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Effect of Plant Growth Regulators (PGRs) on Flowering, Fruit Yield and Fruiting Parameters in Meadow Orchard of Guava *(Psidium guajava* L.*)* cv. Allahabad Surkha

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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 from August 2025 to February 2026 at the Research Field, Department of Horticulture, Naini Agricultural Institute, Faculty of Agriculture (FoA), Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, India, to study the effects of plant growth regulators (PGRs) on flowering, fruit yield, and fruiting parameters in the meadow orchard of guava (*Psidium guajava* L.) cv. Allahabad Surkha. The experiment was laid out in a randomised

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block design (RBD) with three replications and 13 (12 + 1) treatments: T0, control (water spray); T1, chlormequat chloride (CCC) at 300 ppm; T2, CCC at 350 ppm; T3, CCC at 400 ppm; T4, GA_3 at 50 ppm; T5, GA_3 at 75 ppm; T6, GA_3 at 100 ppm; T7, triacontanol at 3 ppm; T8, triacontanol at 5 ppm; T9, triacontanol at 10 ppm; T10, NAA at 200 ppm; T11, NAA at 250 ppm; and T12, NAA at 300 ppm. Significant treatment differences were observed for flowering, fruit yield, and fruiting parameters.
The results showed that the foliar application of T5 (GA_3 at 75 ppm) produced the most favourable flowering responses, including the earliest flower initiation (34.17 days), the highest number of flower buds per tree (140.00), the highest flower-bud retention (72.90%), the shortest flowering duration (18.20 days), and the highest number of flowers per shoot (9.80). Treatment T8 (triacontanol at 5 ppm) produced the highest fruit set (55.39%), fruit retention (50.83%), fruit yield per tree (12.49 kg), and fruit yield per hectare (156.13 q ha^{-1}). It also recorded the greatest polar length (6.76 cm), radial diameter (6.41 cm), fruit weight (111.61 g), fruit volume (105.62 ml), flesh thickness (1.70 cm), and pulp weight (107.62 g), together with the lowest seed weight (4.00 g) and 100-seed weight (2.81 g).

Keywords: Chlormequat chloride (CCC); Gibberellic Acid (GA3); triacontanol; Naphthalene Acetic Acid (NAA); plant growth regulator.

1. Introduction

Guava (*Psidium guajava* L.), popularly regarded as the 'Apple of the Tropics', occupies a prominent position among the fruit crops of India because of its nutritional attributes, wide adaptability, and economic potential. It belongs to the family Myrtaceae, which encompasses nearly 150 species of shrubs and small trees in the genus Psidium. Although approximately 20 species bear edible fruits, *P. guajava* L. is the most extensively cultivated and commercially important species because of its fruit quality, consumer preference, and processing potential (Radha & Mathew, 2007). It is native to tropical America and was introduced into India by the Portuguese in the seventeenth century. Guava is also known as the 'Poor Man's Apple' and is commercially cultivated throughout the tropical and subtropical regions of India. Its native range extends from Mexico to Peru, and its chromosome number is 2n = 22 (Radha & Mathew, 2007). The fruit is perishable and has a short postharvest shelf life at ambient temperature because of climacteric ripening and associated physicochemical changes. The phenological behaviour of guava is distinctive because the crop exhibits multiple flowering and fruiting cycles within a year. The flowering seasons are Ambebahar (February–March), Mrigbahar (June–July), and Hastbahar (October–November), corresponding to harvests during July–August, October–December, and February–April, respectively. Guava is predominantly harvested twice annually, during the rainy and winter seasons. This staggered production improves year-round availability and market relevance and may provide greater economic resilience to growers (Kumar et al., 2025). In addition to its use as a fresh table fruit, guava has considerable processing potential. Its high pectin content and characteristic flavour make it suitable for products such as jam, jelly, nectar, and guava slices (Radha & Mathew, 2007). Consequently, guava contributes to nutritional security, the fruit-processing sector, and the rural economy.

