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Effect of Foliar Feeding of Plant Growth Regulator and Nutrients on Phenological Attributes of Guava (*Psidium guajava* L.) cv Apple Colour

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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

Guava, (*Psidium guajava* L.), small tropical tree or shrub of the family Myrtaceae, cultivated for its edible fruits. Guava trees are native to tropical America and are grown in tropical and subtropical areas worldwide. Nutrients and PGR play a crucial role in flowering and fruit production and their deficiency can significantly impact the yield, productivity, and quality of fruits. Therefore, keeping these points in view, the present investigation was carried out on a 10-year-old guava plant in a high-density plantation (3x3) at the Fruit Research Station Imaliya, Department of Horticulture, J.N.K.V.V., Jabalpur (M.P.) during the mrig-bahar season of 2022-23. The study employed a Factorial Randomised Block Design (FRBD) with 20 treatment combinations involving Plant Growth Regulators (PGR) like salicylic acid and various nutrients, replicated three times. Results indicated that the combination of salicylic acid (200 ppm) + borax (0.5%) significantly influenced several phenological parameters. This treatment resulted in the earliest flower bud initiation (18.33 days) after foliar application, the highest average number of flower buds per shoot (7.05), minimum days to 50% flowering (33.67 days), maximum average number of flowers per shoot (6.95), the highest fruit set percentage (92.18%), the highest fruit retention percentage (81.23%), and the lowest fruit drop percentage (18.77%). The application of salicylic acid at 200 ppm in conjunction with borax at 0.5% (S_2 M_4) followed by salicylic acid at 300 ppm with borax at 0.5% (S_3 M_4) demonstrated exceptional efficacy in significantly optimizing phenological parameters when compared to the control.

Keywords: Flower; FRBD; foliar spray; nutrients; PGR; phenological attributes.

1. INTRODUCTION

Guava (*Psidium guajava* L.), a prominent fruit crop in tropical and subtropical regions, belongs to the Myrtaceae family. Originating from tropical America, specifically from Mexico to Peru, guava has grown in commercial importance across various countries. Introduced to India in the early 17th century, it has since become a widely cultivated commercial crop. Major guava-producing states in India include Uttar Pradesh, Madhya Pradesh, Bihar, Gujarat, Karnataka, Andhra Pradesh, and Maharashtra. India has a total guava cultivation area of 328,000 hectares, with an annual production of 4.8 million metric tonnes and a productivity rate of 24.2 metric tonnes per hectare. In Madhya Pradesh, specifically, the guava cultivation area spans 45,000 hectares, with a production of 820,000 metric tonnes and a productivity rate of 20.1 metric tonnes per hectare (NHB 2021,20,21,22,23).

Guava stands out among many other fruits due to its high commercial and nutritional value. It is an inexpensive and rich source of vitamin C, containing 2 to 5 times more vitamin C than fresh orange juice, with levels reaching 260 mg per 100 grams. Additionally, guava is a good source of pectin, a type of polysaccharide. The ripe fruit comprises 12.3-26.3% dry matter, 77.9-86.9% moisture, 0.511% ash, 0.10-0.70% crude fat, 0.82-1.45% crude protein, and 2.0-7.2% crude fiber [1].

In recent years, nutrient deficiencies in guava orchards across India have been linked to reduced yield and quality compared to international standards. Nutrients play a crucial role in fruit production, and their deficiency can significantly impact the yield, productivity, and quality of fruits. Among trace elements, zinc and boron are particularly important for the flowering and fruiting processes. These elements enhance fruit set, reduce fruit drop, and improve fruit quality in various crops [2]. Boron is essential for cell wall formation and reproductive development, while zinc influences auxin metabolism and protein synthesis, both of which are critical for optimal flowering and fruiting (Harsha et al., 2024).

Plant growth regulators (PGRs) function as essential messengers in plants, required in minute quantities to induce significant physiological changes, thereby enhancing crop productivity and quality. Salicylic acid (SA), a notable plant hormone, has demonstrated considerable effectiveness in influencing the flowering parameters of fruit crops. SA plays a critical role in the regulation of flowering by modulating various physiological processes, including the induction of flowering, flower retention, and overall floral development.

