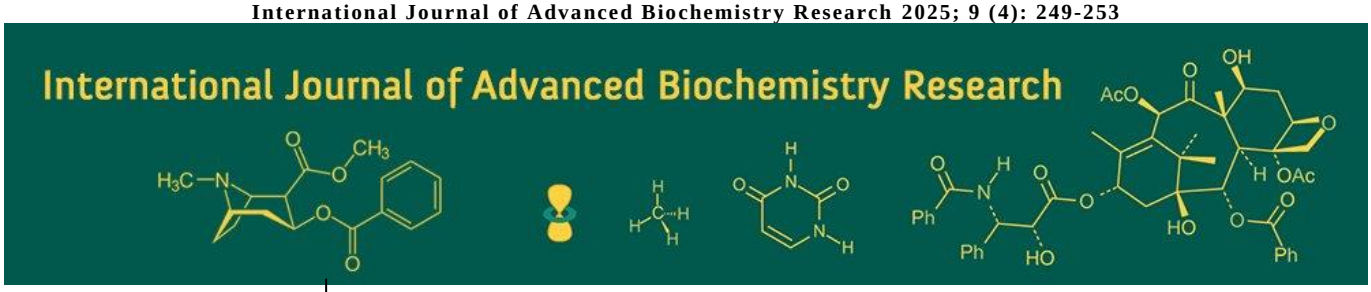

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Assessment of seed germination and seedling biomass of endangered species *Pterocarpus santalinus*

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Abstract
Pterocarpus santalinus (Linn. f) is a very important tree species and valuable plant for the timber and medicinal value. The *Pterocarpus santalinus* (Linn. f) is belongs to Family-Fabaceae. The salient outcome of the experiment result revealed that the germination and growth performance of *Pterocarpus santalinus* seedling at nursery stage help in enhancement of the germination and growth parameter with respect to the seedling height, collar diameter and number of leaves per plant during the period of study. And the species was raised thorough seed and sown in after soaking in water and cow dung slurry for 24 hours. The observation that the treatment sowed better germination percentage is cow dung slurry compare to water-soaked treatment.

Keywords: *Pterocarpus santalinus*, red sanders treatment, seed germination, height, diameter

Introduction
Pterocarpus santalinus (Linn. f) is an endangered species and they are listed in the IUCN Red List, in Red data book *Pterocarpus santalinus* (Linn. f) is a very important tree species and valuable plant for the timber and medicinal value. The *Pterocarpus santalinus* (Linn. f) is belongs to Family-Fabaceae. *P. santalinus* is a small to medium sized deciduous tree having a dense, round crown reaching a height of 10 to 15 m with a girth of about 90 to 160 cm. The bark is typically dark brown in colour with rectangular plates and deeply fissured when matured. When blazed, it exudes a red colour gum with numerous pink streaks. The leaves are pinnately compound which are generally shed during January and March. With the onset of summer, new flush of leaves is produced along with large yellow coloured raceme flowers.

The market has always been in need of larger, better, faster-growing seedlings. The manufacturing of forest seedlings is therefore a constantly developing technique in reforestation. Understanding the development of seedlings in the nursery and their future growth and survival in the field depend heavily on the evaluation of seedling quality. On the other hand, stock quality is frequently evaluated imperfectly and infrequently. While some forestry managers and nurseries evaluate their stock extensively every year, others only do so when an issue occurs.

Pterocarpus santalinus (Linn. f) is commonly used for the anti-inflammation, skin disease and jaundices, use in ayurvedic formulation like: Priyagdavid, Sariwadi Gan and Rakt chandan ghrit. Antipyretic (ferver, headaches), antidiabetes, ulcer.

Materials and Methods
In Jagdalpur one can find different texture of soil varying from sandy clay to loamy sand. The sub-soil found here is largely loamy sand. The climate of Jagdalpur can be classified as tropical savanna climate. There are three main seasons in Jagdalpur namely summers, monsoons and winters. March to May is hot experiencing the summers. The average temperature in summers here ranges from 18 °C to 38 °C. From June to September, Jagdalpur experiences heavy rainfall having a little relief from the hot temperature. The humidity during this period raises and the rainfall it experiences is around 352 mm. Winters which lasts from November to February are warm and dry. The temperature during this time ranges from 31 °C to 11 °C.

