The Pharma Innovation Journal 2019; 8(5): 523-525

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(5): 523-525

www.thepharmajournal.com
Received: 16-03-2019
Accepted: 20-04-2019

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Enhancement of seed germination rate and seedling vigour index in red sanders (*Pterocarpus santalinus* (Linn. F.)): An endangered tree medicinal plant through different pre-sowing seed treatments

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Abstract
Red Sanders (*Pterocarpus santalinus* (Linn. F.)) is an important tree species belongs to family Fabaceae. It is commonly known as Rakta Chandana and Lal chandan. It is a medium sized deciduous tree with clear trunk. This tree is good source of dye and heart wood is used to treat skin diseases, bone fracture, leprosy, spider poisoning, ulcers, general debility etc. It is mainly propagated sexually through seeds but the problem in seed germination is due to hard seed coat which hinders the seed germination. Hence, the present study was carried out with an aim to find out the best seed treatment for maximum germination in *P. Santalinus* at College of Horticulture, Mudigere during the year 2017-18. Seeds were treated with different treatment such as growth regulators (GA_3, NAA, Cytokinine), acid scarification (KNO_3, HCl, H_2SO_4) and organics (hot water, cow urine, cow dung slurry). Among all the treatments seeds treated with 1:1 ratio of cow dung slurry recorded the early germination (11.50 days), days to final germination (45.30 days), maximum germination percentage (47.50%), Final mean germination (1.05), germination value (4.97) and seedling vigour index I (1542.05), seedling vigour index II (312.10) and germination speed (0.62).

Keywords: *Pterocarpus santalinus*, pre-sowing, germination, seedling vigour

Introduction
Red Sanders *(Pterocarpus santalinus* Linn. F) Commonly known as red sanders in English, Rakta chandana in Sanskrit and Kannada. In Kannada, it is also referred as Honne, which is an endemic species to the India (Jackson, 1895) [7]. Red Sanders is a typical leguminous tree of tropical dry deciduous forests; it is being distributed in the Arcot and Chengalpattu districts of Tamil Nadu and also in Karnataka, Kerala, Orissa and West Bengal (Lahari, 1986). *P. santalinus* is a small to medium sized deciduous tree, with an extremely hard, dark purple heart-wood with a bitter flavor (Dhanabal *et al*., 2007) [5].

The bark is blackish brown, 1-1.5 cm thick. Blaze is pale yellow with numerous pink streaks exuding copious red sticky thick gum. Flowers are bisexual, stalked yellow, about 2 cm long and fragrant. Pods are unequally orbicular, flat about 5×4.5 cm including the wing and gradually narrow into a short tip about 1 cm long. One or rarely two seeds present which are more or less kidney shaped, about 1-1.5 cm long, smooth, reddish brown (Arunakumara *et al*., 2011) [3].

Red Sanders wood has an important insoluble or sparingly soluble red wood dye. It contains 16 per cent of the pigment santalin (santalic acid) a major colouring matter. The heartwood has various uses in traditional medicines and is popular for the treatment of diabetes apart from other ailments. The wood paste is applied externally specially for healing various skin diseases, blemishes and for ulcer treatment (Vedavathy *et al*., 1997) [11]. The heartwood is rubbed with water, honey, ghee, and oil, applied as collyrium to alleviate defects of vision. It is also used for treating skin diseases, bone fracture, leprosy, spider poisoning, ulcers, general debility and metal aberrations (Arokiyaraj *et al*., 2008) [2]. Wood and bark brew taken orally to relieve chronic dysentery, worms, blood vomiting, weak vision, and hallucination. Due to the exploitation of its medicinal uses and other beneficial properties of this tree which leads to threatened status. Presence of palisade layer in the seed coat of certain plants belong to the fabaceae family is assumed to be connected with their high degree of impermeability to water diffusion (Rolston, 1978) [10]. The hard seed coat and dormancy creates a serious problem in germination. Use of pre-sowing seed treatments helps in large scale multiplication besides conservation of *P. santalinus.*

Materials and Methods

The experiment was carried out on seeds dormancy breaking studies in *Pterocarpus santalinus* during 2017-18 at College of Horticulture, Mudigere, Chikkamagaluru, Karnataka. Seeds of *Pterocarpus santalinus* were collected during August 2017 from Shivamogga.