Research indicates that SA treatment can lead to earlier flower bud initiation, increased number of flower buds per shoot, and improved flower retention rates. For instance, studies have shown that SA application results in the early initiation of flower buds and a higher number of flowers per shoot, which directly impacts fruit set and overall yield [3,4]. Moreover, SA has been observed to enhance the plant's resistance to stress conditions, thereby supporting sustained flowering and fruiting under adverse conditions [5]. The basic concept of nutrient and plant growth regulators is the adjustment of plant nutrient supply to an optimum level for sustaining the desired crop productivity. The foliar application of nutrients and plant growth regulator plays a significant role in improving the phenological attributes of plants. Therefore, keeping these points in view, the present investigation entitled “Effect of foliar feeding of plant growth regulator and nutrients on phenological attributes of Guava (*Psidium guajava* L.) cv. Apple Colour” to be carried out during (2022-23) with the following objectives.

I. To evaluate the impact of PGR and nutrients on guava growth, yield, and quality of guava.
II. To find out the best combination and dose of PGR and nutrients on growth, yield, and quality of guava

2. MATERIALS AND METHODS

The experiment was conducted at the Fruit Research Station Imaliya, Department of Horticulture, J.N.K.V.V., Jabalpur (M.P.) on 10-year-old guava plants grown in a high-density (3x3) plantation during the mrig-bahar season of 2022-23. The trees were maintained with a consistent cultural regimen. The experimental design was a Factorial Randomized Block Design (FRBD) with 20 treatment combinations, each replicated three times. The study involved two factors: plant growth regulator (Salicylic acid) with four levels and nutrients with five levels. Plants were sprayed with varying concentrations of Salicylic acid (100, 200, and 300 ppm) and nutrients (KNO3 0.5%, ZnSO4 0.5%, Ca(NO3)2 2%, and Borax 0.5%), along with a control. Treatments were applied three times: before bud initiation, at the fruit setting stage, and post-pre-harvest stage. The treatment combinations used in the study are detailed in Table 1.

2.1 Data Collection

Phenological parameters for the guava plants were systematically recorded. Five new emerging uniform shoots, each measuring 30 cm in length, per tree were tagged to observe flower bud initiation, noting the date when the first flower bud appeared after treatment application. The number of buds per shoot was counted visually on these branches, and the mean value

Table 1. Various treatment combinations

S. No.	Notation	Treatment combination
1	$S_0 M_0$	Control
2	$S_0 M_1$	KNO_3 0.5 %
3	$S_0 M_2$	$ZnSO_4$ 0.5%
4	$S_0 M_3$	$Ca(NO_3)_2$ 2%
5	$S_0 M_4$	Borax 0.5%
6	$S_1 M_0$	Salicylic acid 100 ppm
7	$S_1 M_1$	Salicylic acid 100 ppm + KNO_3 0.5 %
8	$S_1 M_2$	Salicylic acid 100 ppm + $ZnSO_4$ 0.5%
9	$S_1 M_3$	Salicylic acid 100 ppm + Ca $(NO_3)_2$ 2%
10	$S_1 M_4$	Salicylic acid 100 ppm + Borax 0.5%
11	$S_2 M_0$	Salicylic acid 200ppm
12	$S_2 M_1$	Salicylic acid 200 ppm + KNO_3 0.5 %
13	$S_2 M_2$	Salicylic acid 200 ppm + $ZnSO_4$ 0.5%
14	$S_2 M_3$	Salicylic acid 200 ppm + $Ca(NO_3)_2$ 2%
15	$S_2 M_4$	Salicylic acid 200 ppm + Borax 0.5%
16	$S_3 M_0$	Salicylic acid 300 ppm
17	$S_3 M_1$	Salicylic acid 300 ppm + KNO_3 0.5 %
18	$S_3 M_2$	Salicylic acid 300 ppm + $ZnSO_4$ 0.5%
19	$S_3 M_3$	Salicylic acid 300 ppm + $Ca(NO_3)_2$ 2%
20	$S_3 M_4$	Salicylic acid 300 ppm + Borax 0.5%

was recorded. The days to 50% flowering were measured from the date of treatments application event based on visual observations of the tagged shoots. The total number of flowers per shoot at full bloom was counted, and the mean value was calculated. Fruit set percentage was determined by counting the initial number of fruits set per shoot and calculating the ratio to the total number of flowers. Fruit retention percentage was calculated by comparing the number of fruits at harvest to the initial fruit set. Fruit drop percentage was calculated using the formula: (Total number of fruit drops / Total number of fruit sets) × 100, as described by Sharma [6]. These measurements provided a thorough analysis of the effects of various treatments on the flowering parameters of guava plants.

