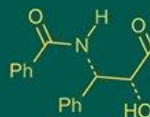


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Effect of different plant growth regulators and chemicals on seed germination and seedling growth of Bael (*Aegle marmelos* L.) under shade net house

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Abstract

An investigation was conducted at Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, Chhattisgarh during the year 2024–2025 to find out the effect of different plant growth regulators and chemicals on seed germination and survival of Bael seedlings under shade net conditions. The experiment was laid out in a Completely Randomized Design with 13 treatments and three replications. The treatments included different concentrations of IBA, NAA, GA₃, Thiourea, KNO₃ and Salicylic acid along with an untreated control. Among all the treatments, GA₃ @ 150 ppm was found most effective in improving germination parameters and survival of plants. The treatment recorded minimum days required for 1st germination (6.67 days), minimum days required for 50% germination (9.30 days), maximum germination percentage (86.70) and maximum survival of plants (91.33%). In comparison, the control treatment recorded maximum days required for 1st germination (14.33 days), maximum days required for 50 % germination (18.10 days) and minimum germination percentage (57.44) and minimum survival of plants (67.83%). Based on the findings of the present investigation, it may be concluded that GA₃ @ 150 ppm was effective in improving seed germination and survival of bael seedlings under protected condition.

Keywords: Bael, Germination, Survival, IBA, NAA, GA₃, Thiourea, KNO₃ and Salicylic acid etc.

Introduction

Bael (*Aegle marmelos* L.) is an indigenous fruit tree of India belonging to the Rutaceae family and is well known for its medicinal, nutritional and economic importance. Bael is mainly propagated through seeds for raising rootstocks. However, its seeds exhibit deep dormancy and poor, irregular germination, which results in uneven seedling emergence and difficulty in producing uniform nursery planting material. Pre-sowing application of plant growth regulators and chemicals can help overcome these germination constraints. Gibberellic acid (GA₃) promotes germination by stimulating hydrolytic enzymes involved in mobilization of stored food reserves, while other chemicals such as thiourea, KNO₃ and salicylic acid may also improve germination and seedling establishment (Lawhale *et al.*, 2020; Basra *et al.*, 2007) ^[1, 5].

Materials and methods

The investigation was carried out during the summer season of 2024–2025 at Pt. Kishori Lal Shukla College of Horticulture and Research Station, Pendri, Rajnandgaon, Chhattisgarh, under shade-net house. The experiment was laid out in a Completely Randomized Design comprising 13 treatments, each replicated three times, with 20 seeds per treatment per replication and 780 seeds in total. The treatments consisted of T₀ – Control, T₁ – IBA @ 100 ppm, T₂ – IBA @ 150 ppm, T₃ – NAA @ 100 ppm, T₄ – NAA @ 150 ppm, T₅ – GA₃ @ 100 ppm, T₆ – GA₃ @ 150 ppm, T₇ – Thiourea @ 100 ppm, T₈ – Thiourea @ 150 ppm, T₉ – KNO₃ @ 100 ppm, T₁₀ – KNO₃ @ 150 ppm, T₁₁ – Salicylic acid @ 100 ppm and T₁₂ – Salicylic acid @ 150 ppm. A potting mixture of soil, sand and well-decomposed farmyard manure (1:1:1, v/v) was filled uniformly into black polyethylene bags provided with drainage holes. Working solutions of GA₃, IBA, NAA and salicylic acid were prepared by dissolving the required quantity initially in ethanol and making the volume up to one litre with distilled

Water, whereas thiourea and KNO_3 were dissolved directly in slightly warm distilled water. Fully mature, healthy and uniform seeds were soaked for 24 hours in their respective treatment solutions at room temperature, while control seeds were soaked in distilled water. After treatment, seeds were gently rinsed with distilled water and immediately sown in the shade-net house, one seed per polybag at a depth of 1.5–2.0 cm. The medium was irrigated one day before sowing and seeds were covered with a thin layer of fine soil mixture. Uniform irrigation, weekly manual weeding and need-based plant protection measures were followed throughout the experiment. Observations were recorded on germination parameters viz., days required for first seed germination, days required for 50% germination, germination percentage and survival of plants. The data were statistically analysed using CRD and treatment differences were tested at 5% level of significance.

