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Effect of Foliar Feeding of Plant Growth Regulators and Nutrients on Leaf Nutrient Status of Guava (*Psidium guajava* L.) cv. Gwalior-27

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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 investigation entitled "Effect of foliar feeding of plant growth regulators and nutrients on leaf nutrient status of Guava (*Psidium guajava* L.) cv. Gwalior-27" was carried out in the Fruit Orchard, Department of Horticulture, R.V.S.K.V.V, CoA, Gwalior district of Madhya Pradesh during mrig-bahar of 2021-22. The field experiment was laid under FRBD (Factorial randomized block design) which contain 20 treatments and were replicated thrice. The result indicated that the leaf nitrogen content (%) as well as leaf calcium content (%) was affected significantly. The highest N content (2.74%) and leaf calcium content (0.75%) were found with M_3 ($Ca(NO_3)_2$ 2%). However, the plant growth regulators and nutrient spray individually and their interactions both had non-significant

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effect on both leaf P as well as K content. Maximum leaf boron content (90.67 ppm) and leaf zinc content (60.58 ppm) was obtained with M_1 (Borax 0.4%) and M_2 ($ZnSO_4$ 0.5%) respectively. Therefore, based on the experimental findings it can be concluded that foliar feeding of PGR's and nutrients was an effective way for enhancing the leaf nutrient status of guava. The effect of nutrients was found to be effective in maximising the leaf N content, leaf boron content, leaf zinc content and leaf calcium content significantly. Although, foliar feeding of various concentrations of PGR's and nutrients independently as well as their interaction effect did not impact any change in the leaf P and K content of the leaf.

Keywords: PGR's; nutrients; foliar feeding; plant nutrient status; FRBD.

1. INTRODUCTION

Guava (*Psidium guajava* L.) the "*apple of the tropics*" and being the member of the family Myrtaceae. It is considered as a "magical" fruit because of its array of nutritive value and medicinal uses. It exceeds most of the other fruits in productivity which makes it profoundly remunerative. The fruit is composed of minerals like calcium, iron and phosphorus and vitamins A, B_1, B_2 and C. Due to its broader adaptability in diverse soils and agro-climatic zones, economical, prolific bearing and being highly remunerative with nutritive values, it has attained more popularity among the fruit growers [1].

In India, it was introduced during the early 17^{th} century by Portuguese and gradually became a crop of commercial significance all over the country. India ranks first in production of guava which comprises about 45.22% of the world production. The total area, production and productivity of guava in India is about 308 thousand ha with 45,82,000 million tonnes production and 23.7 mt/ha productivity respectively [2].

Among different factors, which affect the production and productivity of guava, nutrient assumes great significance. Management of nutrients in guava refers to sustaining the soil fertility and leaf nutrient supply to an ideal level for sustaining the desired fruit quality. Guava is reported to develop characteristic deficiency symptoms of various macro and micronutrients. Insufficiency of either of these nutrients at critical stage of fruit development, significantly hinder the physiological process of plant thus reduce the productivity and quality of produce and making the plant vulnerable to a number of biotic and abiotic stresses. Micronutrients help in the uptake of major nutrients and play an active role in the plant metabolism begins with cell wall development to respiration, photosynthesis, chlorophyll accumulation, enzyme activity hormone synthesis, nitrogen fixation and reduction [3]. The positive effect of zinc application has been well validated [4] in guava. It is a necessary micronutrient involved in enzymatic systems essential for protein synthesis, seed production and maturity rate in plants [5]. It also plays an important role in starch metabolism in plants [6]. It is well known that Zn acts as a co-factor of many enzymes and influences many biological processes such as photosynthesis, nucleic acids metabolism, and biosynthesis of proteins and carbohydrates [7]. It is also, induces pollen tube growth resulted from its role on tryptophan synthesis as an auxin precursor biosynthesis [8]. Singh et al. [9,10] obtained that boric acid has good effect on physico-chemical constitution of guava. The scarcity of boron, second to zinc deficiency, has imparted a major significance to boron amendment. An adequate boron amendment ensures not only ample fruit set, but optimum fruit yield with superior quality in terms of ratio between total soluble solids and acidity [11]. Fruit calcium is an important factor ascertaining quality. Calcium as a constituent of the cell wall, plays a vital role in forming cross-bridges, which influence cell wall potency and considered as the last barrier before cell separation. The association of calcium in the regulation of fruit development and ripening processes is also well established.

