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Effect of pre sowing treatments on seed germination and its parameters in sandalwood (*Santalum album* L.)

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Abstract
A research experiment was conducted during *rabi* 2019-20 under greenhouse to study the effect of pre sowing treatments on seed germination and its parameters in sandalwood. Among seven different pre sowing treatments *viz*., GA_3 100 ppm (T_1), GA_3 300 ppm (T_2), KNO_3 at 2% (T_3), Cow dung for 24 hours (T_4), Cow dung for 48 hours (T_5), Ethrel 100 ppm (T_6) and Control (T_7), pre sowing seed treatment with GA_3 300 ppm (T_2) recorded significantly early emergence of seedling (34.66 days) with maximum germination per cent (34.66%), speed of germination (0.64), mean weekly germination (3.03), collar diameter (2.23 mm), seedling fresh weight (243.16 mg), seedling dry weight (50.00 mg), seedling vigour index (length) (319.15) and seedling vigour index (mass) (1743.83). The root length (4.25 cm), shoot length (5.27 cm) and seedling length (9.55 cm) were found significantly highest in KNO_3 at 2% (T_3).

Keywords: Ethrel, GA_3, germination, KNO_3, pre sowing treatments, sandalwood

Introduction
Indian sandalwood (*Santalum album* L.) is one of the most primitive precious useful plants since ancient times. It is also known as chandan, santal oil, white saunders oil, white or yellow sandalwood oil and east Indian sandalwood oil. The word Sandal has been derived from Chandana (Sanskrit), Chandan (Persian), Savtador (Greek) and Santal (French). For more than 5000 years, India has been the traditional leader of sandalwood. Sandalwood trees are famous and very costly because of its fragrant heartwood and oil. India exports around 2000 tonnes of wood and 100 tonnes of oil annually to other countries and accounts for 99% sandalwood oil production in the world (Rai and sarma [10], 1990).
The major problem that can be addressed during planting stock production in nurseries is the low seed germination. Propagation of sandalwood plant commonly takes place by seeds which are produced only once or twice in a year. Natural regeneration of sandalwood plant is done through endozoochory. Failure of the seed dispersal due to natural calamity or any other hindrances the natural regeneration is hampered. In sandalwood germination is sporadic and takes 4-12 weeks' time to complete germination (Srinivasan [13] *et al*., 1992; Srimathi [12] *et al*., 1995). Fresh seeds show dormancy for two months period. It is likely that the enforced dormancy of seeds is due to presence of hard seed coat or due to the presence of chemical substances in the seed coat which are impervious to water and gases. Natural germination of sandalwood seeds is having very low germination capacity as well as time consuming. Therefore the seed germination needs to be improved by artificial methods. Vira and Smith [15], (1996) reported that the rate and uniformity of sandalwood germination was increased by the gibberellic acid treatment.
Therefore, the present study was conducted to investigate the effect of pre sowing treatments on seed germination and its parameters in sandalwood.

Materials and Methods
The present investigation was carried out during *rabi* 2019-20 in greenhouse of Department of Genetics and Plant Breeding, Junagadh Agricultural University, Junagadh. Seeds of sandalwood was obtained from Paritalav botanical garden, Junagadh Agricultural University, Junagadh. The experimental design followed here is Completely Randomized Design (Factorial) in three replications. In present study, there were seven pre sowing treatments *viz*., GA_3 100 ppm (T_1), GA_3 300 ppm (T_2), KNO_3 at 2% (T_3), Cow dung for 24 shours (T_4), Cow dung for 48 hours (T_5), Ethrel 100 ppm (T_6) and Control (T_7).
For preparation of 100 and 300 ppm GA_3 solution, the stock solution of 2000 ppm was prepared. 100 ppm Ethrel solution was prepared by making 1000 ppm stock solution. 2%

