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Effect of pre sowing seed treatments on seed germination and seedling growth in Rakta Chandana (*Pterocarpus santalinus* L.): An Endangered medicinal plant

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Abstract
Rakta Chandana (*Pterocarpus santalinus* L.) is important tree medicinal plant grown in tropical region of the world and it is endemic to India. The inner bark when injured or cut or damaged, it oozes red colored 'santolin' dye. The IUCN listed this *Rakta Chandana* as an endangered species due to over exploitation. Natural regeneration is less due to low germination percent. Hence, the present study entitled "Effect of pre sowing seed treatment on seed germination and growth in *Pterocarpus santalinus* L.f. An Endangered medicinal plant which belongs to Fabaceae has been carried out at College of Horticulture, Mudigere with an aim to enhance the germination and seedling growth *by* different scarification methods. The per cent germination in *P. santalinus* is very less in control condition. Hence, this experiment was planned to treat the seeds which helps to break dormancy with acid scarification (KNO_3, HCL, H_2SO_4) and chemical scarification (GA_3, NAA, Cytokinin) and soaking of seeds in organic solutions (cow urine, cow dung slurry, hot water treatment). It was found that, the higher germination percentage (47.50), seedling length (32.45 cm), collar girth (3.24 mm) and seedling dry weight (6.57 g) was found in seed treatment with cow dung slurry while control showed poor germination and growth. The results clearly indicate that soaking *P. santalinus* seeds for 48 hours in cow dung slurry results in good germination and better seedling growth. This could be of great use for raising quality seedlings of *P. santalinus*.

Keywords: *Pterocarpus santalinus*, pre-sowing treatments, germination, seedling growth

1. Introduction
Pterocarpus santalinus is a small-to-medium–sized deciduous tree most commonly known as red sandalwood in English and Raktha chandana in Sanskrit and Honne in Kannada, belonging to the family Fabaceae. It is widely distributed in the tropical regions of the world, especially in India, Sri Lanka, Taiwan, and China (Dhanabal *et al*., 2007) [5].
Its distribution in some parts of the vegetation in Tara hill of Kascki district in Nepal was reported by Poudel, 2003. In India, this species is endemic to the hills of Cuddapah, Chittoor, some parts of Nellore in Andhra Pradesh, some pockets of Karnataka and Tamil Nadu; cultivated in Maharashtra, Odisha and West Bengal.
Pterocarpus santalinus L. is one among such species, State tree of Andra Pradesh and Pride of India (Ahmed and Nayer, 1984; Jadav *et al*., 2001) [1, 7]. This species is most commonly grown in southern regions of eastern and Western Ghats. Red sandal wood is used in manufacturing of some musical instruments, name seal, frames, carving. It contains an insoluble or sparingly soluble red dye a major coloring matter used in textile industry, pharmaceutical preparation (Padmalatha and Prasad, 2007) [15]. Heart wood contains the colouring principle called santalin, which are santalin A and B. The other components include Homopterocarpin, pterocarpin, pterocarpol, pterocarptriol, ispterocarpalone, pterocarpo-diolones with ß-eudeslol and cryptomeridol (Soundararajan *et al.* 2016) [18]. Bioactive compounds present in the plant's heartwood have been shown to have a wide range of biological activities, suggesting the potential of *P. santalinus* for the treatment of various diseases *viz*., diabetes, headache, skin diseases, and jaundice and in wound-healing (Rastogi *et al*., 1960 and Arokiyaraj *et al*., 2008) [2]. The *P. santalinus* is also known for its anticancerous property (Huang *et al*., 2010) [9]. The knowledge on seed germination and seedling establishment is a pre requisite in case of propagation, conservation and management of important RET species. The majority of the dry tropical species possess orthodox seeds which are characterised by dormancy due to hard seed

