Original Research Article

Effect of foliar feeding ofplant growth regulator and nutrients onphenological attributes of Guava (*Psidium guajava* L.) cv. Apple Colour.

ABSTRACT:

The experiment 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%). 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.

Key words: foliar spray, phenological attributes, flower, PGR, nutrients, FRBD

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 2022-23).

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 (Mitra and Bose, 2001).

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 (El. Sherif *et al*., 1997). 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 (Rahmani *et al*., 2017). Moreover, SA has been observed to enhance the plant's resistance to stress conditions, thereby supporting sustained flowering and fruiting under adverse conditions (Suman, Pency, Meghawal, & Sahu, 2017). 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.

2.0 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.

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%

2.0Data 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 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 (2004). These measurements provided a thorough analysis of the effects of various treatments on the flowering parameters of guava plants.

3.0 RESULTS AND DISCUSSION

The interaction effect of various PGR concentrations and nutrient treatments on guava characteristics, as delineated in Table 2 and figure 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.

The increase in flowering attributes of guava plants may be due to the role of salicylic acid (SA) as a vital signal for triggering flowering, alongside light and temperature influences. Studies have demonstrated that adding SA externally can prompt flower bud formation in tobacco callus and accelerate the shift from vegetative to reproductive growth in the long-day plant Lemna gibba (Lee TT *et al*., 1965; Cleland CF *et al*., 1982). Furthermore, supplying SA in liquid culture has been shown to stimulate flowering in Lemna gibba (Fu L *et al*., 2017). SA is crucial for flowering induction in various plant species; for example, stress-induced SA accumulation can speed up flowering in Arabidopsis and Lemna paucicostata (Wada KC *et al*., 2010). Mechanistically, SA suppresses a gene called FLOWERING LOCUS C (FLC) while activating key flowering genes like FLOWERING LOCUS T (FT), which then interact with other genes like SUPPRESSOR OF OVEREXPRESSION OF CONSTANS1 (SOC1) and APETALA1 (AP1) to promote flowering. These findings highlight the pivotal role of SA in regulating the flowering process by influencing gene expression pathways.

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 (1997) elucidated boron's pivotal role in pollen tube elongation, an essential process for successful fertilization and fruit set. Additionally, studies by Marschner (2012) and Goldbach et al. (2001) 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 (1996) and Shelp et al. (1999). Furthermore, boron's role in carbohydrate metabolism, as evidenced by studies such as those by O'Neill et al. (2004), contributes to the availability of energy required 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.

Table.2Interaction effect of foliar spray of PGR and nutrients on 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 % and Fruit drop % of guava (*Psidium guajava L.*) cv. Apple Colour.

S.No.	Notation	Days to flower bud initiation	Number of flower buds per	Days to 50% flowering	Average number of	Fruit set	Fruit retention %	Fruit drop %

		after foliar application	shoot	after foliar application	flowers per shoot	%		
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

