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Optimizing Seed Germination in Fresh and Aged Guava (*Psidium guajava* L.) Seeds Using Different Chemicals Scarification Treatments

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Abstract

The present investigation was conducted during 2024–2025 at the Horticulture Laboratory of Shree Guru Gobind Singh Tricentenary University, Gurugram (Haryana). The study evaluated the influence of various pre-sowing treatments, including water soaking, hot water soaking (70° C and 80° C),

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sulphuric acid (10% and 20%), gibberellic acid (GA) @200 ppm and 400 ppm, and thiourea (@1000 ppm and 2000 ppm), on seed germination and seedling growth parameters in both fresh and one-year-old guava seed lots. The data were recorded on standard germination percentage, days to emergence of seedling, mean germination time, survival percentage, seedling length, seedling dry weight, vigour indices- I and II and speed of germination. The results revealed that GA at 400 ppm for 24 hours consistently outperformed other treatments, recording the highest germination percentage (57.61% in fresh seeds and 50.56% in one-year-old seeds), minimum days to emergence (17 and 20.33 days, respectively), maximum survival percentage (59.67% and 54.00%), longest seedling length (5.60 cm and 4.20 cm), and greatest seedling dry weight (328.00 mg and 281.00 mg). This treatment also enhanced vigour indices- I and II and speed of germination. GA at 200 ppm and thiourea at 1000 ppm also showed promising results, though inferior to GA3 at 400 ppm. The findings demonstrate that pre-sowing seed treatment with GA (400 ppm) is highly effective in improving germination and seedling growth of guava seeds, thereby offering a practical strategy for enhancing seedling establishment in nurseries.

Keywords: Guava; seed germination; pre-sowing treatment; gibberellic acid; seed vigour; seedling growth.

1. Introduction

Guava (*Psidium guajava* L.), a member of the family Myrtaceae, is a small to medium-sized fruit tree native to tropical America, particularly Mexico and Peru (Somya et al., 2025). In India, it ranks fifth among fruit crops after mango, banana, papaya, and citrus, and is widely known as the “Apple of the Tropics” due to its affordability and year-round availability (Singh, 2011). India is the world’s largest producer, contributing nearly 45% of global guava output, with major cultivation in Uttar Pradesh, Bihar, Madhya Pradesh, and Haryana (NHB, 2023). In 2023–24, Haryana produced about 183,643 metric tonnes of guava from 16,750 hectares, with Allahabad Safeda, Hisar Safeda, Hisar Surkha, and Sardar as prominent cultivars (NHB, 2023). The crop plays a significant role in the state’s fruit economy, generating employment and supporting processing industries (Sharma et al., 2022).

Guava is valued for its high vitamin C content, dietary fiber, pectin, minerals, and antioxidants, making it important for both nutrition and processing into products such as jelly, jam, and nectar. Although commercial propagation relies mainly on vegetative methods like air layering and grafting, seed propagation remains essential for raising rootstocks (Boricha et al., 2020). However, guava seeds exhibit physical dormancy due to a hard seed coat and have short viability, which results in delayed germination and poor seedling establishment (Nonogaki, 2014). Since raising healthy rootstocks is vital for vegetative propagation in Haryana’s expanding guava orchards, pre-sowing treatments such as soaking, scarification, and growth regulators are needed to improve germination and seedling vigor (Jhade, 2018).

Pre-sowing treatments, including soaking, acid scarification, growth regulators, and chemicals, have been applied to improve seed germination and seedling vigor. The present study was therefore undertaken to assess the effects of different pre-sowing seed treatments on germination, seedling growth, and seed quality of guava seeds of varying ages.

2. Material and Methods

The laboratory experiments were conducted at the Horticulture Laboratory, Faculty of Agricultural Sciences, Shree Guru Gobind Singh Tricentenary University, Gurugram, Haryana, India (28º27’ N, 77º00’ E) situated at 217 m above mean sea level during 2024–25.