KNO_3 was prepared by taking 24 gms KNO_3 in a cylindrical flask and making volume to 1200 ml. Cow dung slurry was prepared by mixing fresh cow dung in water to get slurry. After this, the required amount of seeds were soaked in 100 ppm GA_3, 300 ppm GA_3, 100 ppm ethrel, 2% KNO_3 for about 12 hrs and in cow dung slurry for about 12 and 24 hrs respectively. The soaked seeds were sown in the sand and soil mixture @ 100 seeds per tray. Five competitive plants per treatment in each replication were selected randomly for recording observations. Analysis of variance for Completely Randomized Design (Factorial) was computed as per the method of Gomez and Gomez [4] (1984). Vigour index in terms of length and mass were determined as per formulae given by Abdul-Baki and Anderson [1] (1973).

Results and Discussion

In this experiment, different pre sowing treatments produced significant influence on germination per cent (%), time taken for initiation of germination (TTIG), time taken for completion of germination (TTCG), speed of germination, mean weekly germination, root length of seedling (cm), shoot length of seedlings (cm), seedling length (cm), collar diameter (mm), seedling fresh weight (mg)**,** seedling dry weight (mg), seedling vigour index (length) and seedling vigour index (mass). On an average, the early emergence of seedling (34.66 days) with maximum germination per cent (34.66%), speed of germination (0.64), mean weekly germination (3.03), collar diameter (2.23 mm), seedling fresh weight (243.16 mg), seedling dry weight (50.00 mg), seedling vigour index (length) (319.15) and seedling vigour index (mass) (1743.83) were observed in GA_3 300 ppm (T_2). Time taken for completion of germination was found highest in GA_3 100 ppm (T_1). Whereas root length (4.25 cm), shoot length (5.27 cm) and seedling length (9.55 cm) were found significantly highest in KNO_3 at 2% (T_3). The significant increase in germination percentage along with early emergence of seedling in GA_3 300 ppm (T_2) might be due to the fact that it antagonize the ill effect of inhibitors and induce *de novo* synthesis of proteolytic enzymes like alpha amylase and ribonuclease. These enzymes hydrolyse starch in the endosperm providing the essential sugar for the initiation of growth process in the developing embryo. The results obtained in the present investigation are in accordance with the findings of Vira and Smith [15] (1996) and Nikam and Barmukh [6] (2009) in sandalwood, Anand [2] *et al*. (2012) in *Melia dubia*, Caliskan [3] *et al*. (2012) in fig seeds, Jayawardena [5] *et al*. (2015) and Sutheesh [14] *et al*. (2016) in sandalwood, Patil and Krishna [8] (2016) in canes, Palepad [9] *et al*. (2017) in custard apple, Shankar and Devakumar [11] (2018) and Pamungkas and Nichols [7] (2019) in sandalwood.

On the other hand, germination per cent (16.16%), speed of germination (0.26), mean weekly germination (1.37) and seedling vigour index (length) (129.58) were observed to be minimum in T_6 (ethrel 100 ppm). Time taken for initiation of germination was found late and time taken for completion of germination was found low in case of T_5 (cow dung for 48 hours) (48.33 days, 75.83 days respectively). Significantly the minimum root length (3.55 cm), shoot length (4.13 cm), seedling length (7.68 cm) and seedling fresh weight (196.66 mg) were obtained in T_7 (control). Seedling vigour index (mass) (685.16) and seedling dry weight (36.50 mg) were observed minimum in T_4 (cow dung for 24 hours).