Design of Experiment-RBD (Randomized Blocks Design)
Instrument Used For the Study

1. **Vernier Calliper:** The diameter of the seedling shoot is measured.
2. **Meter Scale/Steel Scale:** A meter scale or steel scale is used to measure a seedling's height.
3. **Tape-**This is used to measure a seedling's root length.
4. **Oven Machine:** Used for drying the seedlings for measurement of weight at the end of experimentation.

Weighting Machine: Used for weight of soil for making ratio of soil for all treatment and pot who contains. And also used for weight of root, shoot, and seedling for experiment purpose. All instruments are shown in Photo Plates.
The following leaf emergence growth parameters were recorded for each species and treatment

- Seedling Height
- Seedling Collar Diameter
- Number of Leaf Per Seedling
- Root Length of Seedling
- Shoot Length of Seedlings
- Total Length of Seedlings
- Biomass of Seedling.

Germination Studies
Germination parameters were recorded under laboratory and field conditions.

Germination Percentage (GP)

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seed sown}} \times 100$$

Germination energy (%)

$$\text{GE (\%)} = \frac{\text{Number of seed germinated up to time of peak germination}}{\text{Total number of seed sown}} \times 100$$

Survival percent (%)

$$\text{Survival (\%)} = \frac{\text{Total number of survived individuals of a species}}{\text{Total number of planted Individual}} \times 100$$

The following table showed the treatments nomenclature and treatments description

S. No.	No. of Treatment	Name of Treatment	Poly bags/row
1.	T_1	Soil + seed (No Treatment)	10
2.	T_2	Soil + vermicompost + seed (No Treatment)	10
3.	T_3	Soil + water-soaked seed	10
4.	T_4	Soil +vermicompost + water-soaked seed	10
5.	T_5	Soil + cow dung seed	10
6.	T_6	Soil + vermicompost + cow dung seed	10
Total			60

Results and Discussions
Soil
The pH of the laterite soil was analysed with help of pH meter in the laboratory and it range from 6.81 to 6.82. and used for the present experimentation. The data on soil analysis with respect to available nutrient are present. The perusal of data revealed that the soil was low in available nitrogen (16 mg/kg) available phosphorous (23 mg/kg) and available potassium (46 mg/kg) As per the normal range of soil NPK, the laterite soil was found relatively low.

Seed germination: Different treatments significantly affected the germination period for the species. The fastest germination is observed in T_6.

Germination percentage: The highest germination percentage (100%) was observed in *Pterocarpus santalinus* (T_6). The lowest germination percentage was observed (86.67%) in (T_5).
The seedling height in *Pterocarpus santalinus* during 65 days after seed sowing were tabulated, analyzed and presented revealed that overall best height performance in the maximum seedling height was observed in T_1 (14.7), T_2 (13.0), T_3 (12.9), T_4 (13.6), T_5 (12.9) and T_6 (13.1) cm.
Whereas the collar diameter in *Pterocarpus santalinus* during 30 days after seed sowing were tabulated, analyzed and presented revealed that overall best collar diameter performance in the maximum collar diameter was observed in T_1 (1.43), T_2 (1.53), T_3 (1.51), T_4 (1.23), T_5 (1.27) and T_6 (1.25) mm.
Whereas the Number of leaves in *Pterocarpus santalinus* during 15 days after seed sowing were tabulated, analyzed and presented revealed that overall best Number of leaf performance in the average Number of leaves was observed in T_1 (9), T_2 (8), T_3 (10), T_4 (8), T_5 (9) and T_6 (9).
The data on seedling survival of *Pterocarpus santalinus*. were tabulated, analyzed and presented. The perusal of data revealed the *Pterocarpus santalinus*. Seedling survival percent performance maximum in T_6 (100%), T_2 (93%), T_4 (93%) and minimum seedling survival in treatment T_5 (86%).
The seedling survival percent performance of *Pterocarpus santalinus*. was showed the highest in treatment T_6, and lowest depicted in T_5.

Growth performance: Shoot length of the seedlings developed under treatments was highest (14.7 cm) in *Pterocarpus santalinus* (T_1) & lowest (12.9 cm) in (T_3). Highest collar diameter of seedlings was found in (1.53mm) in (T_2) and the lowest collar diameter (1.25mm) in (T_4). The leaf number significantly varied due to the treatments and found highest (10) in T_3 and lowest (8) in T_2, T_4.