Seeds of wild guava (*Psidium guajava* L.) of two age groups, *viz*. fresh and one-year-old, were used for the study. Healthy seeds were extracted from ripe fruits, separated from fleshy mesocarp, thoroughly washed, shade dried to about 12–15% moisture, and stored in cloth bags under room conditions. Before treatment, the seeds were immersed in 1% NaOCl solution for 10 min, rinsed thoroughly in running water for 3 min, and surface dried. The experiment was laid out in Completely Randomized Design (CRD) with ten treatments replicated thrice. Each treatment consisted of 30 seeds per replication. The treatments were: untreated control (T_1), water soaking for 48 h (T_2), hot water soaking at 70°C (1 min, T_3), hot water soaking at 80°C (1 min,

T_4), sulphuric acid quick dip at 10% (T_5) and 20% (T_6), GA_3 soaking @ 200 ppm (24 h, T_7), GA_3 @ 400 ppm (24 h, T_8), thiourea @ 1000 ppm (24 h, T_9) and thiourea @ 2000 ppm (24 h, T_{10}). After treatments, seeds were thoroughly washed with tap water to remove residues.

For standard germination test, 30 seeds of each treatment in three replicates were placed in moist sand medium and kept at 27 ± 1°C with 80–85% RH in a seed germinator. Germination count was recorded at regular intervals up to 30 days, and normal seedlings were considered as per ISTA (2001) rules. Mean germination time (MGT) was calculated using the formula of Ranal and Santana, (2006). Seedling length was measured from 10 randomly selected normal seedlings, and dry weight was recorded after oven drying at 65 ± 2°C for 48 h.

3. Results and Discussion

Standard germination (%): Different pre-sowing seed treatments significantly influenced the germination percentage of guava seeds of both ages (fresh and one-year-old). Germination ranged from 38.6% to 57.6% in fresh seeds and 30.7% to 50.6% in one-yearold seeds. The maximum germination (57.6%) was observed with soaking in GA_3 @ 400 ppm for 24 h, which was statistically at par with GA_3 @ 200 ppm, whereas the minimum was recorded in control (38.6%). Similar trends were observed in aged seeds where GA_3 @400ppm recorded 50.6% germination as shown in the Table 1 given below. The improvement under GA_3 treatments may be attributed to enhanced enzymatic activity, particularly the activation of α-amylase, leading to efficient mobilization of stored food reserves. These findings agree with a recent study reporting improved germination of guava and papaya seeds following GA_3 treatment.

Days to emergence of seedlings: The number of days required for seedling emergence was reduced significantly under GA_3 treatments. The earliest emergence (17.0 days for fresh seeds and 20.3 days for aged seeds) was recorded in GA_3 @400ppm (Table 1), while the maximum days (25.0 and 30.0, respectively) were recorded in control. Faster emergence in GA_3 -treated seeds might be due to its role in promoting cell elongation and early radicle protrusion (Taiz et al., 2015).

Mean germination time (MGT): Mean germination time decreased with pre-sowing treatments. The lowest Mean germination time (14.0 and 16.0 days for fresh and aged seeds, respectively) was recorded in GA_3 @ 400 ppm, while the highest (24.0 and 25.0 days) was observed in the control as given in the Table 1. The reduced Mean germination time under GA_3 treatments suggests accelerated germination due to improved water uptake and enzymatic activity (Finch-Savage, 2006; Weitbrecht et al., 2011).

