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RESEARCH ARTICLE

Evaluating the impact of various seed priming agents on germination behaviour of Bael (*Aegle marmelos* L.)

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Abstract

The bael seeds has poor germination and higher seedling mortality during nursery stage. Therefore, it becomes important to standardize the pre-seed treatment protocol and exact concentration of hormone and other chemicals for higher seed germination and seedling growth for commercial bael nursery - industry in India. Hence, the present study was planned to determine the effect of the priming agents on seed germination, seedling growth of Bael (*Aegle marmelos* L. Correa). Effect of seed priming agents like H_2O, GA_3, H_2O_2, NAA at different concentrations on seed germination and growth of bale seedling grown under shade net house was observed in the present study. All the seedling characters were measured as per ISTA guidelines. Among the priming agents GA_3 200 ppm recorded as the best priming treatment with respect to the parameters, viz. germination percentage (89.92 %), shoot length (20.53), number of leaves per plant (2.11), root diameter (3.50 cm), root length (23.22 cm), fresh weight of plant (6.21 g), dry weight of plant (3.48 g), Vigour index I (1845), Vigour index II (2088) and Vigour index III (313) than other seed priming treatments. The results highlight how priming can significantly improve the germination and growth of bael seedlings; the GA_3 at 200 ppm solution treatments stand out as particularly successful technique for the better germination and establishment of Bael nursery under shade net house conditions.

Keywords: GA_3; germination; root length; seed priming; vigour index

Introduction

A Bael (*Aegle marmelos* L. Correa.) is a popular medicinal cum fruit tree belonging to the family Rutaceae. It is native of India and is popularly known as bael fruit or stone apple tree, Bengal -quince, *bilva*, golden apple in India. Bael fruit is highly nutritious and extensively used in the Ayurvedic and Siddha systems of medicines to treat a varied variety of disorders and diseases (1-3). Tree is a slender, medium sized, aromatic tree having dimorphic branching habit, reach 6.0-7.5 m in height and 90-120 cm in girth with a fluted bole of 3.0-4.5 m and growing wild throughout the tropical and subtropical region of India (4, 5).

Generally, the bael seed has poor germination (50-60 %) and higher seedling mortality, owing to adverse edaphic conditions during nursery stage. Therefore, it becomes important to standardize the pre-seed treatment protocol and exact concentration of hormone and other chemicals for higher seed germination and seedling growth for commercial bael nursery - industry in India. Quality seedlings production helps maximum survivability in the field and increases the productivity of the fruit crops (6). Hydro priming has shown a positive impact on seedling germination percentage and dry matter production in bael (7). The pre-seed treatment chemicals or hormones enhances the seed germination, seedling growth and rooting system for better establishment. Gibberellins are concerned for promotion of germination by activating the different biochemical reaction in the synthesis of hydrolases (especially, α-amylase) in the endosperm of seeds. Its breakdown is generally believed to be an essential process for germination (8).

Improvement of bael seed germination was also noticed when seed treating with GA_3 at different concentrations (9, 10). The application of the bio-regulators is effective in improving seedling germination parameters and well field establishment (10). Notably few research documents are available on bael seed pre-treatment and seedling growth. Hence, the quality production of seedlings is essential for maximum field establishment in bael. Keeping these facts in view, the research was undertaken to determine the effect of the priming agents on seed germination, seedling growth parameters under nursey conditions.

Materials and Methods

The field experiment was conducted during 2023 at Research

Farm, Department of Spices, Plantation, Medicinal and Aromatic Crops, College of Horticulture, Anantharajupeta, Dr. YSR Horticultural University which falls under tropical zone with an average annual rainfall of 900 mm and is situated at an altitude of 162 m (531 feet) above mean sea level in Andhra Pradesh state of India. The fresh fruits were collected from fruit science block, college of Horticulture, Anantharajupeta during June and July, 2023 and the seeds were extracted as wet extraction and were dried under shade for a week to reduce the moisture content to 10 %. The seeds were extracted carefully, washed with clean water and dried in shade for a day. The seeds were then treated with water at 12 and 24 hr, GA_3 at 100, 150 and 200 ppm, H_2O_2 (0.5 % and 1.0 %) and NAA (50 and 100 ppm) concentration separately each for 24 hr as per the treatment imposition.