coat which are commonly overcome by mechanical or acid scarification. Indiscriminate use and illegal logging, poor natural regeneration potential, narrow habitat and change in micro climatic in the habitat resulted in the severe depletion of natural population of *Pterocarpus santalinus* (Madhava Chetty and Rao, 1990; Sanjappa, 2001) [11, 17]. Red sanders are conventionally propagated through vegetative methods and hard seed coat coupled with less viability (Dayanad *et al.,* 1998; Naidu *and* Rajendrudu, 2001) [4, 14]. According to earlier studies using conventional vegetative propagation methods like semi hard wood cuttings, cleft grafting and air layering were not successful in producing sufficient numbers of planting material for forestry programs (Kesava reddy *et al.,* 1990) [8]. Considering the poor natural regeneration the present study was carried out to investigate the effects of pre sowing seed treatment techniques for seed germination and seedling growth in *P. santalinus.*

2. Material and Method

The experiment was carried out at College of Horticulture, Mudigere, Chikkamagaluru, Karnataka. The seeds were treated with different acids, organic solutions and growth regulators to break the dormancy and to induce early germination. seeds were subjected to different soaking duration based on treatments; seeds treated with the acids (KNO_3, HCL, H_2SO_4), growth regulators (GA_3, NAA, Cytokinin) and organic solutions (cow urine, cow dung slurry, hot water treatment) are kept for the duration of 20 minutes, 6 hours and 48 hours respectively. Before sowing the seeds, polyethane bags of size 8 X 6 inches were filled with a potting mixture contains sand, soil and well rotten FYM in the ratio of 1:2:1 respectively to facilitate aeration and proper drainage, a number of perforations were done to the polybags before filling them with prepared media mixture. After seed treatment only one seed was sown per polybag by dibbling and then covered with a thin layer of soil. Observations on germination and growth parameters were recorded up to five months after sowing.

3. Result and Discussion

The results with respect to the germination parameters such as number of days taken for completion of germination and Germination percentage are furnished in Table 1. Different pre-sowing treatments in *P. santalinus*, were significantly influenced the days taken for final germination. Among all the treatments, seeds treated with cow dung slurry (45.50 days) had taken minimum days to complete the germination, which was on par with H_2SO_4 at 2 per cent (46.50 days) which was significantly superior to control (69.50 days). The maximum germination percentage (47.50) was observed in seeds treated with cow dung slurry which was on par with T_{15} - cow urine (41.67%). The least germination percentage was recorded in control (16.67%). All other treatments were also found to be significant over control. The early and better germination in the cow dung slurry treatment might be due to growth promotors present in cowdung coupled with longer duration of soaking helps in softening of the seed coat which increased the permeability due to diffusion and early emergence of radicle which triggers the germination process in the seed (Basavaraj *et al.,* 2002, Lokesh, 2007) [3, 10].

The data pertaining to growth such as number of leaves and seedling length at 150 days after sowing as influenced by pre-sowing seed treatments is presented in Table 1. The number of leaves (17.49) and length of the seedling (32.45 cm) were found maximum in the cow dung slurry treatment and the minimum number of leaves (8.50) and short seedlings (21.20 cm) were noticed in control. Treating the seeds with cow dung slurry might have helped for improving the germination of the seeds with a stimulatory effect as that of bird's digestive tract (Gowda *et al.,* 2003; Naidu and Mastan, 2001) [6, 13].

Table 1: Effect of pre-sowing seed treatments on germination and seedling growth of *P. santalinus*