Recent advances in the field of nutrition of various fruit crops have confirmed that leaf nutrient analysis is a laudable tool for detecting deficiencies and toxicity of various essential elements and represents an important tool for determining future fertilization requirements (Korkmaz and Askin) 2015. Information regarding nutritional aspect of guava is very limited and less studies has been conducted to find out the effect of leaf nutrients of guava on growth, yield and quality parameters of guava. Therefore, it has become imperative to find out influence nutrients on leaf nutrient status of guava.

2. MATERIALS AND METHODS

The experiment was carried out in the Fruit Orchard, Department of Horticulture, R.V.S.K.V.V, CoA, Gwalior district of Madhya Pradesh during mrig-bahar of 2021-22 on twenty-seven years old guava trees cv. Gwalior-27 planted at 6 x 6 m distance and 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 regulators contains 5 level and second is nutrient which contains 4 levels. The plants were sprayed with different concentrations of plant growth regulators (propyl gallate 200 & 300 ppm and gibberellic acid 50 & 100 ppm) and nutrients (Borax 0.4%, $ZnSO_4$ 0.5% and $Ca(NO_3)_2$ 2%) 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 have been used presented in Table1 and Table 2. The details of the treatments are as follows:

Table 1. Factor-A: PGR's

Notation	PGR's	Dose
P_0	Control	Water spray
P_1	Propyl gallate	200 ppm
P_2	Propyl gallate	300 ppm
P_3	Gibberellic acid	50 ppm
P_4	Gibberellic acid	100 ppm

Table 2. Factor-B: Nutrients

Notation	Nutrient	Dose
M_0	Control	Water spray
M_1	Borax	0.4 %
M_2	$ZnSO_4$	0.5 %
M_3	$Ca(NO_3)_2$	2 %

2.1 Leaf Nutrient Status

The leaf samples were collected before harvesting and gently washed and then rinsed in 0.1N HCl and distilled water instantly after leaf sampling, dried in oven at 70°C, dried samples were grind in an electric grinder. These samples were used for the analysis of NPK and nutrients status of leaves.

2.2 Estimation of Nitrogen

Total nitrogen was estimated by the "Kjeldahal Distillation" method. Two hundred gram of grind material of leaves was taken in "micro-Kjeldahal tube" in which 10-15 ml of conc. H_2SO_4 was added. Further 2g of digestion activator (Salt mixture copper sulphate+ potassium sulphate) to the sample were added. The tubes were kept in digestion unit for digestion. After digestion, the material was taken for distillation and after distillation, distillate ammonia-metaborate was titrated against 0.4N H_2SO_4 [12].

2.3 Estimation of Phosphorus, Potassium and Micronutrients

One gram oven dried plant sample was taken and digested in 100 ml conical flask with 10 ml of di-acid mixture (2:5) consisting of chemically pure concentrated perchloric acid and nitric acid respectively and digested material was filtered through Whatman No. 40 filter paper in 100 ml. volumetric flask and filtrate was diluted to mark. This was used for estimation of P, K and micronutrients.

2.4 Phosphorus Estimation

Ten ml of aliquot from the colorless filtrate was taken in 25 ml, volumetric flask for determination and then 5 ml of ammonium molybdate vanadate mixture was added to it and volume was made up to 25 ml. after shaking well. It was kept for 30 minutes and color intensity was measured in Spectrophotometer 20 at 470 nm wave length, after setting the instrument to zero with blank as described by Jackson [13].

2.5 Potassium Estimation

Ten ml aliquot of the filtrate was taken in 100 ml volumetric flask and it was diluted to mark with distilled water. The potassium content in extract was estimated by flame photometer.

2.6 Estimation of Zinc

Extract prepared in preceding Para was used for the estimation of zinc (mg kg^{-1}) and the reading was taken on the Atomic Absorption Spectrophotometer as described by Lindsay and Norwell [14] and micronutrient concentrations was calculated and expressed in ppm.

