tree 13	25	0	0
14	Tree 14	25	0	0
15	Tree 15	25	5	20
16	Tree 16	25	6	24
17	Tree 17	10	7	70

Table:3. Seed viability percentage

Germination Test

In the germination test on nursery bed, the observation was made for 10 days. The first sign of germination was observed on 5thday after sowing. Out of the 17 populations, seeds from 8 populations were showed germination and rest of the populations did not show any germination after 10 days of sowing. Among 8 populations which showed germination, highest percentage germination (82%) was observed in population number-16 (Erode, Tamil Nadu), followed by population number-1 (75%)(Bhadravati, Karnataka), population number-2(73%)(Bhadravati, Karnataka), population number-10 (72%) (Aralaguppe, Coffee Estate, Karnataka), population number-9 (70%) (Aralaguppe Coffee Estate, Karnataka), population number-15 (70%) (Erode, Tamil Nadu), population number-8 (66%) (Aralaguppe Coffee Estate, Karnataka), population number-17 (7%) (Palakkad, Kerala). The Population number-11 (Haliyal, Karnataka) showed least percentage of (1%) germination (Table 4).

Number of Days	Tree 1	Tree2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7	Tree 8	Tree 9	Tree 10	Tree 11	Tree 12	Tree 13	Tree 14	Tree 15	Tree 16	Tree 17
Day 1	17	12	0	0	0	0	0	15	5	32	0	0	0	0	1	1	1
Day 2	36	20	0	0	0	0	0	29	23	59	1	0	0	0	5	5	5
Day 3	56	43	0	0	0	0	0	41	47	64	1	0	0	0	8	12	7
Day 4	71	55	0	0	0	0	0	52	58	69	1	0	0	0	18	21	7
Day 5	73	73	0	0	0	0	0	66	66	73	1	0	0	0	47	43	7
Day 6	75	76	0	0	0	0	0	67	73	75	1	0	0	0	61	55	7
Day 7	76	78	0	0	0	0	0	67	74	76	1	0	0	0	72	77	8
Day 8	77	79	0	0	0	0	0	68	74	77	1	0	0	0	80	81	9
Day 9	77	73	0	0	0	0	0	69	71	74	1	0	0	0	76	83	9
Day 10	75	73	0	0	0	0	0	66	70	72	1	0	0	0	70	82	7

Table:4. Seed germination percentage (%) of *Dalbergia latifolia*

Statistical Analysis

The results were statistically analyzed by considering one variable and performed using One-way ANOVA at 0.05 level of significance ($p \leq 0.05$). The analysis considered 8 populations which showed germination. From the analysis, F_{crit} = 2.139656 whereas F_{stat} = 6.520567. This clearly indicates that $F_{statistical}$ value is greater than that of $F_{critical}$ value. This deduces that there is a statistical significance in the data at the level of significance 0.05. This statistical significance shows that variation in seed germination of different

locations is present. The seeds from Bhadravati, Aralaguppe coffee estate of Karnataka and Erode, Tamil Nadu had the best germination rates Seedlings of Aralaguppe and Erode populations showed higher values comparison with other populations. The maximum germination percentage was observed in present studies was 82% is compared with 70% in the earlier studies **(**7). Out of the 17 populations, seeds from 8 populations were showed germination and rest of the populations did not show any germination after 10 days of sowing may be due to the species are steady in growth, reduced in rejuvenation, low germination rate (7) and slow initial growth (8). Out of the 17 populations, seeds from 8 populations were showed germination may be due to seed viability due to rainfall condition in Aralaguppe Coffee Estate located in Chikmagaluru district has a mix of Evergreen, moist-deciduous, dry-deciduous vegetation and receives good rainfall (2439 mm rainfall - in year 2022), whereas Erode district of Tamil Nadu has Tropical Dry Deciduous Forest to Sub- tropical hill forests and receives a rainfall of 575mm to 833 mm (in year 2022) (9 and 10. TTC (2,3, -triphenyl tetrazolium chloride), in presence of living tissues (embryos) with active respiration it turns red due to reduction and forms formazan). light pink colour indicates a seed with reduced viability when compared to a seed that stains dark red (11). Seeds of population number-7 which had the highest seed weight of 6.1g did not show germination having a viability percentage of 12% in TTC test and seeds of population number 3, 4, 5, 6, 12 did not germinate even though they gave positive results for TTC test (Table 3). This maybe because of some of disadvantages of TTC test which is difficulty in differentiating between dormant and non-dormant seeds, due to the presence of microorganisms harmful for the seedling emergence remain undetected (12).

CONCLUSION

Dalbergia latifolia is a premier timber yielding tree listed in RED Data book and CITES Appendices II. Studies on seed collection, storage, germination and standardization of silviculture procedure will helps in production of quality planting stock and good yield. Which in long way helps in sustainable utilization and effective conservation of species. The amount of rainfall and associated species plays a crucial role in growth of *Dalbergia latifolia* and best growth was found in ranges where rainfall ranges from 750 mm – 5000mm, Seeds obtained from these regions in Karnataka and Tamil Nadu found to be of high quality in terms of percentage viability and vigor as the environmental conditions in these localities are highly congenial.

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CITATION OF THIS ARTICLE

Rajani C K, Supriya V, Kushala M, Syed Mehdi Hussain, Prashanth K R, Syed F. Morphometric characterization and seed germination *of Dalbergia latifolia* Roxb. Bull. Env. Pharmacol. Life Sci., Vol 13 [10] September 2024: 48-53.