

EFFECT OF GA₃ AND TIME OF SEED SOAKING ON GERMINATION AND SEEDLING VIGOUR OF SANDALWOOD

ABSTRACT

The experiment entitled, "effect of GA₃ and time of seed soaking on germination and seedling vigour of sandalwood" was carried out under greenhouse condition with two factors *i.e.*, different GA₃ levels *viz.*, Control (g₀), seed soaking in GA₃ 100 ppm (g₁), seed soaking in GA₃ 200 ppm (g₂), seed soaking levels *viz.*, in GA₃ 300 ppm (g₃), seed soaking in GA₃ 400 ppm (g₄), seed soaking in GA₃ 500 ppm (g₅) and seed soaking for 12 hours (t₁), seed soaking for 18 hours (t₂) and seed soaking for 24 hours (t₃). The results of the study revealed that, significantly minimum days for germination (21.44), higher survival percentage at 60 days after sowing (65.35), number of roots per seedling at the time of final survival (4.40), maximum length of roots per seedling at 60 days after sowing (7.58 cm) and height of plant at 90 days after sowing (12.27 cm), maximum survival percentage (100) at 15 days after bagging and stem diameter at 90 days after sowing (0.24 cm) was recorded with treatment g₅ (Seed soaking in GA₃ 500 ppm). From the pooled data, significantly early germination (22.00 days), maximum survival percentage (59.87) at 60 days after sowing, number of roots (4.00) per seedling at the time of final survival, length of roots per seedling (7.76 cm) at 60 days after sowing, height of plant at 90 days after sowing (12.03 cm), maximum survival percentage (99.69) at 15 days after bagging and stem diameter at 90 days after sowing (0.23 cm) was recorded with treatment t₃ (Seed soaking for 24 hours). From the present investigation, sandalwood seed soaking treatment with GA₃ 500 ppm for 24 hours recorded early germination, higher survival and superior in seedling vigour.

Key word: GA₃, Green house, Seed, Sandalwood and Time of soaking.

INTRODUCTION

Sandalwood (*Santalum album* L.) is the fragrant heartwood of some species of genus *Santalum*. The widely distributed and economically important *Santalum* genus belongs to the family *Santalaceae*. It is native to Indonesia (Java and the Lesser Sunda Islands), the Philippines, and Western Australia. It is commonly known as the true sandalwood, white sandalwood, or Indian sandalwood. It was one of the plants exploited by Austronesian arboriculture and it was introduced by Austronesian sailors to East

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Asia, Mainland Southeast Asia and South Asia during the ancient spice trade, becoming naturalized in South India by at least 1300 BCE.

Sandal is one of the most primitive precious useful plants since ancient times. Ecologically sandal has adapted various agroclimatic and soil conditions for in situ regeneration with an exception of waterlogged areas and very cold places. Sapwood is white to pale yellow, sharply demarcated from the yellowish brown to dark brown heartwood, hard, heavy, lustrous and straight-grained to slightly wavy, fine textured with pleasant characteristic smell (Rao et al., 2007). Sandalwood trees are famous and very costly because of its fragrant heartwood and oil.

The various PGR's treatment for specific period of time also helpful for early growth phases. GA triggers the respiratory and metabolic activities and activates certain genes resulting in the production of various components required for the active growth and development of embryo. Thus GA overcomes the dormancy and induces germination. In case of sandal, the basic problem is seed germination artificially. The seeds were treated with hot and cold water, GA₃ in different concentrations for its artificial germination.

After a certain period, seedlings were started to germinate. By observing all these peculiarities the germinated seeds were transferred to polybags and hycopots. Now, it is being realized that the only way to counter smuggling activities and to meet demand for sandalwood encouraging sandal domestication may be the only option. But, an easy technology is to be explored for the plantation to be taken up by the general people. Keeping all these views in mind the authors undertook the venture for the same since over a couple of years for its propagation and survivality to explore the areas of suitable as well as congenial edaphic factors. Day to day growth and development were observed and recorded all these data properly which have been exhibited in this context.