3. RESULTS AND DISCUSSION

3.1 Effect of PGR

A critical assessment of the data indicated that there was statistically significant effect of individual PGR on days taken to flower bud initiation of guava. Different PGR helped in flowering parameters of guava. Result revealed that earliest days taken to flower bud initiation (19.67 days) after foliar application, the highest average number of flower buds per shoot (6.19), minimum days to 50% flowering (36.33 days), maximum average number of flowers per shoot (6.13), the highest fruit set percentage (81.58%), the highest fruit retention percentage (75.20%), and the lowest fruit drop percentage (24.80%)., was recorded in S_2 (salicylic acid 200 ppm), as compared to S_0 (control) i.e., during first year 2022-23.

3.2 Effect of Nutrients

Investigation revealed that various nutrients have a statistically significant impact on phenological attributes of guava. Result revealed that earliest days taken to flower bud initiation (18.92 days) after foliar application, the highest average number of flower buds per shoot (6.70), minimum days to 50% flowering (34.92 days), maximum average number of flowers per shoot (6.62), the highest fruit set percentage (86.85%), the highest fruit retention percentage (78.48%), and the lowest fruit drop percentage (21.52%)., was recorded in M_4 (borax 0.5%), as compared to S_0 (control) i.e., during first year 2022-23.

3.3 Interaction Effect

The interaction effect of various PGR concentrations and nutrient treatments on guava characteristics, as delineated in Table 2 and Fig. 1, revealed significant improvements. The application of (S_2 M_4) salicylic acid (200 ppm) + borax (0.5%) resulted in the highest observed values for earliest flower bud initiation (18.33 days) after foliar application, the highest average number of flower buds per shoot (7.05), minimum days to 50% flowering (33.67 days), maximum average number of flowers per shoot (6.95), the highest fruit set percentage (92.18%), the highest fruit retention percentage (81.23%), and the lowest fruit drop percentage (18.77%). These results were closely followed by the combination of salicylic acid (300 ppm and borax 0.5%), both showing superior performance compared to the control.

Salicylic acid (SA) significantly enhances flowering in fruit crops by acting as a key signalling molecule that influences gene expression, mitigates stress, and interacts with other plant hormones. Studies have demonstrated that SA promotes earlier and more synchronized flowering, improves flower quality, and increases resilience to environmental stresses such as frost and drought [7-9]. These effects lead to higher yields and better fruit quality in crops like apples, grapes, tomatoes, and guavas, making SA a valuable tool in modern agriculture [10,11]. For instance, SA-treated apple trees and grapevines show improved flowering and fruit set, directly benefiting commercial production and economic viability [8.9]. Thus, SA serves as a powerful enhancer of flowering in fruit crops, optimizing both productivity and quality.

Among all the nutrient treatments, Boron, in the form of borax, has emerged as a crucial micronutrient contributing to enhanced phenological parameters in plants. Several studies underscore its significance in promoting flowering attributes. For instance, research by Shorrocks [12] elucidated boron's pivotal role in pollen tube elongation, an essential process for successful fertilization and fruit set. Additionally, studies by Marschner [13] and Goldbach et al. [14] have highlighted boron's involvement in cell wall structure and function, which influences flower bud initiation and development. Moreover, boron's interaction with other nutrients, particularly calcium, has been shown to regulate flowering time and fruit development, as demonstrated by the work of Brown and Hu [15] and Shelp et al. [16]. Furthermore, boron's role in carbohydrate metabolism, as evidenced by studies such as those by O'Neill et al. [17-20], contributes to the availability of energy required

Table 2. Interaction effect of foliar spray of PGR and nutrients on some phenological growth and harvest characteristics of guava of (*Psidium guajava L.*) cv. Apple Colour