The data on seedling shoot length along with their shoot length of was presented and tabulated .

The perusal of data showed that the maximum shoot length was recorded under in T_1 (14.7), T_2 (13.0), T_3 (12.9), T_4 (13.6), T_5 (12.9) and T_6 (13.1) cm.

The data on Seedling Root length of *Pterocarpus santalinus* was presented and tabulated. The perusal of data showed that the maximum Root length was recorded under in T_1 (14.1), T_2 (12.6), T_3 (13.1), T_4 (8.6), T_5 (10.9) and T_6 (17.8) cm.

The data on seedling fresh weight and dry weight along with their shoot and root weight of was presented and tabulated

The perusal of data showed that the maximum fresh shoot weight was recorded under in T_1 (0.774), T_2 (0.606), T_3 (0.746), T_4 (0.782), T_5 (0.725) and T_6 (0.687) gm. Similarly the fresh root weight under different treatment was observed with the maximum fresh root weight in T_1 (0.200), T_2 (0.131), T_3 (0.087), T_4 (0.071), T_5 (0.171), T_6 (0.104) gm.

The perusal of data revealed that the maximum dry shoot weight along with their shoot and root weight of was presented. recorded under in T_1 (0.303), T_2 (0.242), T_3 (0.275), T_4 (0.311), T_5 (0.254), T_6 (0.286) and Similarly the dry root weight under different treatment with maximum dry root weight was recorded in T_1 (0.079), T_2 (0.081), T_3 (0.059), T_4 (0.051), T_5 (0.109), T_6 (0.081) gm.

The data on seedling shoot and root length along with their shoot and root length of *Pterocarpus santalinus* was presented. The perusal of data showed that the maximum length of shoot and root length was recorded under in T_1 (28.84), T_2 (25.56), T_3 (26.00), T_4 (22.17), T_5 (23.81) and T_6 (30.86) cm.

The trends of seed germination performance Which showed the maximum seed germination percent in T_6, T_4 and T_2 and minimum depicted in T_5.

The data on seed germination energy of were *Pterocarpus santalinus*. tabulated analyzed and presented in table (1). The perusal of data revealed that the seed germination energy in *Pterocarpus santalinus*. was recorded maximum under T_6 (30) 12th, T_4 (28 seeds) after 16th day of seed sowing followed by T_3 (27 seeds) after 16th day of seed showing T_2 (28 seeds) after 15th day of seed sowing, minimum seed germination energy recorded under T_1 (27 seeds) after 14th day after seed sowing and peak day is 16th (26 seeds) day after seed sowing under T_5.

Table 1: Growth Performance of Emerged Seedling under Different Seed Treatment of *Pterocarpus santalinus*

Treatment	shoot Length (cm)	root length (cm)	Total length of seedling (cm)	Collar diameter (mm)	No. of leaf/plant	Fresh weight of shoot (gm)	Fresh weight of root (gm)	Total Fresh Weight (gm)	Dry weight of shoot (gm)	Dry weight of root (gm)	Total dry weight (gm)
T1	14.7	14.1	28.84	1.43	9	0.774	0.200	0.974	0.303	0.079	0.382
T2	13.0	12.6	25.56	1.53	8	0.606	0.131	0.737	0.242	0.081	0.323
T3	12.9	13.1	26.00	1.51	10	0.746	0.087	0.833	0.275	0.059	0.334
T4	13.6	8.6	22.17	1.23	8	0.782	0.071	0.853	0.311	0.051	0.362
T5	12.9	10.9	23.81	1.27	9	0.725	0.171	0.896	0.254	0.109	0.363
T6	13.1	17.8	30.86	1.25	9	0.687	0.104	0.791	0.286	0.081	0.367