Before sowing the seeds, polybags of having size of 8 X 6 inches' were filled with a mixture of 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 is sown per polybag by dibbling and then covered with a thin layer of soil.

There were 18 treatments; in each treatment, 60 seeds were used. The seed treatment comprises of use of growth regulators (GA_3, NAA, Cytokinin), acids (KNO_3, HCL, H_2SO_4) and organics (cow urine, cow dung slurry). The growth regulators treated seeds are kept for the duration of 6 hours, acid treated seeds are kept for 20 minutes and organics treated seeds are kept for 48 hours.

Observations for germination parameters were recorded every day up to three months from sowing and for seedling attributes of three seedling from each treatments and from two replications were recorded at monthly intervals.

Days to initiate germination: The polybags were observed daily for seedling emergence. The days on which the first seedling emerged was expressed days to initial germination.

Days to final germination

The number of days taken for the last seedling emerged was recorded and expressed as days to final germination.

Germination percent

The number of normal seedlings produced in each replication was counted and average was expressed in percent.

$$\text{Germination percentage} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds sown}} \text{ X } 100$$

Final mean germination

Final mean germination was calculated by dividing the cumulative germination percentage/total number of days

Germination value

It was calculated using the formula suggested by Djavanshir and Pourbeik (1976) [6]

$$GV = (\Sigma DGS/N) \times GP \times 10$$

Where DGS is daily germination speed, which is computed by dividing the cumulative germination percentage by the number of days since the beginning of the test.

Seedling vigour index I

Vigour index values were computed using the formula (Abdul-Baki and Anderson, 1973) [1].

Vigour index I = Germination (%) × Total seedling length (cm)

Seedling vigour index II

Vigour index II = Germination (%) × dry weight of the seedling (g/seedlings)

Statistical analysis of data

The experiment was carried out in randomized complete block design. Data were analyzed by analysis of variance (ANOVA) to detect significant differences between mean. Significantly differing mean were tested based on F test value at 0.05 probability level. Variance in data has been expressed as mean ± standard error.

Results and Discussion

Seed germination is the emergence and development from the seed embryo of those essential structures which are indicative of the ability to produce a normal plant under favourable condition. All the observed parameters were statistically significant. Treatment of pods with different chemicals, growth regulators and organics showed remarkable increase in germination percentage and other seed germination characters. Among the observed parameters for the effect of cow dung slurry treatment on seed germination and seedling characters, least number of days to initial germination (11.50 days), days taken to the final germination (45.30 days), maximum germination percentage (47.50%) and final mean germination (1.05) showed significant difference for treatment effect (Table 1). The early germination and good germination percentage in cow dung slurry might be due to softening of the seed coat which increased the permeability to diffusion and early emergence of radicle which triggers the germination process in the seed. Similar results were reported by Basavaraj *et al.* (2002) [4] in *Elaeocarpus munronii* where cow dung treatment recorded maximum germination per cent compared to control. Lokesh (2007) [9] also reported higher seed germination in *Terminalia chebula* with cow dung slurry for 30 days.

Table 1: Germination period, germination percentage and final mean germination in *Pterocarpus santalinus*

Treatments	Days to initiation of germination	Days to final germination	Germination%	Final mean germination
T_1 - GA_3 (100 ppm)	21.00	59.50	31.67	0.53
T_2 - GA_3 (200 ppm)	19.00	55.50	39.17	0.71
T_3 - NAA (100 ppm)	22.50	60.50	28.33	0.47
T_4 - NAA (200ppm)	20.50	58.00	25.83	0.45
T_5 - Cytokinin (20 ppm)	24.00	61.00	22.50	0.37
T_6 - Cytokinin (30 ppm)	21.00	59.00	23.33	0.40
T_7 - KNO_3 (1%)	22.00	56.50	32.50	0.58
T_8 - KNO_3 (1.5%)	21.50	52.00	35.83	0.69
T_9 - HCl (1%)	17.00	52.00	31.67	0.61
T_{10} - HCl (2%)	16.50	51.00	35.83	0.70
T_{11} - H_2SO_4 (1%)	16.00	49.00	32.50	0.67
T_{12} - H_2SO_4 (2%)	13.50	46.50	36.67	0.79
T_{13} - Hot water (50°C)	18.00	52.00	30.83	0.59
T_{14} - Hot water (80°C)	22.50	65.50	17.50	0.27