Flowering during April–May produces the rainy-season crop, whereas flowering during July–August produces the winter-season crop. Under Tarai conditions, guava trees produce approximately 90% of the crop during the rainy season, 8–9% during the winter season, and 1–2% during the spring season. Rainy-season fruits are generally of poorer quality and lower nutritive value and are more affected by insects, pests, and diseases. In contrast, winter-season guava fruits are superior in nutritional quality and taste. The number of people with diabetes in India is increasing, and guava is considered a suitable fruit for people with diabetes. Therefore, the quality of rainy-season fruits needs to be improved so that this crop can also be remunerative (Mishra et al., 2020).

Guava (*Psidium guajava* L.) cv. Allahabad Surkha is an important red-fleshed commercial cultivar of northern India, particularly in the Prayagraj (formerly Allahabad) region of Uttar Pradesh. The cultivar is known for its attractive apple-red skin, deep-pink pulp, pleasant aroma, sweetness, and high consumer preference. The trees are vigorous, compact, dome-shaped, and productive, and they produce large, uniform fruits with relatively few seeds under suitable management practices. The cultivar is valued for both fresh consumption and processing because of its fruit quality, vitamin C content, and appealing colour. Allahabad Surkha Guava is also registered as a Geographical Indication because of its distinctive quality attributes associated with the agro-climatic conditions of the Prayagraj region. These characteristics make Allahabad Surkha a suitable cultivar for evaluating the effects of plant growth regulators on flowering, fruiting, yield, and fruit quality under meadow-orchard conditions.

Allahabad Safeda forms the mainstay of the Indian guava industry because of its high yield, fruit quality, and broad market acceptance. Lalit, a cultivar suitable for both processing and table use, is also gaining popularity.

At the time of manuscript preparation, the official National Horticulture Board/Department of Agriculture & Farmers Welfare portal provided 2024–25 final estimates and 2025–26 advance estimates; state-wise final guava data for 2025–26 were not available (Department of Agriculture & Farmers Welfare, n.d.).

1.1 Physiological Basis of PGRs

- **GA_3:** Promotes cell elongation, floral induction, enzyme activation, and assimilate translocation, thereby contributing to earlier flowering and increased reproductive growth (Kapadnis & Singh, 2022; Yadav et al., 2026). Recent field evidence in guava further indicates that GA_3-based foliar treatments can influence yield and fruit-quality responses, whereas the magnitude of the response remains dependent on the treatment context (Masood et al., 2025).
- **Triacontanol:** Enhances photosynthesis, chlorophyll synthesis, antioxidant defence, nutrient uptake, and carbohydrate translocation, thereby improving fruit set, yield, and fruit quality (Khedr & Khedr, 2024; Kumar et al., 2024; Sharma et al., 2024). Recent evidence in young guava plants also shows that triacontanol can modify physiological and biochemical responses under defined stress conditions, supporting its physiological activity in this crop (Hussain et al., 2025).
- **CCC:** Restricts excessive vegetative growth by inhibiting gibberellin biosynthesis and diverts assimilates towards reproductive growth, thereby improving flowering efficiency (Yadav et al., 2026).
- **NAA:** Reduces flower and fruit drop by maintaining auxin balance and strengthening fruit attachment, thereby improving fruit retention and yield (Lanusungit et al., 2022). Field evidence from another fruiting horticultural crop likewise indicates that responses to GA_3 and NAA can vary with concentration and treatment combination, reinforcing the need for dose-specific evaluation (Naga et al., 2025).

