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Influence of Foliar Spray of Plant Growth Regulator and Nutrients on Yield and Yield Attributing Traits on 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

The most substantial tropical and subtropical fruit crop in India is the guava (*Psidium guajava* L.), which is a member of the Myrtaceous family. It is indigenous to Tropical America, spanning from Mexico to Peru, and through time, many nations have turned to it as a commercially successful fruit crop. Nutrients and PGR play a crucial role in fruit growth and yield attributes their deficiency can significantly impact the yield, productivity, and quality of fruits. Therefore, keeping these points in view, the present investigationThe study was conducted on a 10-year-old guava plant orchard grown in a (3*3) high density plantation at the Fruit Research Station, Imaliya, Department of Horticulture, Jawaharlal Nehru Krishi Vishwavidyalaya (J.N.K.V.V.), Jabalpur (M.P.) during mrig-bahar 2022-23. The field experiment was designed using FRBD (Factorial randomized block design) and included 20 treatment combinations of PGR (salicylic acid) and various nutrients with three replications. The findings showed that among all the fruit development parameters, *i.e*., fruit length (6.89 cm), fruit width (7.62 cm), average fruit weight (238.50 g), fruit volume (215.50 ml), and specific gravity (1.11g/cc), were achieved greatest in the treatments combination of (Salicylic acid 300 ppm + KNO3 0.5%) and all the yield attributing characteristics *i.e*., number of fruits per plant (97.83 fruit), yield / plant (22.40 kg) and yield / hectare (248.86 qt). The highest value was found in the treatment combination (Salicylic acid 200 ppm + Borax 0.5%) followed by (Salicylic acid 200 ppm + $ZnSO_4$ 0.5%) as compare (control).

Keywords: Foliar spray; FRBD; morphological characteristics; nutrients; PGR; and yield.

1. INTRODUCTION

“Guava (*Psidium guajava* L.) is a significant tropical and subtropical fruit crop from the Myrtaceous family. It is native to tropical America, ranging from Mexico to Peru, and has steadily gained commercial relevance as a fruit crop in various nations. It was introduced to India in the early 17th century and has since become a commercial crop throughout the country. In India, guava is mainly grown in Uttar Pradesh, Madhya Pradesh, Bihar, Gujarat, Karnataka, Andhra Pradesh, and Maharashtra, with a total cultivated area of 3.08 lakh hectares, an annual production of 4582 thousand MT (NHB 2020-21), and productivity 23.7 metric tonnes per ha, whereas in Madhya Pradesh, the area, production, and productivity of guava is 41.69 thousand ha, 776.75 MT and 19.58 MT/ha, respectively” [1-5].

“Guava claims superiority over several other fruits because of its commercial and nutritional value. It is a rich and cheap source of vitamin C (2 to 5 times more than fresh orange juice *i.e*.,260mg/100g) and pectin (a polysaccharide substance). The ripe fruit contain 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 fibre” [6].

“In recent years Guava orchards in India showing nutrient deficiency and could be responsible for lesser yield and quality compared to international market. Nutrient play an important role in production and its deficiency leads in lowering the production, productivity, and quality of fruits. Among the trace elements, zinc and boron play significant role in flowering and fruiting process. Boron and zinc increase the fruit set reduce fruit drop and improve fruit quality in various fruit crops” [7]. “Calcium compounds extend the shelf-life of fruits by maintaining firmness, minimizing rate of respiration, protein breakdown, disintegration of tissues and disease incidence” [8]. “Potassium also stimulates the synthesis of chlorophyll and increased photosynthetic activity resulting in increased stored food material in the tissue leading in increase the size of fruits” [9].

“The plant growth regulators (PGR) act as messengers and needed in small quantities at low concentration. They enhance the rapid changes in physiological activity and improve crop productivity and quality. The use of plant growth regulators has resulted in some outstanding achievements in several fruit crops with respect to growth, yield, and quality” [10]. “Among these plant hormones, salicylic acid (SA) shown potential effectiveness in maintaining yield and morphological growth of fruits” [11]. “Fruit yield per plant is also attributed to fruit retention percentage. Thus, fruit yield per plant seems to be the combined effect on single fruit weight and number of fruits per plant” [12]. “Zinc sulphate is also helpful to increase fruit size and yield” [13].