2.7 Estimation of Boron

The plant sample (0.5 g) was taken in porcelain/platinum dishes. $Ca(OH)_2$ 0.5 g was added to the sample and was ignited in the muffle furnace at 550 °C for 4 hours. White grey ash obtained which was cooled with a little distilled water and then added 5ml 0.1 N HCl. The content was transferred to 25 ml volumetric flask and made up to 25 ml with distilled water. For analysis of boron, 1 ml aliquot was taken and estimated by spectrophotometer and micronutrient concentrations was calculated and expressed in ppm.

2.8 Estimation of Calcium

Calcium content was estimated by feeding the digested sample into a standard atomic absorption spectroscopy meter having appropriate hallow cathode lamps and values were plotted on graph and micronutrient concentrations was calculated and expressed in ppm respectively.

3. RESULTS AND DISCUSSION

3.1 Nitrogen Content (%)

Analysis of guava leaf samples showed that application of nutrients significantly increased the nitrogen content of leaves over control as evident in Table 3. and Table 4. Nevertheless, foliar feeding of M_3 ($Ca(NO_3)_2$ 2%) recorded the maximum leaf N content (2.74%) while, the minimum leaf N content (2.19%) was recorded with control (M_0), but the factor A (plant growth regulators) and their interaction with factor B (nutrients) was found non-significant. The results are found similar with the earlier findings of [15]. They have reported an increase in leaf nitrogen concentration with increased concentration of Nitrogen, which might be due to the intake of good amount of nitrogen by the leaves. These observations are also in line with previous result in guava [16].

3.2 Phosphorus Content (%)

The information in Tables 5 and 6 made it abundantly evident that foliar feeding of PGRs and nutrients and their interaction effect had been shown to be statistically insignificant.

3.3 Potassium Content (%)

The data presented in Table 5 and Table 6 clearly indicated that foliar feeding of PGR's and nutrients and their interaction effect had no statistically significant influence on leaf K content.

3.4 Boron Content (ppm)

The findings in Tables 9 and 10 clearly indicated that leaf boron content increased considerably significantly with the increase in boron concentration during investigation but the effect of factor A (plant growth regulators) individually and their interaction with factor B (nutrients) was not statistically significant. However, maximum boron content (90.67ppm) was seen under M_1 (Borax 0.4%), whereas the minimal (67.30ppm) was observed under M_0 (control). It is might be due to the increased level of biomass production or the dilution effect, balances out the element's concentration. These findings concur with those made earlier by [17]. Also, [18] stated a synergistic relationship between zinc and boron content and noted an increment in the zinc content followed by an increase in boron content. Similar findings were also reported by (Rajkumar *et al*. 2017) who indicated that the doses of boric acid were found most effective to enhance the leaf B status of guava leaves influenced by the external application of borax.

3.5 Zinc Content (ppm)

The data showed in Tables 11 and 12 clearly indicated that leaf zinc content increased significantly after the foliar feeding of various concentrations of nutrients but the effect of factor A (plant growth regulators) individually and their interaction with factor B (nutrients) was not statistically significant. It was also observed that the maximum leaf zinc content (60.58ppm) was obtained with M_2 ($ZnSO_4$ 0.5%) while minimum leaf zinc content (41.58 ppm) was recorded in treatment M_0 (control). Higher content of zinc in leaf was reported with the application of zinc as observed earlier by various workers [19,20,21,17,22] (Rajkumar et al., 2017; Vikas et al 2020).

3.6 Calcium Content (%)

The data presented in Tables 13 and 14 clearly revealed that the maximum calcium content (0.75%) was recorded in M_3 ($Ca(NO_3)_2$ 2%) whereas, minimum calcium (0.57%) was recorded in M_3 (control), but the effect of factor A (plant growth regulators) individually and their interaction with factor B (nutrients) was found non-significant. The increase in leaf calcium concentration with rose in the concentration of calcium was earlier reported in guava [15]. The above finding was in agreement with results that there is synergistic relationship found between calcium and boron content and revealed that an increment in the calcium content enhances the boron as well as calcium concentration [18]. Hence, spray of calcium and boron alone or in combination are necessary to maintain the optimum calcium content in leaves of guava [23-25].