T_{15} - Cow urine (1:1)	15.50	51.50	41.67	0.81
T_{16} - Cow urine (1:2)	17.50	53.50	31.67	0.59
T_{17} - Cow dung slurry (1:1)	11.50	45.50	47.50	1.05
T_{18} – Control	27.50	69.50	16.67	0.24
S. Em±	1.16	2.39	2.23	0.05
CD @ 5%	3.47	7.13	6.66	0.14

Among the different seed pretreatment studied for germination and seedling parameters. The maximum germination value (4.971), highest germination speed (0.62), Seedling Vigour Index I (1135.85) and II (184.81) was observed in seeds treated with cow dung slurry at 1:1 ratio (Table 2) followed by H_2SO_4 (2%). The increased germination process in cow dung slurry might be due to the increased microbial population, presence of anaerobic condition and moderate temperature which triggers the germination process in the seed. Results are in conformity with Lokesh (2007) [9], reported that higher seed germination in *Terminalia chebula*, Vijayalakshmi, and Renganayaki (2017) [12] reported that in *P. santalinus*, the seeds treated with cow dung slurry treatment at 48 hours recorded maximum synchronized germination of about 51 per cent.

Table 2: Germination value, germination speed, Seedling Vigour Index I and II in *Pterocarpus santalinus*

Treatments	Germination value	Germination rate/ speed	SVI I	SVI II
T_1 - GA_3 (100 ppm)	1.696	0.31	590.64	64.98
T_2 - GA_3 (200 ppm)	2.767	0.42	785.59	98.74
T_3 - NAA (100 ppm)	1.340	0.28	505.05	54.73
T_4 - NAA (200ppm)	1.166	0.26	504.33	59.25
T_5 - Cytokinin (20 ppm)	0.832	0.22	402.62	43.23
T_6 - Cytokinin (30 ppm)	0.930	0.23	454.28	50.88
T_7 - KNO_3 (1%)	1.889	0.34	629.78	85.30
T_8 - KNO_3 (1.5%)	2.493	0.41	739.21	100.56
T_9 - HCl (1%)	1.938	0.36	642.33	85.67
T_{10} - HCl (2%)	2.520	0.42	770.88	104.22
T_{11} - H_2SO_4 (1%)	2.172	0.40	681.05	87.33
T_{12} - H_2SO_4 (2%)	2.909	0.47	811.56	118.01
T_{13} - Hot water (50 ℃)	1.828	0.35	637.41	84.35
T_{14} - Hot water (80 ℃)	0.468	0.16	353.70	33.92
T_{15} - Cow urine (1:1)	3.374	0.48	860.43	120.82
T_{16} - Cow urine (1:2)	1.899	0.35	621.75	82.49
T_{17} - Cow dung slurry (1:1)	4.971	0.62	1135.85	184.81
T_{18} – Control	0.406	0.14	285.47	26.11
S. Em±	0.188	0.02	47.56	7.05
CD @ 5%	0.560	0.08	141.91	21.05

Conclusion

Pterocarpus santalinus is an important medicinal tree it is suitable for social forestry and agro forestry programmes. It can also grow in wide range soil and climatic conditions. Among all the pre sowing treatments, seeds treated with cow dung slurry (1:1) for 48 hours exhibited all the germination parameters and produce good quality seedlings. Therefore, it is suggested to use this as a pre sowing seed treatment for large scale production of *P. santalinus*, it also help in conservation as it is an endangered tree.

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