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 vital role in improving the growth, yield, quality of fruits. Hence the present investigation is 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 yield attributing traits of guava.
II. To find out the best combination and dose of PGR and nutrients on growth, yield and yield attributing traits of guava.

2. MATERIALS AND METHODS

The experiment was carried out in the Fruit Research Station, Imaliya, Department of Horticulture, Jawaharlal Nehru Krishi Vishwavidyalaya, (J.N.K.V.V.), Jabalpur (M.P.) on 10-year-old guava plant under (3*3) high density plantation during mrig-bahar of 2022-23. Trees were maintained under uniform cultural schedule. The experimental was laid out in FRBD (Factorial randomized block design) comprising 20 treatment combinations and were replicated thrice. There were two factors, first is plant growth regulator (Salicylic acid) containing 4 level and second is nutrient which contains 5 levels. The plants were sprayed with different concentrations of plant growth regulator (Salicylic acid 100, 200 and 300 ppm), nutrients (KNO_3 0.5%, $ZnSO_4$ 0.5%, $Ca(NO_3)_2$ 2 % and Borax 0.5%) and control. Treatments were given thrice i.e., first, before bud initiation, second, at fruit setting stage and third after pre harvest stage. The following treatment combinations has been used, are presented in Table1.

2.1 Data Collection

The study evaluated the impact of various treatments on fruit characteristics and yield parameters. Fruit length was measured in centimeters from stem to calyx end using vernier calipers, while fruit width was recorded at the center of the fruit. The average fruit weight was determined by weighing five randomly selected fruits from each tree using an electric balance and calculating the mean. Fruit volume was measured via the water displacement method using a measuring cylinder, and specific gravity was computed by dividing the average fruit weight by the average fruit volume. The number of fruits per plant was determined by counting all mature fruits harvested from each tree. Yield per plant was recorded using an electric weighing machine, summing the weights of all harvested fruits. Yield per hectare was estimated by multiplying the average yield per plant by the total number of plants per hectare, calculated to be 1111 plants based on a planting density of 3 m x 3 m.

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%

3. RESULTS AND DISCUSSION

The interaction effect of various PGR concentrations and nutrient treatments on guava characteristics, as delineated in Table 2 and Fig. 1, revealed significant improvements as compare to control. The application of Salicylic acid at 300 ppm + KNO3 at 0.5% (S3 M1) resulted in the highest observed values for fruit length (6.89 cm), fruit width (7.62 cm), fruit weight (238.50 g), fruit volume (215.50 ml), and specific gravity (1.11 g/cc). Conversely, the control (S0 M0) recorded the lowest values for these parameters, with fruit length at 5.28 cm, fruit width at 6.14 cm, fruit weight at 177.90 g, fruit volume at 170.36 ml, and specific gravity at (1.04 g/cc).

The interaction effect of PGRs and nutrients, as detailed in Table 3 and Fig. 2, demonstrated significantly enhanced outcomes for the number of fruits per tree, yield per plant (kg), and yield per hectare (qt). The combination of Salicylic acid at 200 ppm + Borax at 0.5% (S2 M4) resulted in the highest number of fruits per tree (97.83), the highest yield per plant (22.40 kg), and the highest yield per hectare (248.86 qt). While, the control treatment (S0 M0) recorded the lowest values, with (73.84) fruits per tree, a yield per plant of (13.14 kg), and a yield per hectare of (145.99 qt).

The reason behind the increment of both morphological as well as yield attributing characteristics might be because of positive influence of salicylic acid on growth characteristics of guava are in agreement with those reported by Khodary et al. [14], Szepsi et al. [15], and Stevens et al. [16] on tomato, Gunes et al. [17] on maize, El-Tayeb et al. [18] on barley, Amin et al. [19] on onion, and Yildirim et al. [20] on cucumber. The positive effect of salicylic acid could explain that SA plays an important role in the regulation of several vital processes and growth in plants [21]. “As a natural phenolic compound in many plants, salicylic acid is an important component in the plant signal transduction pathway. It was reported that salicylic acid application promotes cell division and cell enlargement” [22,23].