Table 1. Effect of treatments on standard germination %, days to emergence of seedling and mean germination time

Treatment Details	Germination (%)		Days to emergence		Mean germination time	
	Fres h	1yr old	Fresh	1yr old	Fresh	1yr old
Control	38.62	34.36	25.00	30.00	24.00	25.00
Water soaking for 48 hrs	46.36	44.73	19.67	25.67	17.33	18.67
Hot water soaking at 70°C for 1 min	42.91	41.59	21.67	27.33	20.00	20.67
Hot water soaking at 80°C for 1 min	44.56	43.89	21.00	27.00	18.67	19.67
10% Sulphuric acid treatment (Quick Dip)	39.89	36.37	24.67	29.00	23.33	23.67
20% Sulphuric acid treatment (Quick Dip)	41.10	39.39	22.67	28.33	21.67	22.00
Soaking in GA_3 @ 200 ppm for 24 hrs	56.07	49.46	17.67	21.00	14.67	16.67
Soaking in GA_3 @ 400 ppm for 24 hrs	57.61	50.56	17.00	20.33	14.00	16.00
Soaking in thiourea @ 1000 ppm for 24 hrs	51.96	48.46	18.00	21.67	15.33	17.33
Soaking in thiourea @ 2000 ppm for 24 hrs	49.84	46.77	19.00	24.00	16.33	18.00
C.D. @ 5%	2.38	1.21	0.70	1.04	0.99	0.77

Seedling survival (%): Seedling survival percentage ranged between 30.0% and 59.7% in fresh seeds, and 24.7% to 54.0% in aged seeds (Table 2). The maximum survival was noted in GA_3 @ 400 ppm, while the control recorded the minimum. Higher survival in GA_3 treated seeds could be linked to stronger seedlings with better root systems, enabling higher establishment (Taiz et al*.,* 2015; Hussain et al*.,* 2016).

Seedling length (cm): Significant variation was observed in seedling length across treatments as presented in Table 2. Fresh seeds treated with GA_3 @ 400 ppm for 24 h, produced the longest seedlings (5.60 cm), followed by GA_3 @ 200 ppm (5.43 cm), while the shortest seedlings (3.03 cm) were in the control. Aged seeds showed similar results. The stimulatory effect of GA_3 on cell elongation and division could explain increased seedling length (Yamaguchi, 2008).

Seedling dry weight (mg): Seedling dry weight ranged from 186.0 mg to 328.0 mg in fresh seeds and 154.0 mg to 296.0 mg in aged seeds. The highest values were recorded in GA_3 @ 400 ppm, while control showed the lowest (Table 2). This increase may be attributed to better biomass accumulation through enhanced photosynthetic activity and assimilate distribution (Arteca, 1996; Bewley et al.,2013).

Vigour Index – I: The results (Table 3) indicated that pre-sowing treatments significantly influenced Vigour Index – I of guava seeds. The highest values were recorded with soaking seeds in GA_3 @ 400 ppm for 24 hrs (205.00 in fresh seeds and 105.67 in one-year-old seeds), which was statistically comparable with soaking in GA_3 @ 200 ppm for 24 hrs and soaking in thiourea @ 1000 ppm for 24 hrs. The lowest values (136.00 and 87.00, respectively) were obtained under the control. These results clearly demonstrate the positive role of GA_3 pre-soaking in enhancing seedling vigour by improving germination and growth performance, even in aged seed lots.

Vigour Index – II: Data presented in Table 3 showed that Vigour Index – II was also significantly affected by pre-sowing treatments. The maximum values were obtained with soaking seeds in GA_3 @ 400 ppm for 24 hrs (11,923.00 in fresh seeds and 7,493.00 in oneyear-old seeds), which remained statistically at par with soaking in GA_3 @ 200 ppm for 24 hrs. The lowest vigour indices (7,153.00 and 5,857.33, respectively) were recorded in the control. The superiority of GA_3 treatments can be attributed to improved germination, greater shoot elongation, and enhanced metabolic activity, which facilitated efficient utilization of food reserves (Kucera et al*.,* 2005; Copeland, 2001, Abdul-Baki, and Anderson, 1973). These results are consistent with earlier findings in aonla papaya, Indian gooseberry (Rinku et al*.,* 2019), tamarind and khirni (Ratna et al*.,* 2018).