Seeds were sowed in 25 × 15 cm size polythene bags, the polythene bags were punctured to get better drainage and filled with the garden mixture which was prepared by well mixing of two parts of soil, one part of fine sand and one part of well-rotted farmyard manure (FYM). Nursery operations like regular watering, weeding and plant protection measures like spraying of insecticides against insect, pest and diseases was taken.

During the process of germination, the seeds were observed for germination and the results were reported in percentage.

$$\text{Germination percentage (\%)} = \frac{\text{Number of germinated seeds}}{\text{Total number of seed}} \times 100 \quad \text{(Eq. 1)}$$

Ten randomly selected normal seedlings were measured for the growth parameters, namely, number of leaves, root length (cm), shoot length (cm) and dry matter production (g). The vigour index was calculated using the following formula and expressed as whole number.

Vigour index I = Germination (%) × Mean length of the seedling (cm).

Vigour index II = Germination (%) × root length (cm).

Vigour index III =

Germination (%) × Dry matter production/10 seedling (mg).

The experimental design used in the shade net was complete randomized block design (CRD) with ten treatments and replicated thrice. The data gathered for the above-mentioned parameters were subjected to analysis of variance and tested for significance and the percentage values were transformed to arcsine values prior to statistical analysis. The significance of treatments was worked out by comparing the difference between two treatments mean using CD at 5 % level of significance (11, 12).

Results and Discussion

Seed germination percentage

The findings of the study are presented in the Table 1. The data depicted a significant difference among the seed priming agents on bael seed germination character. The maximum seed germination (89.92 %) was recorded in seed were treated with GA_3 at a concentration of 200 ppm and the minimum (53.13 %) germination percentage was recorded in the control (53.33 %) treatment. It might be attributed to the external application GA_3 stimulated the activity of enzymes, these enzymes play key role for the conversion of starch to sugar and subsequent absorption by the enzyme, thus the embryo develops and burst through the seed coat resulting in speed seed germination. These observations are in conformity with those of scientist (10), who observed maximum germination percentage where seed treated with GA_3 than other treatments in Bael. The similar results were also previously reported (13-15).

Shoot length

The maximum shoot length was measured with GA_3 200 ppm at 30, 60 and 90 DAS with 16.02, 18.52 and 20.53 cm, respectively, which was on par with 150 ppm GA_3 (15.72, 18.20 and 19.80 cm) and the minimum shoot length was observed in control (9.01, 9.32 and 10.0 cm) at 30, 60 and 90 DAS (Table 1 and Fig. 1). It is evident from the data that shoot length of bael seedlings was significantly influenced by different seed treatments. The increased shoot length in the bael seedling might be because this hormone enhanced osmotic absorption of nutrients, which triggered cell elongation and thus fastening the height of the seedling (16).

Number of leaves

The number of leaves bael seedling was significantly affected by different seed priming agents (Table 1). The maximum number of leaves per seedling shoot length was recorded with GA3 200 ppm at 30, 60 and 90 DAS with 2.11, 4.19 and 6.29, respectively and the minimum number of leaves was observed in control (2.00, 3.15 and 4.3) at 30, 60 and 90 DAS.

The higher number of leaves of seedling is due to the GA_3 priming treatment which might have helped for the higher synthesis of photosynthate and their active translocation to the root zone through the phloem, which triggered cell division and elongation, higher nutrient and water absorption of the seedlings. These observations are in conformity with those of Dilip et al. (16), who observed maximum number of leaves, where seed treated with GA_3 than other treatments in Bael.

Root diameter and root length

The data pertaining to root diameter (cm), root length (cm) of bael seedling have been presented in Table 2. The maximum of root diameter (3.50 cm) at 90 DAS was recorded in the seeds priming with treatment 200 ppm GA_3, which was statistically at par with treatment 150 ppm GA_3 (3.40 cm) and the minimum of root diameter (1.60 cm) was recorded in control. Further, seeds treated with 200 ppm GA_3 recorded maximum root length (23.22 cm) and the minimum (11.08 cm) was recorded in the control treatment (Fig. 1). The maximum root diameter and root length in the bael seedlings might be the effect of GA_3, it induces the root growth by obtaining higher nutrients than other treatments. Similar results were also obtained by Meena and Jain (17), who observed that seeds treated with 200 ppm GA_3 of papaya significantly influenced the root diameter and root length in papaya and noticed maximum root length with GA_3 500 ppm in papaya than other treatments (14). Our findings were supported by the other studies (9, 18-21).