The main aims and objects are to study the integrated scientific approach of seed germination, its growth behaviour in nursery for production of quality and healthy planting stock and raising successful plantation subsequently. There has no any work related to germination of sandalwood was carried out under Gujarat state, so, keeping above things in mind the attempt was being taken to study the "effect of GA₃ and time of seed soaking on germination and seedling vigour of sandalwood" was carried out under greenhouse condition.

MATERIAL AND METHODS

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An experiment entitled, effect of GA₃ and time of soaking on germination of sandalwood seed, was carried out under greenhouse condition at Department of Horticulture, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Present experiment were evaluated with two factors viz., different GA₃ levels viz., Control (g₀), seed soaking in GA₃ 100 ppm (g₁), seed soaking in GA₃ 200 ppm (g₂), seed soaking in GA₃ 300 ppm (g₃), seed soaking in GA₃ 400 ppm (g₄), seed soaking in GA₃ 500 ppm (g₅) and seed soaking for 12 hours (t₁), seed soaking for 18 hours (t₂) and seed soaking for 24 hours (t₃).

White Sandal (*Santalum album* L.) was tried in three trials viz., First trial: 17th May to 17th August, Second trial: 22nd July to 22nd October, Third trial: 27th September to 27th December were carried out in plug tray under greenhouse condition. Seed treatment of GA₃ was given as per treatment and standard media i.e. Vermiculite: Poultry Manure: Vermicompost (2:1:1) were used on volume basis in plug tray. The experiment was laid out in Factorial Completely Randomized Design as described by Nigam and Gupta (1979) with three repetitions. The treatments evaluated and observations were recorded periodically in relation to germination, survival and seedling vigour.

RESULTS AND DISCUSSION

Effect of time of seed soaking (T):

The pooled data of three trial revealed that the significantly early germination (22.00 days), maximum survival percentage (59.87) at 60 days after sowing, number of roots (4.00) per seedling at the time of final survival, length of roots per seedling (7.76 cm) at 60 days after sowing and height of plant at 90 days after sowing (12.03 cm) were recorded with treatment t₃ (Seed soaking for 24 hours) and which was significantly superior over all other treatments.

From the pooled data, it was noted that not significant the maximum survival percentage (99.69) at 15 days after bagging and stem diameter at 90 days after sowing (0.23 cm) was recorded with treatment t₃ (Seed soaking for 24 hours).

It was observed that soaking of seeds in gibberellic acid is one of the most successful methods for accelerating the germination of the seeds of sandalwood (Rai, 1990 and Tennakoon et al., 2000). Similar results have been reported by Raviraja Shetty et al. (2016) in *Celastrus paniculatus* a wild a threatened medicinal plant where the seeds treated with lower concentration of GA₃ i.e. 400ppm.

Effect of level of GA₃ (G):

The results of three trial pooled data found that significantly minimum days for germination (21.44), higher survival percentage at 60 days after sowing (65.35) and number of roots per seedling at the time of final survival (4.40) was recorded with treatment g₅ (Seed soaking in GA₃ 500 ppm), which was significantly superior over other treatments. The significantly maximum length of roots per seedling at 60 days after sowing (7.58 cm) and height of plant at 90 days after sowing (12.27 cm) were recorded with treatment g₅ (Seed soaking in GA₃ 500 ppm) and it was statistically at par with treatment g₄ (Seed soaking in GA₃ 400 ppm). The cytological basis of gibberellic acid involves the promotion of cell elongation and cell division ultimately increasing the length of root and shoot and also the plant height (Achard et al., 2009).

From the pooled data, it was noted that not significant survival percentage (100) at 15 days after bagging and stem diameter at 90 days after sowing (0.24 cm) was recorded with treatment g₅ (Seed soaking in GA₃ 500 ppm).