Speed of germination: The speed of germination was improved under GA_3 treatments, with GA_3 @ 400 ppm recording the maximum values (1.88 and 1.78 for fresh and aged seeds, respectively) compared to the control (0.78 and 0.61) as shown in Table 3. This suggests rapid and uniform germination in GA_3 -primed seeds. The faster germination under GA_3 treatment may be attributed to its role in stimulating hydrolytic enzyme activity, particularly amylases, which accelerate the breakdown of stored food reserves into simpler forms readily utilized by the

Table 2. Effect of treatments on seedling survival %, seedling length and seedling dry weight

Treatment details	Survival %		Seedling length		Seedling dry wt.	
	Fresh	1yr old	Fresh	1yr old	Fresh	1yr old
Control	30.00	24.67	4.50	3.80	284.00	257.00
Water soaking for 48 hrs	42.67	43.00	5.33	4.13	316.00	271.67
Hot water soaking at 70°C for 1 min	38.67	36.00	5.14	4.04	311.00	267.33
Hot water soaking at 80°C for 1 min	40.33	40.67	5.26	4.11	313.67	269.33
10% H_2SO_4 treatment (Quick Dip)	33.00	28.00	4.63	3.83	288.00	259.00
20% H_2SO_4 treatment (Quick Dip)	36.00	32.33	4.83	3.95	305.00	264.00
Soaking in GA_3@200ppm for 24 hrs	55.67	52.00	5.56	4.18	325.33	279.33
Soaking in GA_3@400ppm for 24 hrs	59.67	54.00	5.60	4.20	328.00	281.00
Soaking in thiourea @1000ppm for 24hrs	50.33	49.67	5.44	4.17	321.00	277.67
Soaking in thiourea @2000ppm for 24hrs	45.67	46.67	5.38	4.15	318.33	275.00
C.D. at 5%	1.91	2.34	0.09	0.04	2.43	1.17

Table 3. Effect of treatments on vigour index – I and II and speed of germination.

Treatment details	Vigour Index – I		Vigour Index – II		Speed of germination	
	Fresh	1yr old	Fresh	1yr old	Fresh	1yr old
Control	136.00	87.00	7,153.00	5,857.33	1.72	1.53
Water soaking for 48 hrs	192.33	97.67	10,555.33	6,889.00	1.80	1.54
Hot water soaking at 70°C for 1 min	179.33	94.33	10,036.67	6,421.33	1.75	1.58
Hot water soaking at 80°C for 1 min	187.67	96.33	10,218.67	6,573.00	1.78	1.64
10% H_2SO_4 treatment (Quick Dip)	149.33	88.00	8,274.33	5,937.67	1.73	1.61
20% H_2SO_4treatment (Quick Dip)	165.00	91.33	9,838.33	6,226.33	1.84	1.57
Soaking in GA_3 @ 200 ppm for 24 hrs	203.00	103.67	11,615.33	7,376.33	1.86	1.75
Soaking in GA_3 @ 400 ppm for 24 hrs	205.00	105.67	11,923.00	7,493.00	1.88	1.78
Soaking in thiourea @1000 ppm for 24 hrs	200.33	101.33	11,229.67	7,280.33	1.83	1.72
Soaking in thiourea @2000 ppm for 24 hrs	198.00	100.00	10,990.00	7,154.67	1.81	1.67
C.D. at 5%	6.53	2.66	376.41	104.52	0.03	0.03

embryo. In addition, GA enhances cell elongation and reduces mechanical resistance of seed coverings, thereby promoting quicker radicle protrusion and uniform seedling emergence.

4. Conclusion

The pre-sowing chemical scarification significantly enhanced germination, seedling growth, and vigour in both fresh and one-year-old guava (*Psidium guajava* L.) seeds. Gibberellic acid (GA_3) at 400 ppm for 24 hours emerged as the most effective treatment, promoting the highest germination percentage, earliest emergence, greatest seedling survival, and superior vigour indices. The treatments with GA_3 at 200 ppm and thiourea at 1000 ppm also improved seed performance, though to a lesser extent. These results underscore the efficacy of GA_3 (400 ppm) as a practical intervention for optimizing seedling establishment in guava nurseries.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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