Table 2. Interaction effect of foliar spray of PGR and nutrients on fruit length (cm), fruit width (cm), average fruit weight (g), fruit volume (ml) and specific gravity (g/cc) of guava (*Psidium guajava L.*) cv. Apple Colour.

S.No.	Notation	Fruit length (cm)	Fruit width (cm)	Average fruit weight (g)	Fruit volume (ml)	Specific gravity g/cc
1	S_0 M_0	5.28	6.14	177.90	170.36	1.04
2	S_0 M_1	6.12	6.72	212.10	195.60	1.08
3	S_0 M_2	6.05	6.72	205.70	190.25	1.08
4	S_0 M_3	5.52	6.35	184.10	173.68	1.06
5	S_0 M_4	5.81	6.60	195.60	181.20	1.07
6	S_1 M_0	5.36	6.25	180.50	172.42	1.04
7	S_1 M_1	6.47	7.16	221.30	201.80	1.09
8	S_1 M_2	6.31	6.88	218.40	199.52	1.09
9	S_1 M_3	5.68	6.40	187.50	174.95	1.07
10	S_1 M_4	5.88	6.64	198.90	186.24	1.08
11	S_2 M_0	5.45	6.32	181.20	173.10	1.05
12	S_2 M_1	6.78	7.46	231.60	208.50	1.11
13	S_2 M_2	6.55	7.30	225.80	205.60	1.10
14	S_2 M_3	5.75	6.48	190.40	177.46	1.07
15	S_2 M_4	6.25	6.78	214.50	198.56	1.08
16	S_3 M_0	5.63	6.38	185.40	174.23	1.06
17	S_3 M_1	6.89	7.62	238.50	215.50	1.11
18	S_3 M_2	6.81	7.55	235.50	211.95	1.11
19	S_3 M_3	5.76	6.52	194.20	181.10	1.07
20	S_3 M_4	6.69	7.35	226.40	206.50	1.10
SEm±		0.068	0.081	2.666	2.190	0.001
CD at 5%		0.195	0.231	7.634	6.270	0.002

Table 3. Interaction effect of foliar spray of PGR and nutrients on Number of fruits per plant), Yield per plant (kg), and Yield per hectare (qt) of guava (*Psidium guajava L.*) cv. Apple Colour

S.No.	Notation	Number of fruits per plant	Yield per plant (kg)	Yield per hectare (q)
1	S_0 M_0	73.84	13.14	145.99
2	S_0 M_1	78.25	15.62	173.54
3	S_0 M_2	84.74	17.11	190.09
4	S_0 M_3	76.12	14.62	162.43
5	S_0 M_4	87.11	17.45	193.87
6	S_1 M_0	74.58	14.00	155.54
7	S_1 M_1	80.55	16.00	177.76
8	S_1 M_2	91.24	18.77	208.53
9	S_1 M_3	77.20	15.20	168.87
10	S_1 M_4	92.28	19.64	218.20
11	S_2 M_0	75.35	14.24	158.21
12	S_2 M_1	88.74	18.00	199.98
13	S_2 M_2	96.71	21.24	235.98
14	S_2 M_3	83.24	16.74	185.98
15	S_2 M_4	97.83	22.40	248.86
16	S_3 M_0	76.95	15.02	166.87
17	S_3 M_1	90.38	18.21	202.31
18	S_3 M_2	92.80	20.12	223.53
19	S_3 M_3	82.64	16.22	180.20
20	S_3 M_4	94.47	20.65	229.42
SEm±		1.193	0.393	4.371
CD at 5%		3.416	1.126	12.513