Recent field evidence in guava indicates that responses to plant bioregulators are concentration-dependent and can influence yield, fruit quality, and economic performance (Sharma et al., 2024). Research in muskmelon likewise shows that the agronomic and economic outcomes of gibberellin-based treatments vary with regulator combinations and concentrations, supporting crop- and dose-specific field evaluation (Prasad et al., 2026). Broader evidence from fruit crops indicates that conventional and newer plant growth regulators, including triacontanol, may affect fruit set, yield, quality, and postharvest performance through distinct physiological pathways. Responses to triacontanol in pomegranate further demonstrate that crop and environmental conditions can influence treatment outcomes (Khedr & Khedr, 2024; Kumar et al., 2024). In guava, field evaluations of novel plant growth regulators have also reported treatment-dependent effects on yield and shelf-life traits, further supporting regulator-specific assessment under defined production conditions (Gupta et al., 2025). Recent work in *Psidium* further demonstrates that growth-regulator responses can vary among genotypes and seasons, providing additional support for cultivar- and environment-specific evaluation (Galvão et al., 2026).

1.2 Justification

The study entitled ‘Effect of Plant Growth Regulators (PGRs) on flowering, fruit set, fruit yield and biochemical attributes in the meadow orchard of guava (*Psidium guajava* L.) cv. Allahabad Surkha’ was undertaken because of important constraints in guava production. Although guava is a nutritionally rich and commercially valuable fruit, its cultivation is often affected by irregular flowering, low fruit set, and poor fruit quality, which reduce yield and profitability. Environmental stresses and suboptimal agronomic practices may further aggravate these constraints.

Plant growth regulators (PGRs) offer a potential means of influencing key physiological processes, including floral induction, fruit retention, and quality development. PGRs such as NAA, GA_3, and triacontanol may improve fruit set, reduce fruit drop, and enhance fruit size, sweetness, and shelf life. The present study therefore evaluated different PGR treatments to identify suitable concentrations for improving flowering, yield, and fruit quality, with the aim of enhancing productivity and profitability.

However, comparative evidence remains limited regarding the response of guava cv. Allahabad Surkha grown under a meadow-orchard system to CCC, GA_3, triacontanol, and NAA across the concentration ranges evaluated in the present study. In particular, their relative effects on flowering, fruit retention, yield, fruiting attributes, and treatment economics under the agro-climatic conditions of Prayagraj have not been sufficiently established. The present investigation was therefore designed to address this cultivar- and production-system-specific research gap.

1.3 Objective

- To study the effects of different plant growth regulators on the flowering, fruit yield, and quality of guava (*Psidium guajava* L.) cv. Allahabad Surkha.
- To determine the efficacy of the plant growth regulators and identify their optimum concentrations.
- To assess the economics of the different treatments.

2. Materials and Methods

The present investigation was conducted during 2025–2026 at the Research Field, Department of Horticulture, Naini Agricultural Institute (NAI), Faculty of Agriculture (FoA), Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj. Prayagraj District lies in the subtropical belt of south-eastern Uttar Pradesh and experiences very hot summers and cold winters. Uniform, healthy, bearing guava trees grown under similar cultural practices were selected for the study. A total of 39 trees of guava cv. Allahabad Surkha were selected for the experiment.

The experiment comprised 13 (12 + 1) treatments, each replicated three times in a randomised block design (RBD): T0, control (water spray); T1, chlormequat chloride (CCC) at 300 ppm; T2, CCC at 350 ppm; T3, CCC at 400 ppm; T4, GA_3 at 50 ppm; T5, GA_3 at 75 ppm; T6, GA_3 at 100 ppm; T7, triacontanol at 3 ppm; T8, triacontanol at 5 ppm; T9, triacontanol at 10 ppm; T10, NAA at 200 ppm; T11, NAA at 250 ppm; and T12, NAA at 300 ppm. The plots had a spacing of 2 × 4 m. The experimental field was 30.9 m long and 14.8 m wide, with a gross area of 457.32 m^2 and a net area of 312 m^2. Observations were recorded for flowering parameters, namely days to flower initiation, number of flower buds per tree, flower-bud retention (%), flowering duration (days), and number of flowers per shoot; fruit-yield parameters, namely fruit set (%), fruit retention (%), fruit yield per tree (kg), and fruit yield per hectare (q ha^{-1}); and fruiting parameters, namely polar length (cm), radial diameter (cm), fruit weight (g), fruit volume (ml), flesh thickness (cm), pulp weight (g), seed weight (g), and 100-seed weight (g).