Gibberellic acid is known to induce the expression of genes encoding enzymes that mobilize the reserved food material stored in the endosperm which includes starch, protein and lipids. This helps in increasing the biological yield of the plant. The overall increase in the growth of the plant is due to gibberellic acid which leads to the increase in rate of photosynthesis (Patel et al., 2018).

Conclusion

From the present investigation, sandalwood seed soaking treatment with GA₃ 500 ppm for 24 hours recorded early germination, higher survival and superior in seedling vigour.

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Table: 1 Effect of GA₃ and time of seed soaking on germination and survival of sandalwood (*Santalum album* L.)

Treatments	Days taken for germination				Survival percentage at 60 days after sowing				Survival percentage at 15 days after bagging			
	Trial I	Trial II	Trial III	Pooled	Trial I	Trial II	Trial III	Pooled	Trial I	Trial II	Trial III	Pooled
Time of seed soaking (T):												
t₁ (Seed soaking for 12 hours)	22.72	23.16	23.33	23.07	50.16	53.40	51.97	51.84	99.53	99.53	94.44	97.83
t₂ (Seed soaking for 18 hours)	22.44	23.33	22.77	22.85	52.21	54.86	52.96	53.34	98.61	99.53	100.0	99.38
t₃ (Seed soaking for 24 hours)	21.61	22.33	22.05	22.00	58.33	60.73	60.55	59.87	99.07	100.0	100.0	99.69
S.Em.±	0.17	0.31	0.24	0.14	0.92	0.79	0.64	0.45	0.75	0.37	3.20	1.10
C.D. at 5 %	0.50	NS	0.70	0.40	2.64	2.28	1.85	1.29	NS	NS	NS	NS
GA₃ levels (G):												
g₀ (Control)	24.55	24.77	25.33	24.88	46.29	47.40	48.14	47.28	100.0	100.0	88.88	96.29
g₁ (Seed soaking in GA₃ 100 ppm)	22.22	23.11	22.88	22.74	51.47	52.18	51.84	51.83	97.22	99.07	100.0	98.76
g₂ (Seed soaking in GA₃ 200 ppm)	21.88	22.44	22.33	22.22	50.73	54.70	53.70	53.04	98.14	100.0	100.0	99.38
g₃ (Seed soaking in GA₃ 300 ppm)	22.00	22.88	22.66	22.51	51.47	56.92	55.18	54.52	99.07	100.0	100.0	99.69
g₄ (Seed soaking in GA₃ 400 ppm)	21.66	22.66	21.77	22.03	55.55	61.36	57.36	58.09	100.0	99.07	100.0	99.69
g₅ (Seed soaking in GA₃ 500 ppm)	21.22	21.77	21.33	21.44	65.88	65.44	64.73	65.35	100.0	100.0	100.0	100.0
S.Em.±	0.24	0.44	0.34	0.20	1.30	1.12	0.91	0.65	1.07	0.53	4.53	1.56
C.D. at 5 %	0.71	1.26	1.00	0.57	3.73	3.23	2.62	1.82	NS	NS	NS	NS
T X G												
S.Em.±	0.43	0.76	0.60	0.35	2.25	1.95	1.58	1.12	1.85	0.92	7.85	2.70
C.D. at 5 %	1.23	NS	NS	NS	6.47	5.60	4.54	3.16	NS	NS	NS	NS
CV %	3.35	5.78	4.60	4.71	7.29	6.00	4.97	6.14	3.24	1.61	13.27	8.21

Table: 2 Effect of GA₃ and time of seed soaking on number of roots and length of roots per seedling of sandalwood (*Santalum album* L.)