Table 3. Effect of foliar feeding PGR's and nutrients on Nitrogen content (%) of guava (*Psidium guajava L.*) cv. Gwalior-27

(A) PGR's	Nitrogen content (%)
P_0 Control	2.33
P_1 Propyl gallate 200ppm	2.37
P_2 Propyl gallate 300ppm	2.40
P_3 Gibberellic acid 50ppm	2.43
P_4 Gibberellic acid 100ppm	2.46
SE(m) ±	0.066
CD (5%)	NS
(B) Micronutrients	
M_0 Control	2.19
M_1 Borax 0.4%	2.25
M_2 $ZnSO_4$ 0.5%	2.59
M_3 $Ca(NO_3)_2$ 2%	2.74
SE(m) ±	0.061
CD (5%)	0.173

Table 4. Interaction effect (A X B) of PGR's and nutrients on Nitrogen content (%) of guava during 1st year, 2nd year and pooled

	Nitrogen content (%)				
	PGR's				
Micronutrients	P_0	P_1	P_2	P_3	P_4
M_0	2.07	2.12	2.10	2.29	2.38
M_1	2.20	2.23	2.17	2.31	2.35
M_2	2.55	2.50	2.46	2.54	2.58
M_3	2.72	2.61	2.60	2.73	2.72
SE(M) ±	0.132				
CD (5%)	NS				

Table 5. Effect of foliar feeding PGR's and nutrients on Phosphorus content (%) of guava (*Psidium guajava L.*) cv. Gwalior-27

(A) PGR's	Phosphorus content (%)
P_0 Control	0.172
P_1 Propyl gallate 200ppm	0.174
P_2 Propyl gallate 300ppm	0.178
P_3 Gibberellic acid 50ppm	0.176
P_4 Gibberellic acid 100ppm	0.180
SE(m) ±	0.006
CD (5%)	NS
(B) Micronutrients	
M_0 Control	0.168
M_1 Borax 0.4%	0.186
M_2 $ZnSO_4$ 0.5%	0.170
M_3 $Ca(NO_3)_2$ 2%	0.170
SE(m) ±	0.006
CD (5%)	NS

Table 6. Interaction effect (A X B) of PGR's and nutrients on Phosphorus content (%) of guava during 1st year, 2nd year and pooled

	Phosphorus content (%)				
	PGR's				
Micronutrients	**P_0**	**P_1**	**P_2**	**P_3**	**P_4**
M_0	0.163	0.167	0.164	0.170	0.174
M_1	0.187	0.183	0.181	0.184	0.180
M_2	0.178	0.177	0.175	0.179	0.173
M_3	0.169	0.169	0.169	0.172	0.173
SE(M) ±	0.010				
CD (5%)	NS				

Table 7. Effect of foliar feeding PGR's and nutrients on Potassium content (%) of guava (*Psidium guajava L.*) cv. Gwalior-27

(A) PGR's	**Potassium content (%)**
P_0 Control	1.63
P_1 Propyl gallate 200ppm	1.64
P_2 Propyl gallate 300ppm	1.70
P_3 Gibberellic acid 50ppm	1.71
P_4 Gibberellic acid 100ppm	1.75
SE(m) ±	0.034
CD (5%)	NS
(B) Micronutrients	
M_0 Control	1.63
M_1 Borax 0.4%	1.74
M_2 $ZnSO_4$ 0.5%	1.71
M_3 $Ca(NO_3)_2$ 2%	1.65
SE(m) ±	0.030
CD (5%)	NS

Table 8. Interaction effect (A X B) of PGR's and nutrients on Potassium content (%) of guava during 1st year, 2nd year and pooled

	Potassium content (%)				
	PGR's				
Micronutrients	**P_0**	**P_1**	**P_2**	**P_3**	**P_4**
M_0	1.57	1.56	1.60	1.69	1.75
M_1	1.74	1.68	1.68	1.78	1.71
M_2	1.71	1.67	1.63	1.70	1.71
M_3	1.64	1.64	1.62	1.68	1.68
SE(M) ±	0.066				
CD (5%)	NS				

Table 9. Effect of foliar feeding PGR's and nutrients on Boron content (PPM) of guava (*Psidium guajava L.*) cv. Gwalior-27