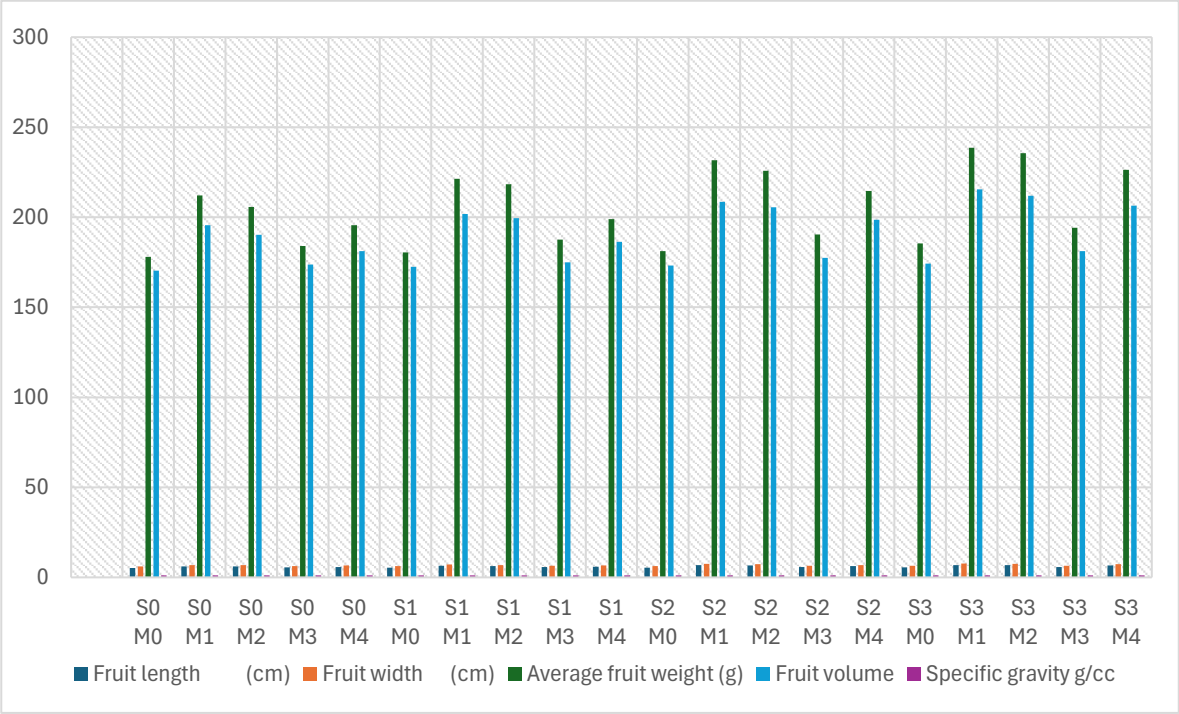

Fig. 1. Interaction effect of foliar spray of PGR and nutrients on fruit length (cm), fruit width (cm), average fruit weight (g), fruit volume (ml) and specific gravity (g/cc) of guava (*Psidium guajava L.*) cv. Apple Colour