Treatments	Number of roots per seedling at the time of final survival				Length of roots per seedling (cm) at 60 days after sowing			
	Trial I	Trial II	Trial III	Pooled	Trial I	Trial II	Trial III	Pooled
Time of seed soaking (T):								
t₁ (Seed soaking for 12 hours)	3.55	3.66	3.88	3.70	6.22	5.75	5.77	5.91
t₂ (Seed soaking for 18 hours)	3.83	3.61	3.66	3.70	6.18	6.25	6.24	6.22
t₃ (Seed soaking for 24 hours)	3.94	3.88	4.16	4.00	8.25	7.41	7.63	7.76
S.Em.±	0.10	0.11	0.10	0.06	0.23	0.22	0.15	0.12
C.D. at 5 %	0.29	NS	0.29	0.17	0.67	0.65	0.44	0.33
GA₃ levels (G):								
g₀ (Control)	3.22	3.11	3.44	3.25	5.55	4.98	4.98	5.17
g₁ (Seed soaking in GA₃ 100 ppm)	3.44	3.55	3.66	3.55	6.04	5.96	6.08	6.03
g₂ (Seed soaking in GA₃ 200 ppm)	4.00	3.66	3.88	3.85	7.13	6.68	6.55	6.79
g₃ (Seed soaking in GA₃ 300 ppm)	3.66	3.66	3.88	3.74	7.00	6.77	6.60	6.79
g₄ (Seed soaking in GA₃ 400 ppm)	3.88	4.00	4.11	4.00	7.80	7.10	7.46	7.45
g₅ (Seed soaking in GA₃ 500 ppm)	4.44	4.33	4.44	4.40	7.78	7.33	7.62	7.58
S.Em.±	0.14	0.16	0.14	0.08	0.33	0.32	0.21	0.17
C.D. at 5 %	0.41	0.47	0.41	0.24	0.95	0.91	0.62	0.47
T X G								
S.Em.±	0.24	0.28	0.24	0.15	0.57	0.55	0.37	0.29
C.D. at 5 %	NS	NS	NS	NS	1.64	NS	1.08	0.82
CV %	11.39	13.18	11.01	11.87	14.43	14.83	10.00	13.30

Table: 3 Effect of GA₃ and time of seed soaking on stem diameter and height of plant at 90 DAS of sandalwood (*Santalum album* L.)

Treatments	Stem diameter at 90 days after sowing (cm)				Height of plant at 90 days after sowing (cm)			
	Trial I	Trial II	Trial III	Pooled	Trial I	Trial II	Trial III	Pooled
Time of seed soaking (T):								
t ₁ (Seed soaking for 12 hours)	0.21	0.20	0.21	0.21	11.00	10.23	10.30	10.51
t ₂ (Seed soaking for 18 hours)	0.21	0.21	0.21	0.21	12.24	10.57	10.73	11.18
t ₃ (Seed soaking for 24 hours)	0.22	0.22	0.23	0.23	13.02	10.40	11.68	12.03
S.Em.±	0.01	0.009	0.01	0.006	0.16	0.23	0.15	0.10
C.D. at 5 %	NS	NS	NS	NS	0.46	0.68	0.44	0.30
GA₃ levels (G):								
g ₀ (Control)	0.20	0.20	0.20	0.20	10.54	9.11	9.15	9.60
g ₁ (Seed soaking in GA ₃ 100 ppm)	0.22	0.20	0.20	0.20	11.12	10.18	10.50	10.60
g ₂ (Seed soaking in GA ₃ 200 ppm)	0.20	0.21	0.21	0.20	12.34	10.94	10.90	11.39
g ₃ (Seed soaking in GA ₃ 300 ppm)	0.22	0.22	0.24	0.22	12.67	11.12	11.38	11.72
g ₄ (Seed soaking in GA ₃ 400 ppm)	0.23	0.22	0.23	0.22	10.74	11.20	11.62	11.85
g ₅ (Seed soaking in GA ₃ 500 ppm)	0.24	0.24	0.24	0.24	13.11	11.85	11.86	12.27
S.Em.±	0.01	0.01	0.01	0.008	0.23	0.33	0.21	0.15
C.D. at 5 %	NS	NS	NS	NS	0.66	0.97	0.62	0.43
T X G								
S.Em.±	0.02	0.02	0.02	0.01	0.39	0.58	0.37	0.26
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
CV %	19.53	17.76	18.37	18.58	5.71	9.46	5.99	7.14