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Effect of growing media on seed germination of red sanders (*Pterocarpus santalinus* Linn. f.)

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Abstract
The present investigation was undertaken to study the "Effect of growing media on seed germination of Red Sanders (*Pterocarpus santalinus* Linn. f.)" at Net House, College of Forestry, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India during 2018-19. The different proportions of media (Soil: Sand: FYM) in dual and triple combinations were used as a treatment for sowing seeds. The experiment was laid out in Completely Randomized Design (CRD) which consists of 8 treatment combinations and three repetitions. The result showed that the minimum days for germination *viz.* FDG (7.67 days), LDG (15.67 days) and MGT (11.74 days) were recorded in media containing Soil + Sand (1:2) *i.e.* T_3. However, TSG (7.33 days) was observed minimum in media containing Soil + Sand (1:1) *i.e.* T_1. The media containing Soil + Sand + FYM (1:1:2) *i.e.* T_5 increased germination (78.33 %), rate of emergence (6.21 %/day), germination energy (63.33 %) and germination index (116.67). Moreover, survival (75.00 %) was observed maximum in T_8: Soil + Sand + FYM (2:1:2). Lower values of above all germination parameters were recorded in Soil + Sand (2:1) *i.e.* T_2.

Keywords: Red sanders, growing media, germination

Introduction

Pterocarpus is a well-known genus of trees and distributed in three tropical regions, *i.e.*, Neotropics, Tropical Africa and Indomalaya (Arunakumar and Joshi, 2014). The most important species which needs immediate attention and concern is *Pterocarpus santalinus* (Family: Fabaceae) an endemic species restricted to Southern parts of Eastern Ghats of India reported by Raju *et al.* (1999) [11].

The heartwood, useful part of plant is extremely hard, blood red in colour with occasional light yellow streaks. Red Sanders wood has demand both in domestic and international markets. There are two types of wood that is popular in trade, one is wavy or ripple grained and the other is straight grained. The wavy grained wood has a huge demand in the international market and is primarily exported to Japan for manufacturing a special musical instrument called as '*Shamisen*' (Anon., 2014) [1]. There is a problem with the adulteration and falsification of plant material in the *P. santalinus* market. The heartwood of *Adenanthera pavonina* Willd., is often sold as a fake substitute for *P. santalinus*, while artificially coloured wood shavings and the sawdust of some other trees are also sold on the market as cheap substitutes (Botanical Survey of India, 2012) [4].

The tree is deciduous in nature, medium sized up to 11.0 m height. The grown area is characterized by hot dry climate with 100 mm of rain in each of the two annual monsoons. The trees are found at altitude ranging from 150-900 m. Jaime *et al.* (2018) [6] reported that there is large-scale abortion of flower buds, flowers and fruit, and has very low fruit set in *P. santalinus*. They also mentioned that traditional seed propagation of *P. santalinus* yields low germination percentages due to a hard testa, poor viability and sensitivity to temperature. Vegetative propagation of *P. santalinus* by semi-hardwood cuttings, cleft grafting or air layering is not able to produce stock numbers required for effective preservation or for commercial purposes. Therefore, the study entitled "Effect of growing media on seed germination of Red Sanders (*Pterocarpus santalinus* Linn. f.)" was undertaken.

Materials and Methods

The present investigation was conducted at Net House of College of Forestry (ACHF), Navsari Agricultural University, Navsari, Gujarat, India.

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The area is geographically located at an elevation of 9 meter above the mean sea level and is situated on 20°57' North latitude and 72°54' East longitude in Gujarat. The climate of Navsari is typically tropical, characterized by fairly hot summer, moderate cold winter and humid warm monsoon. In general, monsoon commences during the second week of June and ends by the second fortnight of September. Most of the precipitation is received from South West monsoon, concentrated during the months of June, July and August.

The potting mixture for this experiment was prepared as per the treatment requirement. The various media *viz.,* Farm Yard Manure (FYM), sand and soil were mixed well in the decided ratio as per treatments to homogenize thoroughly. The media was filled into 8" x 6" size perforated black polythene bags having thickness of 200 micron. The seed were soaked in 500 ppm GA_3 solution for 24 hours as suggested by Patel *et al.* (2018) [10]. The treated seeds were direct sown in polythene bags filled with the decided potting mixtures. One seed was sown in each bag. Bags were irrigated immediately after sowing of seed.