S. No.	Notation	Days to flower bud initiation after foliar application	Number of flower buds per shoot	Days to 50% flowering after foliar application	Average number of flowers per shoot	Fruit set %	Fruit retention %	Fruit drop %
1	S_0 M_0	23.667	4.73	43.333	4.64	65.68	65.24	34.76
2	S_0 M_1	20.667	5.54	38.333	5.48	74.15	70.42	29.58
3	S_0 M_2	20.000	5.85	37.000	5.74	77.84	73.80	26.20
4	S_0 M_3	21.667	5.28	40.000	5.28	72.00	68.28	31.72
5	S_0 M_4	19.667	6.12	36.333	6.12	80.35	74.84	25.16
6	S_1 M_0	22.667	4.95	41.667	4.80	68.23	65.86	34.14
7	S_1 M_1	20.000	5.76	37.667	5.66	75.84	73.04	26.96
8	S_1 M_2	19.000	6.38	35.667	6.24	83.68	77.76	22.24
9	S_1 M_3	20.667	5.46	38.667	5.36	74.00	69.94	30.06
10	S_1 M_4	19.000	6.66	35.333	6.54	85.60	78.23	21.77
11	S_2 M_0	22.000	5.14	40.333	5.14	69.45	66.68	33.32
12	S_2 M_1	19.333	6.25	35.667	6.15	81.30	75.46	24.54
13	S_2 M_2	18.667	6.73	34.667	6.73	87.94	79.14	20.86
14	S_2 M_3	20.000	5.76	37.333	5.68	77.05	73.48	26.52
15	S_2 M_4	18.333	7.05	33.667	6.95	92.18	81.23	18.77
16	S_3 M_0	21.000	5.34	38.667	5.28	72.74	69.22	30.78
17	S_3 M_1	19.667	6.05	36.667	5.86	78.66	74.16	25.84
18	S_3 M_2	19.000	6.46	35.333	6.46	85.00	78.12	21.88
19	S_3 M_3	20.333	5.66	37.667	5.66	75.00	72.28	27.72
20	S_3 M_4	18.667	6.95	34.333	6.86	89.25	79.62	20.38
SEm±		0.185	0.077	0.343	0.077	0.842	0.640	0.638
CD at 5%		0.530	0.220	0.983	0.219	2.410	1.833	1.828

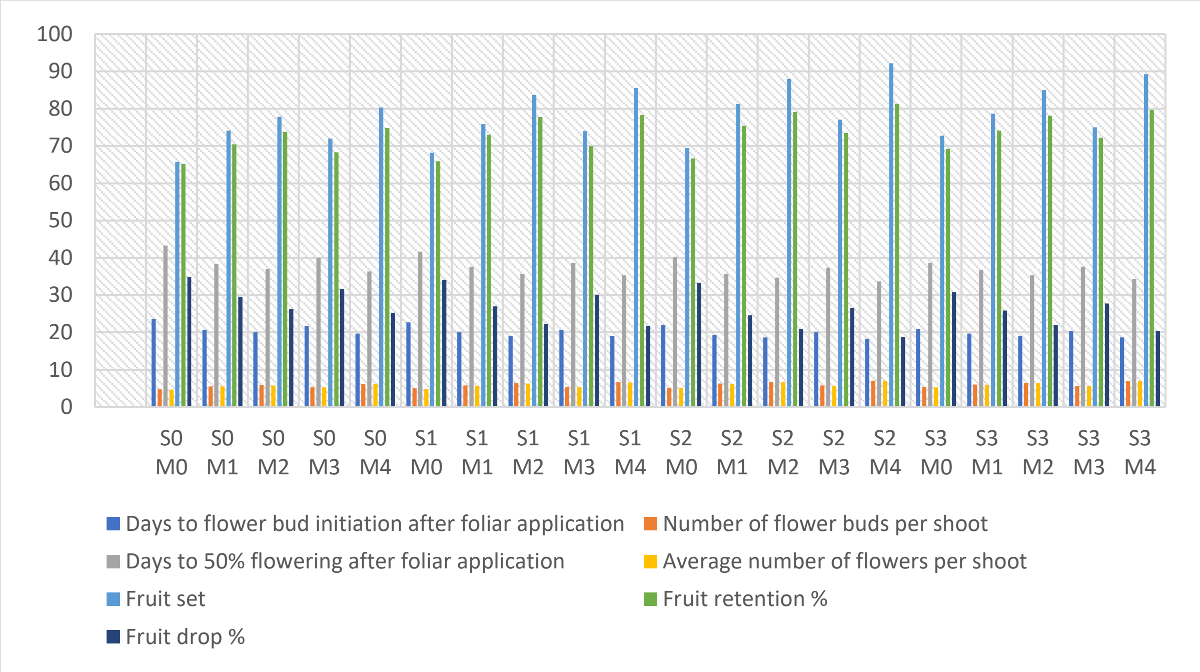

Fig. 1. Interaction effect of foliar spray of PGR and nutrients on some phenological growth and harvest characteristics of guava (*Psidium guajava L.*) cv. Apple Colour

for flowering processes. Overall, the collective findings suggest that borax supplementation can significantly enhance plant phenology by modulating various physiological processes critical for flowering and fruiting [21-23].

4. CONCLUSION

Foliar application of both plant growth regulators (PGRs) and nutrients emerged as a potent strategy for enhancing the phenological attributes of guava. Among the treatment combinations, the application of salicylic acid at 200 ppm in conjunction with borax at 0.5% (S_2 M_4) followed by salicylic acid at 300 ppm with borax at 0.5% (S_3 M_4) demonstrated exceptional efficacy in significantly optimizing phenological parameters when compared to the control.

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 manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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