Results and discussion

Days required for first germination

The analysis of variance revealed significant variation among the different plant growth regulators and chemicals with respect to days required for initiation of germination in bael (*Aegle marmelos* L.) seeds. The minimum number of days required for first germination was recorded in T_6 (GA_3 @ 150 ppm) with 6.67 days, which was statistically at par with T_5 (GA_3 @ 100 ppm) recording 7.33 days. This was followed by T_8 (Thiourea @ 150 ppm) with 8.37 days and T_{12} (Salicylic acid @ 150 ppm) with 9.63 days. The maximum number of days required for first germination was recorded in the control (T_0) with 14.33 days. The early germination under GA_3 treatment may be attributed to its role in overcoming physiological seed dormancy and stimulating hydrolytic enzyme activity, particularly α -amylase, which facilitates rapid mobilization of stored food reserves for embryo growth. The findings are in accordance with Martinez *et al.* (2016) [6], Sabarad *et al.* (2023) and Sagar *et al.* (2024) [8, 9], who reported beneficial effects of hormonal and chemical treatments in reducing germination time.

Days required for 50% germination:

Significant differences were observed among the treatments for days required to attain 50% germination. T_6 (GA_3 @ 150 ppm) recorded the minimum time of 9.30 days, followed by T_5 (GA_3 @ 100 ppm) with 10.20 days and T_8 (Thiourea @ 150 ppm) with 11.40 days. The maximum period of 18.10 days was recorded in the untreated control (T_0), indicating delayed and non-uniform germination. The reduction in days required for 50% germination under GA_3 treatments may be attributed to its role in breaking seed dormancy and promoting faster germination, whereas the beneficial effect of thiourea may be associated with enhanced metabolic activity. Similar reductions in germination time following application of plant growth regulators have been reported by

Kim *et al.* (2019), Yadav and Singh (2019), Kumar *et al.* (2020) and Lawhale *et al.* (2020) [4, 5, 10].

Germination percentage

Pre-sowing treatments significantly influenced the final germination percentage of bael seeds. The highest germination percentage was recorded in T_6 (GA_3 @ 150 ppm) with 86.70%, followed by T_5 (GA_3 @ 100 ppm) with 84.48% and T_8 (Thiourea @ 150 ppm) with 81.68%. The treatments involving IBA, NAA and salicylic acid also improved germination over the control, with values ranging from 63.02 to 76.33%. The lowest germination percentage was recorded in the control (T_0) with 57.44%. The improvement in germination percentage under GA_3 treatment may be attributed to its role in breaking seed dormancy and enhancing enzymatic activity, thereby promoting faster and more uniform germination. The beneficial response to thiourea may be associated with enhanced metabolic activity and its role in overcoming dormancy. The present findings are in agreement with Lawhale *et al.* (2020) and Kumar *et al.* (2020) [4], while Govind *et al.* (2024) [3, 5] also reported higher germination percentage with GA_3 treatments in bael.

Survival

The survival percentage of bael seedlings under shade net house conditions was significantly influenced by different plant growth regulators and chemicals. Among all the treatments, the highest survival percentage was recorded in T_6 (GA_3 @ 150 ppm) with 91.33 percent, followed by T_5 (GA_3 @ 100 ppm) with 88.70 percent and T_{12} (Salicylic acid @ 150 ppm) with 87.30 percent. In contrast, the lowest survival percentage (67.83) was observed in the control (T_0). The improved survival under GA_3 treatments may be attributed to its role in enhancing cell division and elongation, leading to vigorous seedling growth with better root and shoot development, which facilitates efficient uptake of water and nutrients. Salicylic acid treatments enhanced survival by improving stress tolerance, antioxidant activity, and membrane stability, thereby reducing seedling mortality. Similar results were also reported by Basra *et al.* (2007) [1] in Melon, Govind *et al.* (2024) and Mutum *et al.* (2024) [3, 7] in Bael. The present findings are in close agreement with Dhum *et al.* (2025) [2], who reported improved survival in acid lime with seed priming treatments.