The experiment was laid out in Completely Randomized Design (CRD) which consists of 8 treatment combinations and three repetitions. The treatments with their combinations and symbols are described as under:- T_1 : Soil + Sand (1:1), T_2: Soil + Sand (2:1), T_3: Soil + Sand (1:2), T_4: Soil + Sand + FYM (1:1:1), T_5: Soil + Sand + FYM (1:1:2), T_6: Soil + Sand + FYM (2:1:1), T_7: Soil + Sand + FYM (1:2:1) and T_8: Soil + Sand + FYM (2:1:2).

The data on germination parameters *viz.* days to sprout, germination percentage, rate of emergence, germination energy, germination index and survival percentage were recorded and calculated by using following formula.

$$Rate\ of\ emergence = \frac{Percent\ germinated\ seed}{Days\ of\ first\ count} + \cdots + \frac{Percent\ germinated\ seed}{Days\ of\ final\ count}$$

(iv) Germination energy (%): The germination energy was calculated for the energy period (EP) of 16 days, using the following formula (Willan, 1985) [17].

$$Germination\ Energy\ (GE) = \frac{Total\ number\ of\ germinated\ seed\ till\ EP}{Total\ number\ of\ seeds_{tested}} \times 100$$

(v) Germination index: The germination index was calculated by using the formula given by Bench Arnold *et al.* (1991) [2] where, maximum weight given to seeds germinated first and less weight to those germinated later.

Germination index = $(20*n_1) + (19*n_2) + \ldots + (1*n_{20})$

Where, $n_1, n_{2\ldots}n_{20}$ are the number of seeds germinated on first, second and subsequent days until 20 days after sowing and 20, 19, …1 are the time intervals for seed germination up to 20 days in decreasing order.

(vi) Survival (%)
The survival of the seedlings was calculated by using the following formula and expressed in percentage:

$$Survival\ percentage = \frac{Number\ of\ seedling\ survived}{Total\ seedling\ emerged} \times 100$$

The data of various germination characters studied in present investigation was statistically analysed by the procedure of Completely Randomized Design (CRD) as described by Panse and Sukhatme (1985) [9]. The appropriate standard error

(i) Days to sprout: First Days of Germination (FDG) - It is the day after sowing at which first germination events occurred. Last Days of Germination (LDG) - It is the day after sowing up to which last germination events occurred. Time Spread of Germination (TSG) - Time laps between onset and end of the seed germination events. It is calculated as last time of germination minus first time of germination. Mean Germination Time (MGT) – It indicated average length of time require to complete major germination process. Mean germination time was calculated by using following formula suggested by Ranal and Santana (2006) [12] and expressed in days.

$$Mean\ Germination\ Time\ (MGT) = \frac{\sum n\ x\ t}{\sum n}$$

Where, n is the number of seeds germinated at specific time interval corresponding to t and $\sum$n is the total number of seeds germinated during test period.

(ii) Germination (%): According to Scott *et al.* (1984) [13], the higher the germination percentage value, the greater the germination of a seed population. The germination percentage was calculated by using the following formula.

$$Germination\ Percentage\ (GP) = \frac{Total\ germinated\ seed}{Total\ No.of\ seeds} \times 100$$

(iii) Rate of emergence (%/day): The rate of emergence was calculated as formula suggested by Maguire (1962) [8] and expressed in % seedling per day.

of mean (S. Em. ±) and the critical difference (C. D.) were calculated at 5 per cent level of probability.

Results and Discussion
The growth of the plant is influenced to a great extent by growing medium. In addition to the growing media the supply of optimum amount of nutrients is also necessary for production of healthy seedlings with sturdy root system. Less expensive and nutrient rich medium that produce healthy and vigorous seedlings are required.