Table 1: Effect of pre-sowing seed treatment on seed germination and its parameters after 88 days of sowing on germination (%), TTIG, TTCG, speed of germination, mean weekly germination (MWG) and root length (cm)

Treatment	Germination (%)	TTIG	TTCG	Speed of germination	MWG	Root length (cm)
Treatments (T)						
T_1	33.83	41.16	85.33	0.54	2.77	4.08
T_2	34.66	34.66	78.50	0.64	3.03	4.18
T_3	23.33	39.00	82.33	0.40	2.00	4.25
T_4	17.16	47.16	80.33	0.27	1.45	3.84
T_5	21.33	48.33	75.83	0.33	1.77	3.68
T_6	16.16	43.33	82.66	0.26	1.37	3.61
T_7	20.83	41.33	83.66	0.36	1.70	3.55
Mean	23.90	42.14	81.23	0.40	2.01	3.88
S. Em±	0.25	0.24	0.23	0.004	0.02	0.06
CD at 5 %	0.72	0.70	0.68	0.01	0.07	0.18

T_1 – Pre sowing seed treatment with GA_3 100 ppm
T_2 – Pre sowing seed treatment with GA_3 300 ppm
T_3 – Pre sowing seed treatment with KNO_3 2%
T_4 – Pre sowing seed treatment with cow dung for 24 hrs
T_5 – Pre sowing seed treatment with cow dung for 48 hrs
T_6 – Pre sowing seed treatment with ethrel 100 ppm
T_7 – Control

Table 2: Effect of pre-sowing seed treatment on seed germination and its parameters after 88 days of sowing on shoot length (cm), seedling length (cm), collar diameter (mm), seedling fresh weight (mg), seedling dry weight (mg), SVI (length) and SVI (mass)

Treatment	Shoot length (cm)	Seedling length (cm)	Collar diameter (mm)	Seedling fresh weight (mg)	Seedling dry weight (mg)	SVI (length)	SVI (mass)
Treatments (T)							
T_1	4.45	8.53	2.06	228.33	43.66	299.45	1557.33
T_2	4.81	8.98	2.23	243.16	50.00	319.15	1743.83
T_3	5.27	9.55	1.86	236.66	41.83	232.45	1061.33
T_4	4.35	8.18	2.21	199.66	36.50	141.91	685.16
T_5	4.36	8.03	2.13	203.33	38.16	179.31	975.50
T_6	4.27	7.88	2.21	220.00	46.33	129.58	786.66
T_7	4.13	7.68	2.05	196.66	39.50	148.76	763.50

Mean	4.52	8.40	2.11	218.26	42.28	207.23	1081.90
S. Em±	0.07	0.07	0.04	2.56	0.31	2.99	12.62
CD at 5 %	0.22	0.21	0.12	7.42	0.91	8.67	36.56

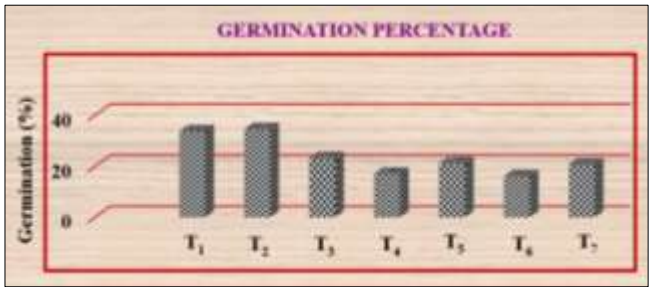

Fig 1: Effect of scarification and different treatments on germination percentage (%) in sandalwood.

Fig 2: Effect of scarification and different treatments on TTIG in sandalwood

Fig 3: Effect of scarification and different treatments on TTCG in sandalwood

Fig 4: Effect of scarification and different treatments on speed of germination in sandalwood

Fig 5: Effect of scarification and different treatments on mean weekly germination in sandalwood

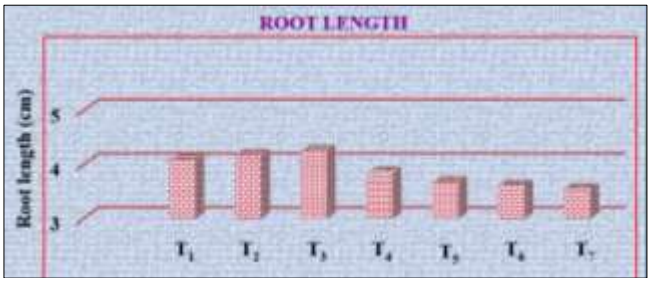

Fig 6: Effect of scarification and different treatments on root length (cm) in sandalwood