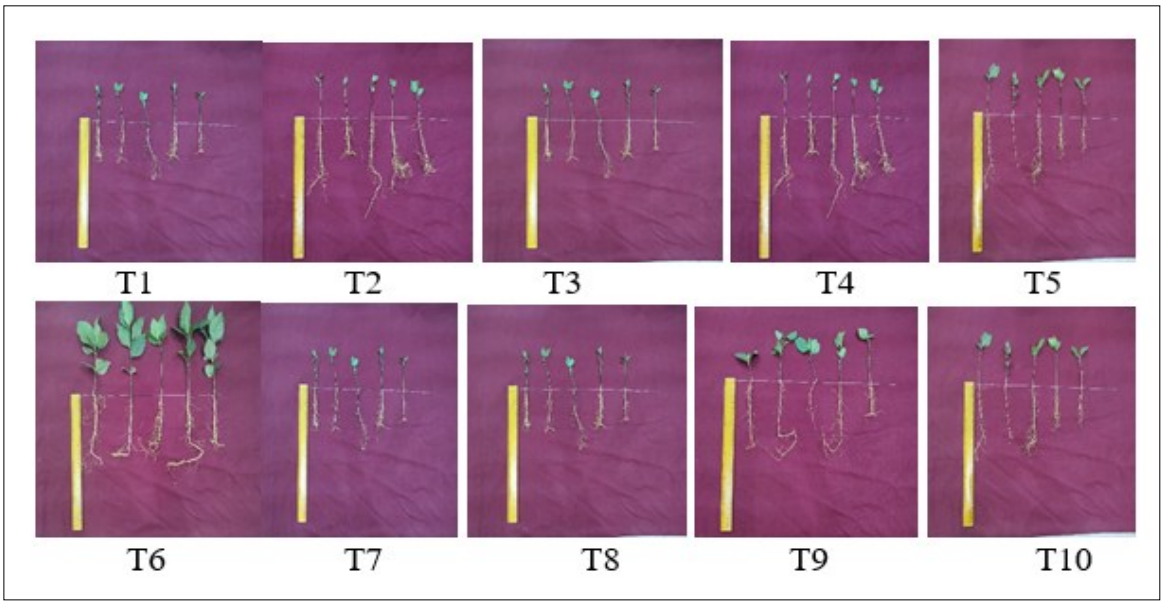

Fig. 1. Effect of different concentration of priming agents on seedling growth of bael.

Table 1. Effect of seed priming agents on seed germination, shoot length and number of leaves of Bael

Treatments	Germination (%)	Shoot length (cm)			Number of leaves		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1 (Control)	53.13	9.01	9.32	10.02	2.00	3.15	4.30
T_2 (12 hr water soaking)	72.20	9.50	10.89	12.68	2.03	3.21	4.49
T_3 (24 hr water soaking)	80.28	9.91	11.08	13.00	2.01	3.60	4.91
T_4 (100 ppm GA_3)	82.11	15.28	17.01	18.21	2.03	3.82	5.21
T_5 (150 ppm GA_3)	85.12	15.72	18.20	19.80	2.08	4.09	5.77
T_6 (200 ppm GA_3)	89.92	16.02	18.52	20.53	2.11	4.19	6.29
T_7 (H_2O_2 0.5 %)	80.04	10.80	12.40	13.51	2.10	3.24	4.82
T_8 (H_2O_2 1.0 %)	81.41	11.32	12.51	13.69	2.01	4.08	5.20
T_9 (NAA 50 ppm)	75.07	13.19	14.80	16.10	2.06	4.11	5.22
T_{10} (NAA 100 ppm)	81.46	15.18	16.32	17.43	2.04	4.10	5.21
SE(m) ±	0.72	0.27	0.28	0.25	0.10	0.20	0.20
CD at 5 %	2.12	0.80	0.83	0.74	0.28	0.58	0.60