3. Results and Discussion

The data on days to flower initiation presented in Table 1 showed that this parameter was significantly influenced by the foliar application of PGRs compared with the control. The fewest days to flower initiation (34.17 days) were recorded for T5 (GA_3 at 75 ppm), whereas the longest period (42.63 days) was recorded for T0, the control (water spray). Shirsat et al. (2021) reported a similar response in gaillardia, in which GA_3 at 200 ppm resulted in the earliest flower initiation. Kapadnis and Singh (2022) likewise reported that GA_3 promoted flowering and fruit setting in meadow-orchard guava. Yadav et al. (2026) also observed that the exogenous application of GA_3 improved flowering behaviour and vegetative growth in guava cv. Allahabad Safeda.

The number of flower buds per tree was significantly influenced by the foliar application of PGRs compared with the control. The highest number of flower buds per tree (140.00) was recorded for T5 (GA_3 at 75 ppm), followed by T6 (GA_3 at 100 ppm), T8 (triacontanol at 5 ppm), T9 (triacontanol at 10 ppm), T4 (GA_3 at 50 ppm), and T11 (NAA at 250 ppm). The lowest number (94.67) was recorded for T0, the control (water spray). These findings agree with those of Kapadnis and Singh (2022), who reported a significant increase in flowers and fruiting buds following GA_3 application in meadow-orchard guava. Kumar et al. (2025) also noted that the appropriate use of plant growth regulators can improve flowering intensity and reproductive efficiency in guava. Flower-bud retention was significantly influenced by the foliar application of PGRs compared with the control. The highest flower-bud retention (72.90%) was recorded for T5 (GA_3 at 75 ppm), whereas the lowest value (52.40%) was recorded for T0, the control (water spray). These findings are consistent with evidence that GA_3 application can improve flowering behaviour, fruit set, and retention in guava (Yadav et al., 2026). Kumar and Deen (2026) also reported that GA_3, applied either alone or in combination with micronutrients, increased fruit retention and reduced flower and fruit drop in guava cv. L-49. They attributed this response to enhanced endogenous auxin activity and reduced abscission of reproductive structures.

Flowering duration was significantly influenced by the foliar application of PGRs compared with the control. The shortest flowering duration (18.20 days) was recorded for T5 (GA_3 at 75 ppm), whereas the longest duration (26.40 days) was recorded for T0, the control (water spray). These results are consistent with reports that foliar GA_3 application influences flowering behaviour, fruit set, and fruit retention in guava (Kapadnis & Singh, 2022; Yadav et al., 2026). Kiran Sagar et al. (2024) similarly reported that GA_3 improved flowering and fruiting parameters in guava cv. Sardar under the Northern Dry Zone conditions of Karnataka, possibly by promoting floral differentiation and reproductive growth.

The highest number of flowers per shoot (9.80) was recorded for T5 (GA_3 at 75 ppm), whereas the lowest number (6.40) was recorded for T0, the control (water spray). The findings are consistent with those of Kapadnis and Singh (2022), who reported improved flowering and fruit setting following GA_3 application in meadow-orchard guava. Kiran Sagar et al. (2024) also observed improved flowering and fruiting characteristics in guava cv. Sardar following GA_3 application. The increase in the number of flowers per shoot may be associated with improved vegetative vigour, floral differentiation, hormonal balance, and assimilate translocation. Comparable responses were reported by Kumar and Deen (2026) and Yadav et al. (2026).