Conclusion

Overall, among the different pre-sowing treatments, GA_3 @ 150 ppm (T_6) was found most effective for improving germination behaviour of bael, as it recorded the earliest first germination (6.67 days), minimum days required for 50% germination (9.30 days), maximum germination percentage (86.70%) and maximum survival of plant (91.33 percent).

Table 1: Effect of different plant growth regulators and chemicals on number of days required for 1st germination, days required for 50% germination, germination percentage and survival percentage of bael under shade net house.

Treatments	number of days required for 1 st germination	days required for 50% germination	germination percentage	Survival percentage
T_0 (Control)	14.33	18.10	57.44	67.83
T_1 (IBA @ 100 ppm)	12.08	15.20	70.93	76.60
T_2 (IBA @ 150 ppm)	10.75	13.80	73.56	80.40
T_3 (NAA @ 100 ppm)	11.38	14.90	72.44	74.53

T ₄ (NAA @ 150 ppm)	10.40	13.60	74.61	77.70
T ₅ (GA ₃ @ 100 ppm)	7.33	10.20	84.48	88.70
T ₆ (GA ₃ @ 150 ppm)	6.67	9.30	86.70	91.33
T ₇ (Thiourea @ 100 ppm)	11.03	14.30	73.67	82.43
T ₈ (Thiourea @ 150 ppm)	8.37	11.40	81.68	85.93
T ₉ (KNO ₃ @ 100 ppm)	12.03	15.90	63.02	78.47
T ₁₀ (KNO ₃ @ 150 ppm)	11.70	15.20	66.01	81.53
T ₁₁ (Salicylic Acid @ 100 ppm)	11.37	14.80	68.34	84.10
T ₁₂ (Salicylic Acid @ 150 ppm)	9.63	12.90	76.33	87.30
SEm±	0.28	0.20	1.07	1.10
CD (p = 0.05)	0.83	0.58	3.12	3.21
CV (%)	4.74	2.54	2.55	2.34

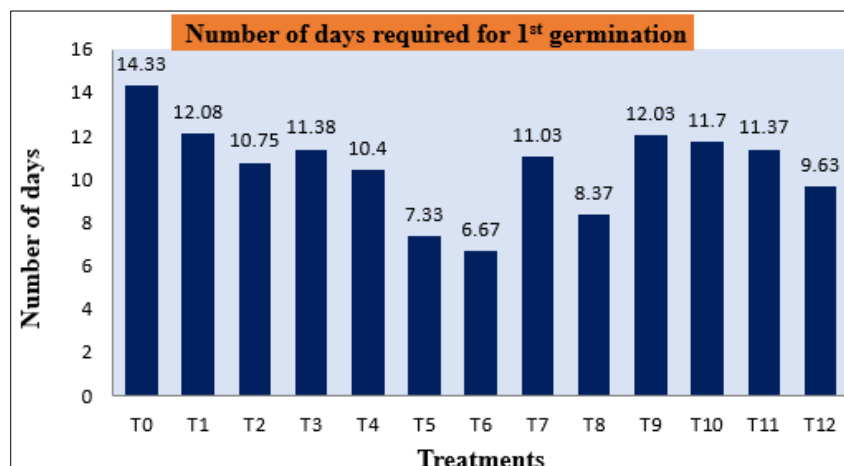


Fig 1: Effect of different plant growth regulators and chemicals on number of days required for 1st germination of bael under shade net house