Fresh weight and dry weight of seedling

The seed priming treatments used in the study showed significant differences among each other for both fresh and dry weight. The maximum fresh weight of plant (6.21 g) was observed from the seeds treated with 200 ppm GA_3, which was statistically at par with the 150 ppm GA_3 and the minimum fresh weight of plant (1.97 g) was obtained from the control treatment. Further, the maximum dry weight of plant registered with 200 ppm GA_3 (3.48 g), which was statistically at par with 150 ppm GA_3 (3.29 g) and the minimum dry weight of plant (1.31 g) was recorded in control treatment. The explanation behind the highest fresh weight and dry weight of seedling might be due to the reason that by seed treatment with GA^3, it increases the cell division, cell elongation, auxin metabolism and mobilizes the water and nutrient uptake ultimately increases the process of photosynthesis and it leads to the maximum plant growth and dry matter accumulation. Our findings were supported by (16), who conducted seed treatment with GA_3 in Kagzi lime and the results revealed the maximum fresh and dry weight at 80 ppm GA_3.The same results also mentioned in jamun seedlings (22).

Vigour index

To further explore the potential application use of various priming agents significantly impacted the Vigour index characters in bael seedlings. Data presented in Table 3 shows that the maximum Vigour index I (1845), Vigour index II (2088) and Vigour index III (313) were obtained from the seeds treated with 200 ppm GA_3, whereas minimum was recorded in

Table 2. Effect of seed priming agents on root diameter, root length, fresh and dry weight of Bael

Treatments	Root diameter (cm)	Root length (cm)	Fresh weight of plant (g)	Dry weight of plant (g)
T_1 (Control)	1.60	11.08	1.97	1.31
T_2 (12 hr water soaking)	1.80	11.49	2.87	1.72
T_3 (24 hr water soaking)	1.71	12.63	2.93	1.80
T_4 (100 ppm GA_3)	3.00	17.27	4.39	2.90
T_5 (150 ppm GA_3)	3.40	18.58	5.70	3.29
T_6 (200 ppm GA_3)	3.50	23.22	6.21	3.48
T_7 (H_2O_2 0.5 %)	1.90	15.52	3.13	1.92
T_8 (H_2O_2 1.0 %)	2.11	17.52	3.32	2.09
T_9 (NAA 50 ppm)	2.50	13.88	4.13	2.69
T_{10} (NAA 100 ppm)	2.51	18.15	4.21	2.52
SE(m) ±	0.11	0.43	0.29	0.09
CD at 5 %	0.34	1.28	0.86	0.27

Table 3. Effect of seed priming agents on vigour index attributes Bael

Treatments	Vigour index I	Vigour index II	Vigour index III
T_1 (Control)	532	589	70
T_2 (12 hr water soaking)	916	829	124
T_3 (24 hr water soaking)	1044	1014	145
T_4 (100 ppm GA_3)	1495	1418	238
T_5 (150 ppm GA_3)	1685	1581	280
T_6 (200 ppm GA_3)	1845	2088	313
T_7 (H_2O_2 0.5%)	1081	1242	154
T_8 (H_2O_2 1.0%)	1114	1426	170
T_9 (NAA 50 ppm)	1208	1041	202
T_{10} (NAA 100 ppm)	1419	1478	205
SE(m) ±	22	10	1.75
CD at 5 %	65	30	5.20

control treatment. This may be due to the strong impact of GA_3 increased the internodal length in growing seedling and shoot through enhancing the feeder rootlets and facilitate to increase uptake of nutrients, water and achieved maximum height of the seedling and vigour index characteristics. The findings of the present study are in line with the study conducted by Bishwas et al. (23) who found maximum seedling vigour index and root shoot ratio in kiwifruit using 200 ppm GA_3. The similar results were also reported in citrus fruits (16, 22).

Conclusion

The findings reveal that germination and its parameters significantly affected by the different seed priming treatments in bael. It was concluded from the above findings, among all the treatments seed primming with GA_3 200 ppm was enhanced germination percentage, root length diameter, seedling fresh and dry weight and seedling vigor index of bae in comparted to other priming and control treatments. The results revealed that, seeds treated with GA^3 200 ppm was recommended to get better germination and for quality seedling production in bael. These values highlight the potential use of gibberellic acid as seed priming agent for producing quality bael seedlings for better graft success and field performance.

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Authors' contributions

GCR, SA and BG carried out the field data observations and germination studies. NVK and GR participated in the design of the study and performed the statistical analysis. ARR conceived of the study and participated in its design and coordination. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The authors declare that there is no conflict of interest.

Ethical issues: None

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