(A) PGR's	**Boron content (ppm)**
P_0 Control	73.24
P_1 Propyl gallate 200ppm	75.14
P_2 Propyl gallate 300ppm	74.03
P_3 Gibberellic acid 50ppm	77.73
P_4 Gibberellic acid 100ppm	78.59
SE(m) ±	1.723
CD (5%)	NS

(B) Micronutrients	
M_0 Control	67.30
M_1 Borax 0.4%	90.67
M_2 $ZnSO_4$ 0.5%	79.89
M_3 $Ca(NO_3)_2$ 2%	68.12
SE(m) ±	1.541
CD (5%)	4.412

Table 10. Interaction effect (A X B) of PGR's and nutrients on Boron content (ppm) of guava during 1st year, 2nd year and pooled

	Boron content (ppm)				
	PGR's				
Micronutrients	**P_0**	**P_1**	**P_2**	**P_3**	**P_4**
M_0	59.45	63.52	64.98	73.60	74.97
M_1	90.32	86.07	87.11	88.01	89.82
M_2	80.68	77.08	77.94	79.78	78.96
M_3	68.11	66.28	66.10	69.52	70.60
SE(M) ±	3.445				
CD (5%)	NS				

Table 11. Effect of foliar feeding PGR's and nutrients on Zinc content (ppm) of guava (*Psidium guajava L.*) cv. Gwalior-27

(A) PGR's	**Zinc content (ppm)**
P_0 Control	47.37
P_1 Propyl gallate 200ppm	48.43
P_2 Propyl gallate 300ppm	47.53
P_3 Gibberellic acid 50ppm	49.73
P_4 Gibberellic acid 100ppm	49.62
SE(m) ±	1.023
CD (5%)	NS
(B) Micronutrients	
M_0 Control	41.58
M_1 Borax 0.4%	50.63
M_2 $ZnSO_4$ 0.5%	60.58
M_3 $Ca(NO_3)_2$ 2%	42.35
SE(m) ±	0.915
CD (5%)	2.619

Table 12. Interaction effect (A X B) of PGR's and nutrients on Zinc content (ppm) of guava during 1st year, 2nd year and pooled

	Zinc content (ppm)				
	PGR's				
Micronutrients	**P_0**	**P_1**	**P_2**	**P_3**	**P_4**
M_0	37.90	39.19	39.90	46.25	44.66
M_1	51.98	50.00	49.48	50.55	51.12
M_2	60.32	59.30	58.76	59.44	60.10
M_3	43.52	40.97	41.98	42.67	42.60
SE(M) ±	2.046				
CD (5%)	NS				

Table 13. Effect of foliar feeding PGR's and nutrients on Calcium content (%) of guava (*Psidium guajava L.*) cv. Gwalior-27

(A) PGR's	Calcium content (%)
P_0 Control	0.588
P_1 Propyl gallate 200ppm	0.655
P_2 Propyl gallate 300ppm	0.650
P_3 Gibberellic acid 50ppm	0.683
P_4 Gibberellic acid 100ppm	0.658
SE(m) ±	0.015
CD (5%)	NS
(B) Micronutrients	
M_0 Control	0.574
M_1 Borax 0.4%	0.632
M_2 $ZnSO_4$ 0.5%	0.670
M_3 $Ca(NO_3)_2$ 2%	0.750
SE(m) ±	0.013
CD (5%)	0.037

Table 14. Interaction effect (A X B) of PGR's and nutrients on Calcium content (%) of guava during 1st year, 2nd year and pooled

	Calcium content (%)				
	PGR's				
Micronutrients	P_0	P_1	P_2	P_3	P_4
M_0	0.550	0.570	0.580	0.600	0.570
M_1	0.640	0.640	0.630	0.640	0.610
M_2	0.680	0.660	0.670	0.680	0.660
M_3	0.750	0.750	0.720	0.710	0.710
SE(M) ±	0.027				
CD (5%)	NS				

4. CONCLUSION

Foliar feeding of PGR's and nutrients given thrice, first, before bud initiation, second, at fruit setting stage and third after pre harvest stage was an effective way for improvement of leaf nutrient status of guava. The treatment of nutrients was found to be effective in maximising the leaf N content, leaf boron content, leaf zinc content and leaf calcium content significantly. Although, foliar feeding of various concentrations of PGR's and nutrients individually as well as their interaction effect was found statistically non-significant.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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