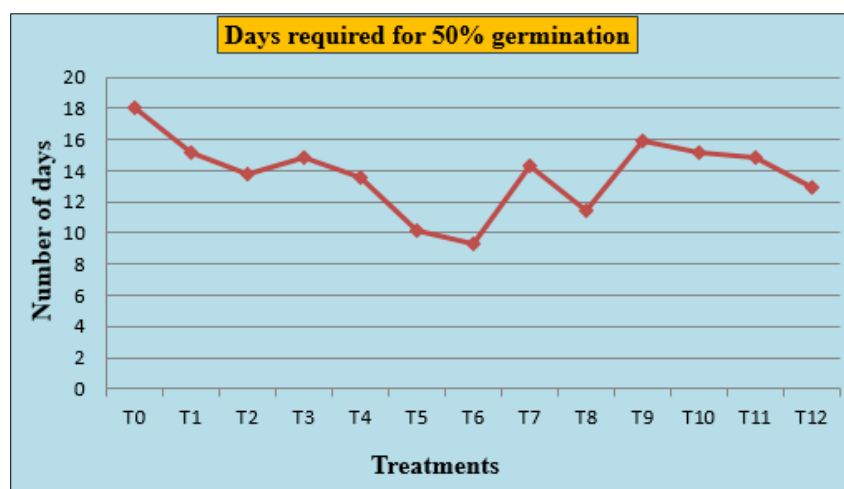


Fig 2: Effect of plant growth regulators and chemicals on days required for 50 germination of bael under shade net house

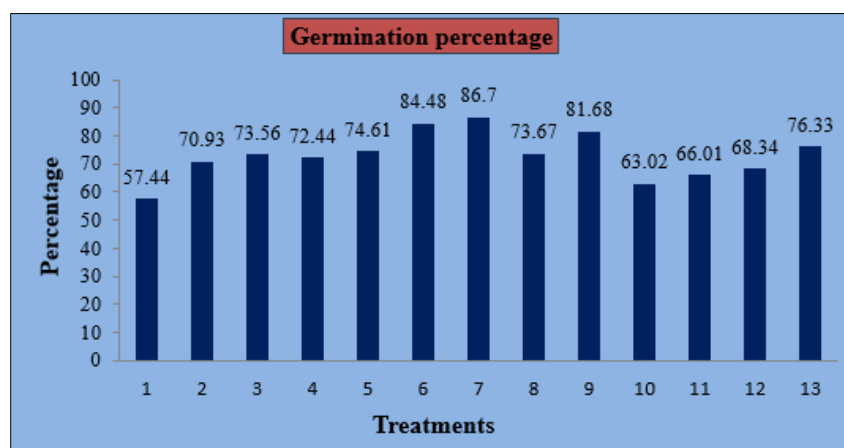


Fig 3: Effect of different plant growth regulators and chemicals on germination Percentage of bael under shade net house

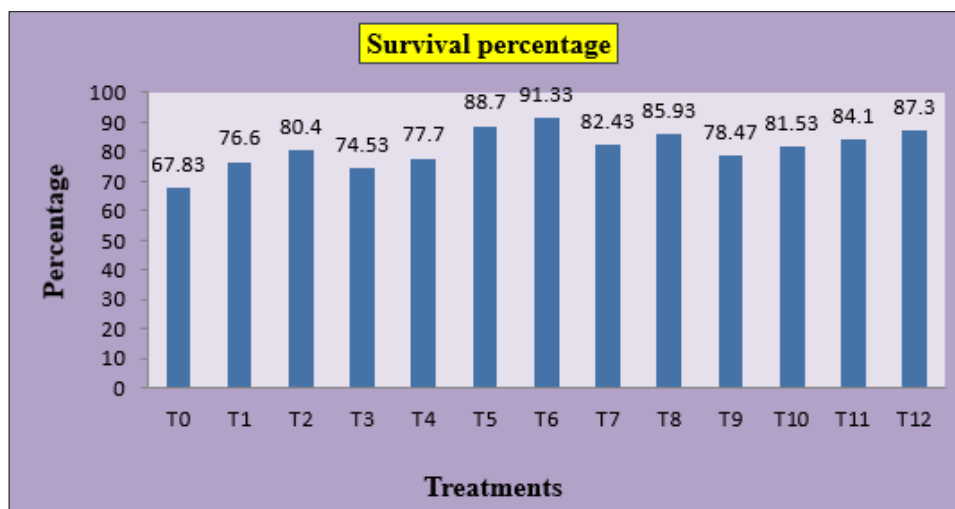


Fig 4: Effect of plant growth regulators and chemicals on survival percentage in bael under shade net house

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