Germination parameters
The treatment T_3 took significantly the minimum days for first days of germination (FDG) *i.e.* 7.67 days, last days of germination (LDG) *i.e.* 15.67 days and mean germination time (MGT) *i.e.* 11.74 days. The treatment T_1 *i.e.* Soil + Sand (1:1) took the minimum days for time spread of germination (TSG) *i.e.* 7.33 days. It might be because of media containing more sand; therefore, it provided more aeration with optimum moisture which may help early sprouting.
The maximum germination (78.33 %) was recorded in T_5 which was on same bar with T_8 (76.67 %), T_7 (73.33 %), T_4 (71.67 %) and T_6 (68.33 %). The maximum rate of emergence

(6.21 %/day) was reported in T_5: Soil + Sand + FYM (1:1:2) which was statistically at par with T_8 (5.97), T_3 (5.67), T_4 (5.34) and T_7 (5.15 percent/day). The maximum germination energy (63.33 %) was also observed in T_5 which was statistically at par with treatment T_3 (60.00 %), T_8 (60.00 %), T_1 (55.00 %) and T_4 (55.00 %). The germination index (119.33) of Red Sanders was also recorded maximum in T_5 which was statistically at par with T_3 (116.67), T_8 (112.67), T_4 (100.33) and T_1 (97.00). The maximum survival (75.00 %) was observed in T_8: Soil + Sand + FYM (2:1:2) which was on same bar with T_5 (73.67 %), T_7 (69.67 %), T_6 (68.33 %) and T_4 (68.00 %). Lower values of above all germination parameters were recorded in T_2: Soil + Sand (2:1).

However, the above all parameters increased in T_5: Soil + Sand + FYM (1:1:2) may be due to less compact media, more pore space and aeration which favor the easy root and shoot sprouting. Secondly, it might be due to that FYM generally facilitate plant rooting; improve water retention capacity and results in the even distribution of nutrients in soil profile. Values of above all parameters except than survival percentage were lower in T_2: Soil + Sand (2:1) because of more proportion of soil. The T_2: Soil + Sand (2:1) had less aeration, pore space and more compact, so it did not facilitate the easy germination of seeds.

These results are in close proximity with the earlier findings of Khan *et al.* (2017) [7] in Mango (*Mangifera indica* L.), Shukla *et al.* (2007) [14] and Handa *et al.* (2005) [5] in *Albizia amara*, Tiwari and Saxena (2003) [16] in sissoo (*Dalbergia sissoo*), Singh *et al.* (2000) [15] in nitrogen fixing tree species sissoo (*Dalbergia sissoo*), khejri (*Prosopis cineraria*) and babul (*Acacia nilotica*).

Table 1: Effect of different growing media on germination parameters of Red Sanders (*Pterocarpus santalinus* Linn. f.)

Treatments	FDG	LDG	TSG	MGT	Germination (%)	Rate of Emergence (%/day)	Germination energy (%)	Germination index	Survival (%)
T_1	9.00	16.33	7.33	13.07	61.67	4.93	55.00	97.00	58.33
T_2	11.67	19.33	7.67	15.91	60.00	3.91	33.33	62.00	56.33
T_3	7.67	15.67	8.00	11.74	63.33	5.67	60.00	116.67	56.00
T_4	9.67	18.33	8.67	14.00	71.67	5.34	55.00	100.33	68.00
T_5	8.33	18.00	9.67	13.35	78.33	6.21	63.33	119.33	73.67
T_6	11.00	19.00	8.00	15.12	68.33	4.65	45.00	79.33	68.33
T_7	9.33	19.67	10.33	14.96	73.33	5.15	46.67	88.67	69.67
T_8	8.67	18.67	10.00	13.71	76.67	5.94	60.00	112.67	75.00
Mean	9.42	18.13	8.71	13.98	69.17	5.22	52.29	97.00	65.67
S.Em. (±)	0.65	0.71	0.73	0.60	4.25	0.40	4.45	9.28	3.85
C D at 5%	1.94	2.12	2.18	1.80	12.74	1.19	13.34	27.81	11.54
C V %	11.87	6.76	14.45	7.44	10.64	13.13	14.74	16.56	14.63

T_1: Soil + Sand (1:1) T_5: Soil + Sand + FYM (1:1:2)
T_2: Soil + Sand (2:1) T_6: Soil + Sand + FYM (2:1:1)
T_3: Soil + Sand (1:2) T_7: Soil + Sand + FYM (1:2:1)
T_4: Soil + Sand + FYM (1:1:1) T_8: Soil + Sand + FYM (2:1:2)

Conclusion
It is concluded from the present study that among the different growing media, Soil + Sand (1:2) *i.e.* T_3 was found to be the most effective for early sprouting and spread of germination. However, the media containing Soil + Sand + FYM (1:1:2) *i.e.* T_5 increased germination parameters. Moreover, growing media *i.e.* Soil + Sand + FYM (2:1:2) increased survival percentage of *P. santalinus*.

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