Fruit-yield attributes, including fruit set, fruit retention, fruit yield per tree, and fruit yield per hectare, were significantly influenced by the foliar application of chlormequat chloride, GA_3, triacontanol, and NAA compared with the control. The improved yield responses under the triacontanol treatment may be associated with increased photosynthetic activity, improved assimilate partitioning, and a more favourable source–sink relationship. Similar effects of plant bioregulators on the growth, yield, quality, and economic performance of guava have been reported by Sharma et al. (2024). Broader evidence indicates that triacontanol can influence reproductive growth, assimilate translocation, nutrient-use efficiency, and fruit quality through several physiological pathways (Khedr & Khedr, 2024; Kumar et al., 2024). Therefore, the increased fruit set, fruit retention, and yield recorded under T8 (triacontanol at 5 ppm) may have resulted from improved physiological efficiency and reproductive development.

The fruit-set data presented in Table 1 showed that fruit set was significantly influenced by the foliar application of PGRs compared with the control. The highest fruit set (55.39%) was recorded for T8 (triacontanol at 5 ppm), whereas the lowest fruit set (40.23%) was recorded for T0, the control (water spray).

Fruit retention was significantly influenced by the foliar application of PGRs compared with the control. The highest fruit retention (50.83%) was recorded for T8 (triacontanol at 5 ppm), followed by T9 (triacontanol at 10 ppm), T7 (triacontanol at 3 ppm), T6 (GA_3 at 100 ppm), T10 (NAA at 200 ppm), T5 (GA_3 at 75 ppm), T11 (NAA at 250 ppm), and T4 (GA_3 at 50 ppm). The lowest fruit retention (35.82%) was recorded for T0, the control (water spray).

Fruit yield per tree was significantly influenced by the foliar application of PGRs compared with the control. The highest fruit yield per tree (12.49 kg) was recorded for T8 (triacontanol at 5 ppm), whereas the lowest yield (7.72 kg) was recorded for T0, the control (water spray).

Fruit yield per hectare was significantly influenced by the foliar application of PGRs compared with the control. The highest fruit yield (156.13 q ha^{-1}) was recorded for T8 (triacontanol at 5 ppm), whereas the lowest yield (96.50 q ha^{-1}) was recorded for T0, the control (water spray). Triacontanol may also enhance antioxidant activity and reduce the abscission of reproductive organs. Comparable responses to plant bioregulators in guava were reported by Sharma et al. (2024).

The fruiting-parameter data presented in Table 1 showed that polar length was significantly influenced by the foliar application of PGRs compared with the control. The greatest polar length (6.76 cm) was recorded for T8 (triacontanol at 5 ppm), whereas the smallest value (4.94 cm) was recorded for T0, the control (water spray). Similar improvements in fruit dimensions following the application of plant growth regulators have been reported in guava (Singh et al., 2017).

Table 1. Effect of Plant Growth Regulators (PGRs) on flowering, fruit yield and fruiting parameters in Meadow orchard Guava (*Psidium guajava* L.) cv. Allahabad Surkha