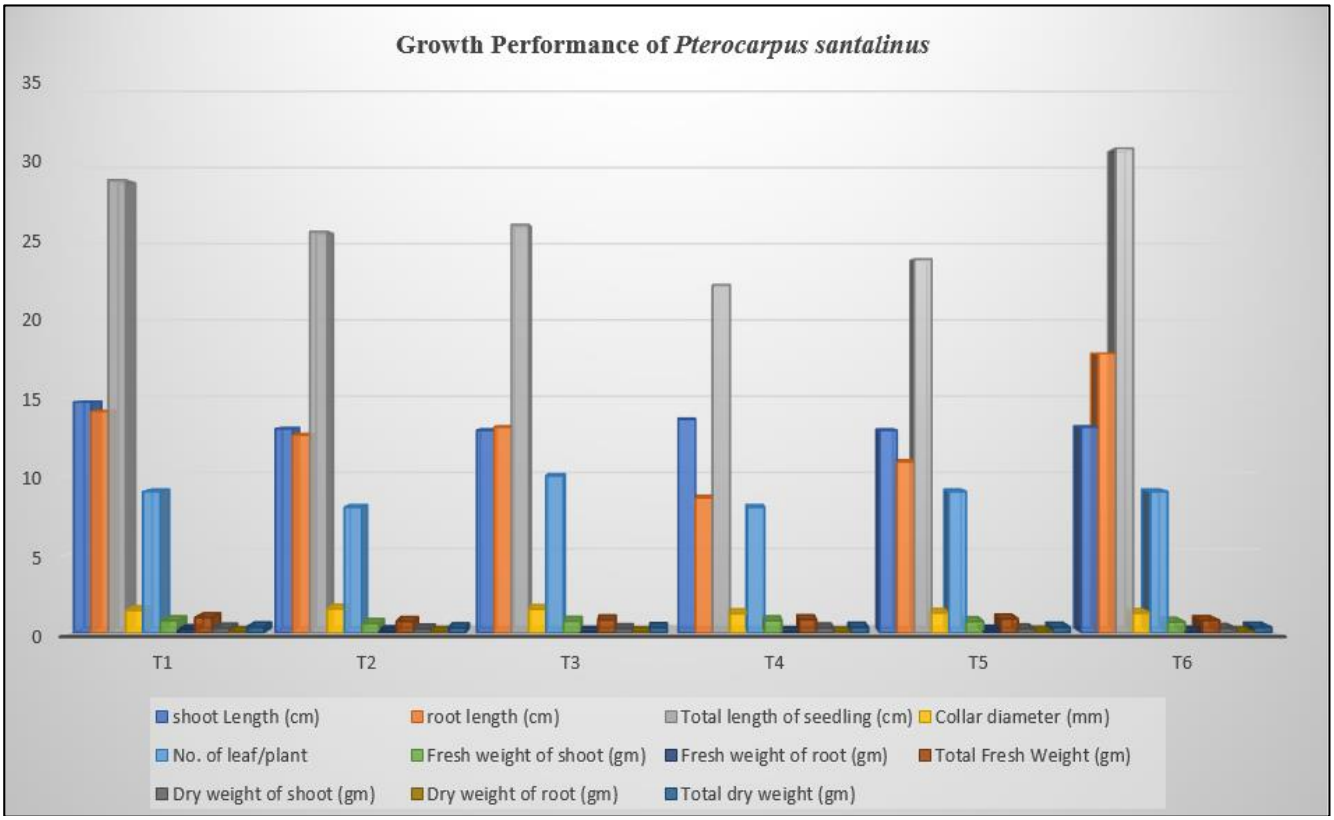

Fig 1: Growth Performance of Emerged Seedling under Different Seed Treatment of *Pterocarpus santalinus*

Conclusion

The study of seed treatment viz. before sowing the seed treatments i. e, without seed treatment with pure soil, without seed treatment with soil + vermicompost, seed treatment with water soaking for 24hrs (only soil), seed treatment with water soaking (soil + vermicompost), seed treatment with cow dung for 24hrs (only soil), seed treatment with cow dung for 24hrs (soil + vermicompost) seedling quality characters of *Pterocarpus santalinus* and . The study revealed that *Pterocarpus santalinus* performance better germination and germination energy in case of seed treated with of cow dung (soil + vermicompost), Control before sowing.

The number of leaves in *Pterocarpus santalinus* was recorded more in water soaking 24hrs with soil to seed treated with Control. The seedling was observed more survival in seed treated with the cow dung.

The seed coat of *Pterocarpus santalinus* is very hard due to which the *Pterocarpus santalinus* seed goes into dormancy period or the seed germination is late which also causes problems in germination *Pterocarpus santalinus* can be grown by giving hard coat seed treatment like scarification for better germination percentage to get better and fast germination.

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