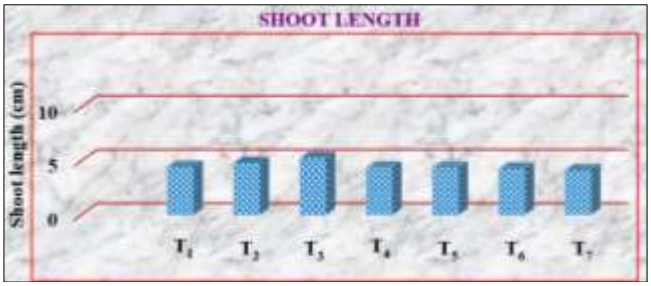

Fig 7: Effect of scarification and different treatments on shoot length (cm) in sandalwood

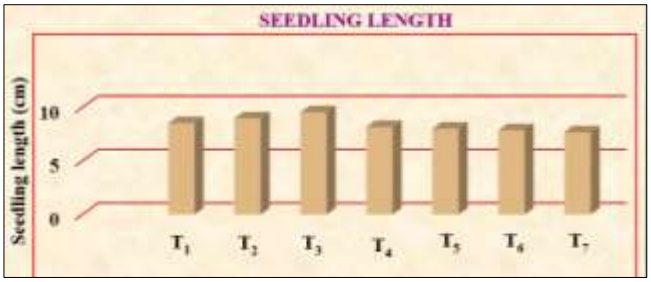

Fig 8: Effect of scarification and different treatments on seedling length (cm) in sandalwood

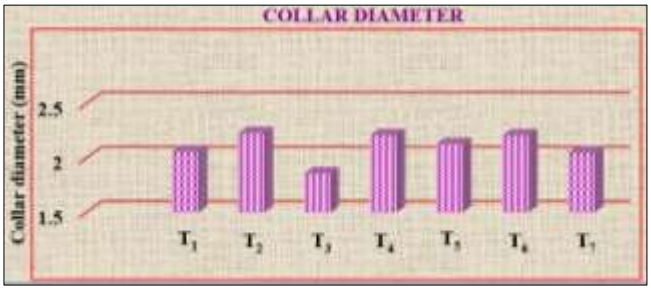

Fig 9: Effect of scarification and different treatments on collar diameter (mm) in sandalwood

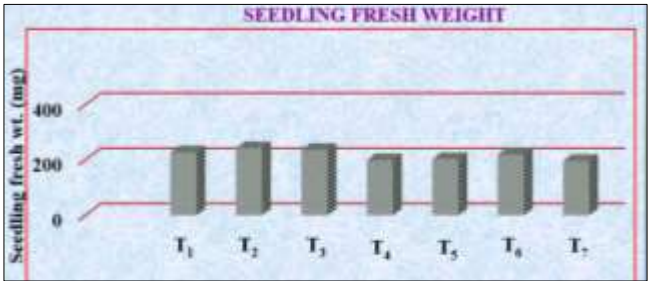

Fig 10: Effect of scarification and different treatments on seedling fresh weight (mg) in sandalwood

Fig 11: Effect of scarification and different treatments on seedling dry weight (mg) in sandalwood

Fig 12: Effect of scarification and different treatments on seedling vigour index (length) in sandalwood

Fig 13: Effect of scarification and different treatments on seedling vigour index (mass) in sandalwood

Conclusion

Looking into above discussion, it is concluded that seeds treated with GA_3 @300 ppm (T_2) treatment produced significantly the faster initiation of germination and showed highest germination per cent, speed of germination, mean weekly germination, collar diameter, seedling fresh weight, seedling dry weight, seedling vigour index (length) and seedling vigour index (mass). Significantly the highest root length, shoot length and seedling length were noted in KNO_3 at 2% (T_3) when compared to other treatments.

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