Treatments	Days to final germination	Germination %	Number leaves/seedling	Seedling length (cm)
T_1 - GA_3 (100 ppm)	59.50	31.67	11.17	25.91
T_2 - GA_3 (200 ppm)	55.50	39.17	13.17	28.64
T_3 - NAA (100 ppm)	60.50	28.33	10.50	24.66
T_4 - NAA (200ppm)	58.00	25.83	12.34	26.28
T_5 - Cytokinin (20 ppm)	61.00	22.50	10.67	19.92
T_6 - Cytokinin (30 ppm)	59.00	23.33	11.33	25.91
T_7 - KNO_3 (1%)	56.50	32.50	12.00	27.09
T_8 - KNO_3 (1.5%)	52.00	35.83	14.84	28.11
T_9 - HCl (1%)	52.00	31.67	12.84	25.70
T_{10} - HCl (2%)	51.00	35.83	15.00	28.48
T_{11} - H_2SO_4 (1%)	49.00	32.50	14.84	26.59
T_{12} - H_2SO_4 (2%)	46.50	36.67	16.59	28.23
T_{13} - Hot water (50□)	52.00	30.83	14.68	25.72
T_{14} - Hot water (80□)	65.50	17.50	10.83	25.46
T_{15} - Cow urine (1:1)	51.50	41.67	15.83	28.81
T_{16} - Cow urine (1:2)	53.50	31.67	15.00	27.65
T_{17} - Cow dung slurry (1:1)	45.50	47.50	17.49	32.45
T_{18} - Control	69.50	16.67	8.50	21.20
S. Em±	2.39	2.23	0.56	1.31
CD @ 5%	7.13	6.66	1.68	3.89

The data on seedling growth characters such as fresh and dry weight of seedling, collar girth and root volume was recorded at 150 days after sowing. The maximum seedling fresh weight (14.02 g) and dry weight (6.57 g), collar girth (3.24 mm) and root volume (1.33 cc) was recorded in cow dung slurry treatment. The lower value was recorded in control. The rapid growth and better establishment of seedlings in cow dung treatment might be due to the presence of growth promoting substances (auxins) and nutrients (Sankaranarayanan *et al.,* 1994; Swamy *et al.,* 1999; Misra *et al.,* 2002) [19, 20, 13].

Table 2: Effect of pre-sowing seed treatments on seedling growth of *P. santalinus*

Treatments	Seedling fresh weight (g)	Seedling dry weight (g)	Collar girth (mm)	Root volume (cc)
T_1 - GA_3 (100 ppm)	10.41	4.35	1.68	0.67
T_2 - GA_3 (200 ppm)	12.27	5.08	1.99	0.84
T_3 - NAA (100 ppm)	10.50	4.02	1.70	0.63
T_4 - NAA (200ppm)	11.26	4.54	1.82	0.79
T_5 - Cytokinin (20 ppm)	10.00	3.93	1.70	0.62
T_6 - Cytokinin (30 ppm)	10.71	4.42	1.78	0.66
T_7 - KNO_3 (1%)	11.34	4.39	1.91	0.85
T_8 - KNO_3 (1.5%)	11.82	4.77	2.03	0.89
T_9 - HCl (1%)	11.44	3.98	1.88	0.85
T_{10} - HCl (2%)	12.36	5.22	2.12	0.85
T_{11} - H_2SO_4 (1%)	12.06	4.63	2.12	0.67
T_{12} - H_2SO_4 (2%)	13.15	5.48	2.23	1.07
T_{13} - Hot water (50 □)	11.31	4.98	2.04	0.82
T_{14} - Hot water (80 □)	10.31	4.09	1.83	0.61
T_{15} - Cow urine (1:1)	12.98	5.31	2.57	1.09
T_{16} - Cow urine (1:2)	11.70	4.85	2.11	0.87
T_{17} - Cow dung slurry (1:1)	14.02	6.57	3.24	1.33
T_{18} - Control	7.68	2.83	1.39	0.39
S. Em±	0.45	0.19	0.07	0.05
CD @ 5%	1.33	0.56	0.22	0.16

Fig 1: Seedlings of *Pterocarpus santalinus* at five months after sowing

Fig 2: Developmental stages of *Pterocarpus santalinus* from sowing

4. Conclusion

From the present study, it is concluded that, among all the treatments, cow dung slurry (1:1) gave the better results with respect to germination and seedling growth attributes followed by the H_2SO_4 at 2 per cent in *P. santalinus*. Hence, it is concluded that, sexual propagation of *P. santalinus* by treating the seeds with cow dung slurry (1:1) is reliable for commercial production of seedlings and also in the conservation perspective as it is an endangered tree and it is a quick and easy method of propagation. Treating the seeds before sowing helps in achieving the higher success.

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