Treatment Notion	Days to flower initiation	No. of flower bud per tree	Flower bud retention (%)	Flowering duration (Days)	Number of flowers per shoot	Fruit set (%)	Fruit retention (%)	Fruit yield per tree (kg)	Fruit yield (q ha-1)	Polar length (cm)	Radial diameter (cm)	Fruit weight (g)	Fruit volume (ml)	Flesh thickness (cm)	Pulp weight (g)	Seed weight (g)	100 Seed weight (g)
T_0	42.63	94.67	52.40	26.40	6.40	40.23	35.82	7.72	96.50	4.94	4.62	78.21	74.55	0.82	72.41	5.80	3.80
T_1	39.80	106.00	58.70	20.10	7.20	42.05	37.15	8.19	102.38	5.16	4.83	81.62	77.83	0.91	76.02	5.60	3.70
T_2	38.90	112.00	60.30	21.00	7.60	43.51	37.49	8.53	106.67	5.35	5.07	84.31	80.41	1.00	78.90	5.41	3.61
T_3	38.13	118.00	61.80	21.63	7.90	43.41	40.04	9.12	114.00	5.49	5.22	87.92	83.64	1.10	82.72	5.20	3.51
T_4	36.50	126.00	66.40	23.80	8.60	46.83	41.73	9.76	122.04	5.68	5.41	91.21	86.92	1.20	86.20	5.01	3.48
T_5	34.17	140.00	72.90	18.20	9.80	48.90	43.54	10.19	127.38	5.90	5.60	94.82	90.10	1.30	90.11	4.71	3.20
T_6	34.83	136.00	71.20	25.70	9.50	50.31	45.17	10.73	134.08	5.82	5.51	98.61	93.79	1.41	94.12	4.49	3.11
T_7	36.93	122.00	65.30	23.10	8.40	52.52	47.87	11.56	144.46	6.30	6.00	103.32	98.20	1.50	99.01	4.30	3.00
T_8	35.37	130.00	69.60	24.90	9.10	55.39	50.83	12.49	156.13	6.76	6.41	111.61	105.62	1.70	107.62	4.00	2.81
T_9	35.90	127.00	68.20	24.30	8.83	53.10	48.57	12.10	151.25	6.41	6.22	106.82	101.50	1.61	102.61	4.21	2.91
T_{10}	37.77	116.00	62.73	22.00	7.80	49.52	44.10	10.56	131.96	6.05	5.72	96.51	91.71	1.31	91.71	4.80	3.31
T_{11}	37.20	120.00	63.93	22.60	8.10	47.19	42.10	9.65	120.67	5.83	5.50	92.69	81.50	1.20	87.58	5.11	3.55
T_{12}	37.50	117.67	63.20	22.30	8.00	44.60	39.51	9.07	113.42	5.60	5.31	89.41	84.25	1.10	84.10	5.30	3.60
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Ed. (±)	**0.128**	**0.445**	**0.100**	**0.041**	**0.026**	**0.657**	**0.060**	**0.172**	**2.147**	**0.135**	**0.040**	**0.286**	**0.050**	**0.030**	**0.291**	**0.027**	**0.048**
C.D. at 0.05%	**0.265**	**0.918**	**0.207**	**0.084**	**0.054**	**1.357**	**0.123**	**0.354**	**4.431**	**0.278**	**0.083**	**0.591**	**0.104**	**0.062**	**0.600**	**0.056**	**0.100**

Radial diameter was significantly influenced by the foliar application of PGRs compared with the control. The greatest radial diameter (6.41 cm) was recorded for T8 (triacontanol at 5 ppm), whereas the smallest value (4.62 cm) was recorded for T0, the control (water spray).

Fruit weight was significantly influenced by the foliar application of PGRs compared with the control. The highest fruit weight (111.61 g) was recorded for T8 (triacontanol at 5 ppm), followed by T9 (triacontanol at 10 ppm) and T7 (triacontanol at 3 ppm). The lowest fruit weight (78.21 g) was recorded for T0, the control (water spray).

Fruit volume was significantly influenced by the foliar application of PGRs compared with the control. The highest fruit volume (105.62 ml) was recorded for T8 (triacontanol at 5 ppm), followed by T9 (triacontanol at 10 ppm), T7 (triacontanol at 3 ppm), T6 (GA_3 at 100 ppm), and T10 (NAA at 200 ppm). The lowest fruit volume (74.55 ml) was recorded for T0, the control (water spray). Similar improvements in fruit volume following the application of plant growth regulators have been reported in guava (Singh et al., 2017).

Flesh thickness was significantly influenced by the foliar application of PGRs compared with the control. The greatest flesh thickness (1.70 cm) was recorded for T8 (triacontanol at 5 ppm), followed by T9 (triacontanol at 10 ppm), T7 (triacontanol at 3 ppm), T6 (GA_3 at 100 ppm), T10 (NAA at 200 ppm), and T5 (GA_3 at 75 ppm). The lowest flesh thickness (0.82 cm) was recorded for T0, the control (water spray).