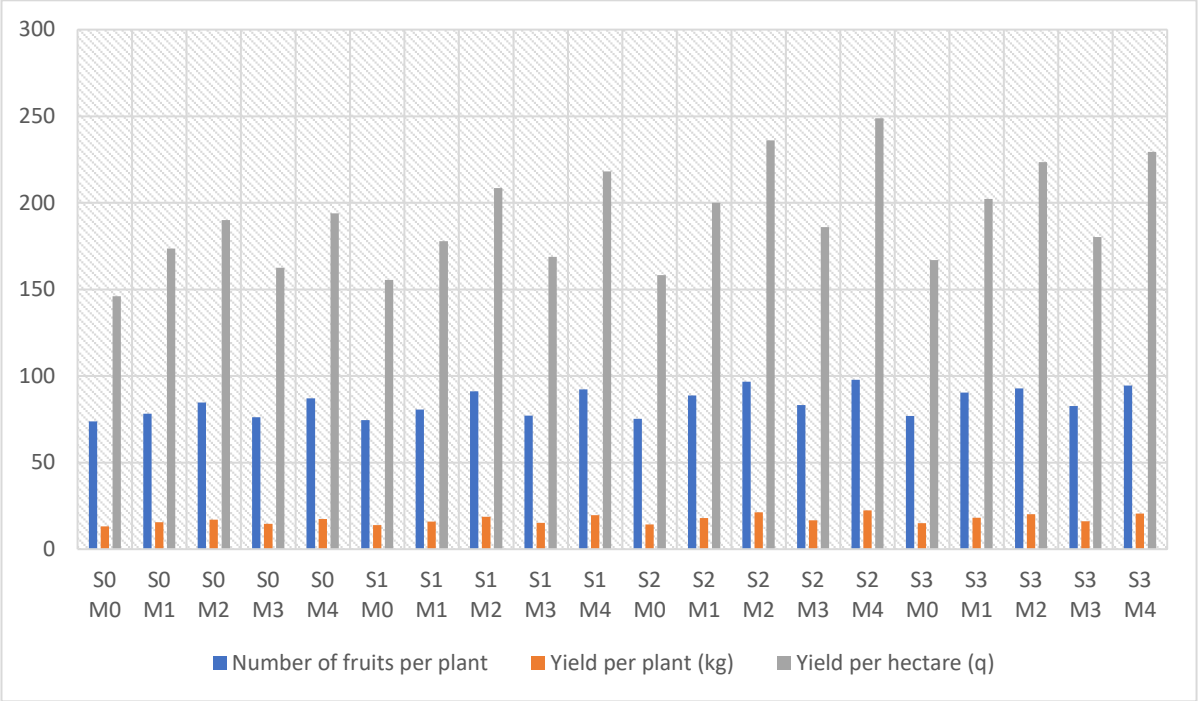

Fig. 2. Interaction effect of foliar spray of PGR and nutrients on Number of fruits per plant), Yield per plant (kg), and Yield per hectare (q)) of guava (*Psidium guajava L.*) cv. Apple Colour

"Among all the nutrient treatments, the increment of both morphological as well as yield attributing characteristics may be linked to the role of KNO_3 in the present study helped to optimizing the plant growth attributes by expediting the transportation of photosynthates from leaves to maturing fruits. The increase in fruit weight may be due to potassium availability, which enhanced the stream of sucrose to the apoplast resulting in increased sugar transportation to the sink tissues and hence promoted the fruit growth" [24]. A similar finding was also reported by Gill et al. [25].

"Pottasium application significantly induced fruit size this could be ascribed to activation of enzymes by K and its involvement in adenosine triphosphate (ATP) production which is important in regulating the rate of photosynthesis which enable the plants to have more food to be stored in the fruits" [26]. ATP is also used as the energy source for many plant activities [27] including cell divisions. "Then cell division largely determines the final number of cells in a fruit and thereafter the final fruit size" [28].

Movchan and Soboroikova [29] reported that boron boosts nitrogen absorption, therefore aiding photosynthesis process, which, in turn, leading to a greater carbohydrate accumulation, thus contributing to increased fruit size and weight [30]. The aforementioned findings have been repeatedly confirmed by the findings of Kumar et al. [31], Gaund et al. (2022), Tiwari et al. [32], M. Thiruppathi [33], Vani et al. [34], Shreekant [35], Poojan et al. [36], Kumar et al. [37], Pratap et al. [38], Lenka et al. [39], Goyal et al. [40], Pippal et al. [41], Kumar et al. [42], and Saini et al. [43].

4. CONCLUSION

Foliar feeding of PGR and was an effective way for improvement of morphological as well as yield attributing characteristics of guava. The treatment combination S_3 M_1 (Salicylic acid 300 ppm + KNO_3 0.5 %) followed by S_3 M_2 (Salicylic acid 300 ppm + $ZnSO_4$ 0.5%) was found to be effective in maximising the morphological parameters significantly. In case of yield parameters treatment combination S_2 M_4 (Salicylic acid 200 ppm + Borax 0.5%) followed by S_2 M_2 (Salicylic acid 200 ppm + $ZnSO_4$ 0.5%) was significantly effective as compare to 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.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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