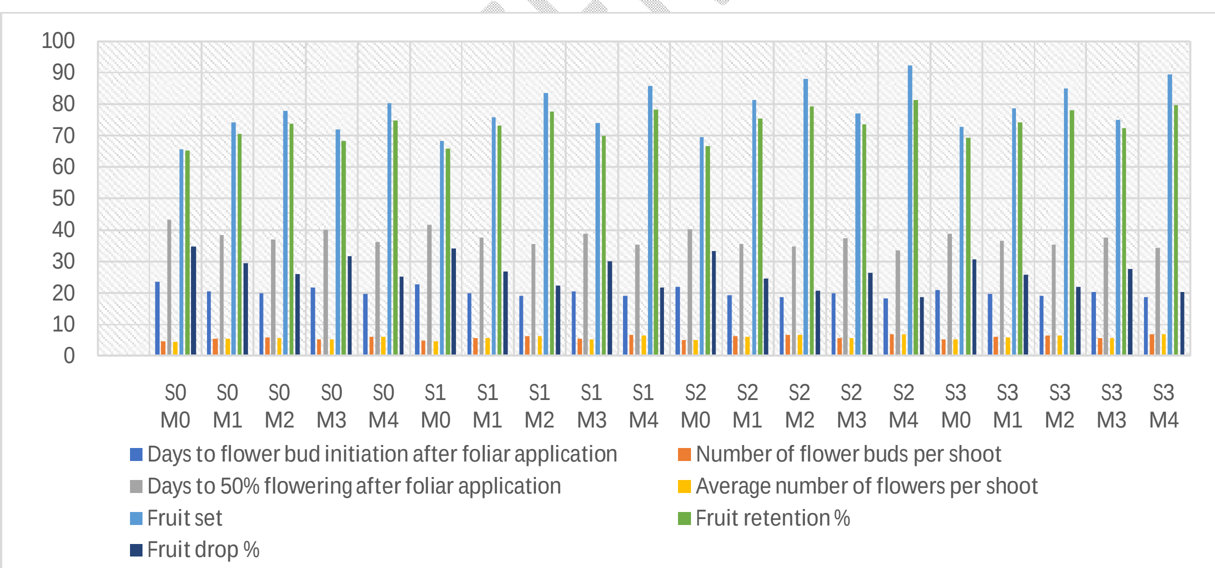

Fig. 1. Interaction effect of foliar spray of PGR and nutrients on Days to flower bud initiation after foliar application, Number of flower buds per shoot, Days to 50% flowering after foliar application, Average number of flowers per shoot, Fruit set %, Fruit retention % and Fruit drop % of guava (*Psidium guajava L.*) cv. Apple Colour.

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.

REFERENCES

AnonymousNational Horticulture Board database 2021. Ministry of agriculture government of India. 2022.

Brown, P. H., & Hu, H. Phloem mobility of boron is species dependent: evidence for phloem mobility in sorbitol-rich species. Annals of Botany. 1996;77(5), 497-505.

Cleland CF, Ben-Tal Y.Influence of giving salicylic acid for different time periods on flowering and growth in the long-day Plant Lemna gibba G3. Plant Physiology.1982; 70:287−90 23.

El-Sherif AA, Saeed WT, Nauman UF. Effect of foliar application of potassium and zinc on behaviour of montakhab E.L. Kanater guava true. Bull. Hort. Res. Ins. Gizd, Jat, G., & LAXMIDAS, K. H. (2014). Response of guava to foliar application of urea and zinc on fruit set, yield and quality. Journal of agrisearch.1997-1998;1(2).

Fu L, Huang M, Han B, Sun X, Sree S, et al. Flower induction, microscopeaided cross-pollination, and seed production in the duckweed Lemna gibba with discovery of a malesterile clone. Scientific Reports.2017; 7:3047

Goldbach, H. E., Wimmer, M. A., &Bangerth, F. Boron in plants and animals: Is there a role beyond cell-wall structure? Journal of Plant Nutrition and Soil Science.2001;164(2), 139-148.

Harsha, P. K. G., Raipuriya, S., Parihar, C., Dangi, J. P., Malik, V., Kantwa, R. C., &Sonaniya, P. Effect of foliar feeding of plant growth regulators and nutrients on morphological and yield attributing characteristics of guava (Psidium guajava L.) cv. Gwalior-27. Metabolism.2023;35,36.

Lee TT, Skoog F. Effects of substituted phenols on bud formation and growth of tohaceo tissue cultures. Physiologia Plantarum 1965; 18:386−402

Marschner, P. Mineral nutrition of higher plants. Academic Press.2012.

Mitra, S.K. and Bose, T.K. Fruits: Tropical & Sub tropical VI. Astral Publication Naya udyog, Calcutta, pp.2001; 610-611.

O'Neill, M. A., Eberhard, S., Albersheim, P., &Darvill, A. G. Requirement of borate cross-linking of cell wall rhamnogalacturonan II for Arabidopsis growth. Science. 2004;294(5543), 846-849.

Rahmani, A. H., Aldebasi, Y. H., & Khan, M. A.). The role of salicylic acid in plants. *Journal of Plant Sciences*. 2017;12(4), 214-225.

Rahmani, N., Ahlawat, T., Kumar, S., & Mohammadi, N. Improving productivity in Mango (Mangifera indica L.) cv. Kesar through foliar sprays of silicon and salicylic acid. *International Journal of Chemical Studies*. 2017;*5*(6), 1440-1443.

Sharma, J., Gupta, A. K., Kumar, C., & Gautam, R. K. S. Influence of zinc, calcium, and boron on vegetative and flowering parameters of gladiolus cv. Aldebran. *The Bioscan.* 2013;*8*(4), 1153-1158.

Shelp, B. J., Bown, A. W., & McLean, M. D. Metabolism and functions of gamma-aminobutyric acid. Trends in Plant Science.1999; 4(11), 446-452.

Shorrocks, V. M. The occurrence and correction of boron deficiency. Plant and Soil. 1997193(1-2), 121-148.

Suman, S., Pency, V. K., Meghawal, P. R., & Sahu, V. Plant growth regulators and their impact on fruit crops: A review. *International Journal of Agriculture and Biology*.2017;19(3), 533-542.

Wada KC, Yamada M, Shiraya T, Takeno K. Salicylic acid and the flowering gene FLOWERING LOCUS T homolog are involved in poor-nutrition stress-induced flowering of Pharbitis nil. Journal of Plant Physiology.2010; 167:447−52