Pulp weight was significantly influenced by the foliar application of PGRs compared with the control. The highest pulp weight (107.62 g) was recorded for T8 (triacontanol at 5 ppm), followed by T9 (triacontanol at 10 ppm), T7 (triacontanol at 3 ppm), T6 (GA_3 at 100 ppm), T10 (NAA at 200 ppm), and T5 (GA_3 at 75 ppm). The lowest pulp weight (72.41 g) was recorded for T0, the control (water spray).

Seed weight was significantly influenced by the foliar application of PGRs compared with the control. The lowest seed weight (4.00 g) was recorded for T8 (triacontanol at 5 ppm), followed by T9 (triacontanol at 10 ppm), T7 (triacontanol at 3 ppm), T6 (GA_3 at 100 ppm), T5 (GA_3 at 75 ppm), and T10 (NAA at 200 ppm). The highest seed weight (5.80 g) was recorded for T0, the control (water spray).

The 100-seed weight was significantly influenced by the foliar application of PGRs compared with the control. The lowest 100-seed weight (2.81 g) was recorded for T8 (triacontanol at 5 ppm), followed by T9 (triacontanol at 10 ppm), T7 (triacontanol at 3 ppm), T6 (GA_3 at 100 ppm), T5 (GA_3 at 75 ppm), and T10 (NAA at 200 ppm). The highest 100-seed weight (3.80 g) was recorded for T0, the control (water spray). Comparable effects of plant growth regulators on guava fruit characteristics have been reported by Singh et al. (2017).

4. Limitations

The present investigation was conducted during a single cropping season under the agro-climatic conditions of Prayagraj, Uttar Pradesh, using only the guava cultivar Allahabad Surkha grown under a meadow-orchard system. The study evaluated selected concentrations of CCC, GA_3, triacontanol, and NAA for their effects on flowering, fruit yield, and fruiting parameters. However, the long-term effects of repeated PGR application, the influence of seasonal variation, economic feasibility, and effects on physiological, biochemical, and molecular characteristics were not investigated. The results should therefore be interpreted within the scope of the experimental conditions under which the study was conducted.

Future investigations may evaluate the combined use of plant growth regulators with micronutrients, organic manures, and biofertilisers to improve flowering, fruit yield, and fruit quality. Studies on the optimum timing and frequency of PGR application and their effects on fruit quality, shelf life, and economic returns may also support the development of practical production technologies for guava cultivation.

5. Conclusion

The present investigation demonstrated significant treatment differences in flowering, fruit yield, and fruiting parameters of guava (*Psidium guajava* L.) cv. Allahabad Surkha under the meadow-orchard conditions of Prayagraj. Among the treatments evaluated, T5 (GA_3 at 75 ppm) produced the most favourable flowering responses, with the earliest flower initiation (34.17 days), the highest number of flower buds per tree (140.00), the highest flower-bud retention (72.90%), the shortest flowering duration (18.20 days), and the highest number of flowers per shoot (9.80). In contrast, T8 (triacontanol at 5 ppm) produced the highest fruit set (55.39%), fruit retention (50.83%), fruit yield per tree (12.49 kg), and fruit yield per hectare (156.13 q ha^{-1}). This treatment also recorded the greatest values for polar length, radial diameter, fruit weight, fruit volume, flesh thickness, and pulp weight, together with the lowest seed weight and 100-seed weight. Thus, within the tested concentrations and experimental conditions, GA_3 at 75 ppm was the most effective treatment for flowering parameters, while triacontanol at 5 ppm was the most effective for fruit yield and fruiting parameters.

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Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, and reference formatting. These AI-assisted tools were not used as authors and did not replace the intellectual contributions or scholarly judgement of the author(s). All AI-assisted outputs, including content, references, and interpretations, were carefully reviewed, revised, verified, and approved by the author(s). The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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