

Efficacy of Foliar Application of Micronutrients on Bio-chemical Attributes of Guava (*Psidium guajava* L.) cv. Allahabad Safeda

ABSTRACT

To assess the efficacy of foliar application of micronutrients, *i.e.* Zinc as a Zinc Sulphate, Copper as Copper Sulphate and Boron as Boric acid on biochemical attributes of guava (*Psidium guajava* L.) cv. Allahabad Safeda fruits during 2019-20, a field experiment was carried out at Horticultural Research Farm- II of the Department of Horticulture, School of Agricultural Science and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow, India on 12-year-old guava plants. The experiment was conducted in randomized block design (RBD) with three replications. Using a digital hand refractometer, biochemical parameters such as total soluble solids were estimated at room temperature. The ascorbic acid, total sugars, reducing sugars, and non-reducing sugars content in the fruit sample were analyzed, the gathered data were statistically analyzed in accordance with Gomez's (1984) methodology. The foliar application of zinc sulphate@ 0.4% showed better quality of fruits in terms of TSS (11.78^o Brix), Acidity (0.4%), Total Sugars (6.34%), sugar acid ratio (15.91) while the application of Boric acid@ 0.4% resulted in maximum value of ascorbic acid (173.373mg/100g) pulp and pectin (1.650) respectively.

Keywords: Micronutrients; bio-chemical attributes; foliar application.

1. INTRODUCTION

The guava (*Psidium guajava* L.) is a fruit that is excellent for table purpose because of its flavor, nutritional value and pectin content. It is also a fruit that is used in processing to make a variety of high-quality products, including jam, jelly, canned fruit products, fruit butter, toffee, cheese and guava nectar. It is an inexpensive and abundant source of pectin and vitamin C [1]. Guava is now being recognized as 'super food' is getting very much attention in the agro-food business due to the attractive characteristics of the fruit, such as health promoting bioactive components, functional elements, *i.e.* rich in ascorbic acid content (up to 300 mg/100g) and good source of pectin which

ranges from 0.5 to 1.8 percent [2]. The most well-liked fruit cultivated in tropical, sub-tropical, and some arid regions of India is the guava (*Psidium guajava* L.), also known as the apple of the tropics. It belongs to *Myrtaceae* family. It can tolerate some drought, but only a small amount of frost. The guava is an important fruit because it is being hardy and can be grown in alkaline or poorly drained soils with a pH of 8.5 [3]. It can also withstand temperatures up to 46^o degrees Celsius and less than 25 millimeters of rainfall per year. The guava is a highly cross-pollinated crop that bears flowers and fruits during the current growing season. It is pollinated by honey bees and andirona insects [4]. The guava fruit develops from an inferior ovary and has a double sigmoid growth curve. The guava fruits have

many seed berries and changes color from dark green to yellowish green in about 4-5 months. Although natural and artificial triploids (2n=33) and aneuploids exist, triploids typically produce fruit without seeds. The common guava is a diploid (2n=22) [5]. The guava plant produces flowers twice or sometimes thrice in a year in northern India. The name of the spring bloom is "Ambe Bahar." "Mrig Bahar" refers to the monsoon or June flowering, while "Hast Bahar" is the third flowering, which occurs in October-November. While the fruit of the Ambe Bahar and Mrig Bahar crops ripens from July to September and November to February, respectively, the fruit of the Hast Bahar tree ripens in the spring, which is also referred to as the summer crop [6]. Its low-calorie profile of essential nutrients is generally broad. The vitamin C content of a single guava (*P. guajava* L.) fruit is approximately four times that of an orange. 80–82% water, 0.71% protein, 0.5% fat, 11–13% carbohydrates, and 2.4% vitamin C are found in guava fruits. Additionally, 100 grams of red guava have 80.8 grams of water, 68 kcal of energy, 2.55 grams of protein, 0.95 grams of fat, 14.32 grams of carbohydrates, 5.4 grams of total dietary fiber, 8.92 grams of sugar, 25 μ grams of total carotene, 1.39 grams of ash, 374 μ grams of β -carotene, 5.204 μ grams of lycopene [7], and 87 mg of vitamin C [8]. The fruit is a good bulk laxative because it is high in soluble dietary fiber (5.4g per 100 g of fruit), flavonoids like beta-carotene, lycopene, lutein, and cryptoxanthin, and vitamin A. Guavas can be eaten raw or processed into a fruit bar, dehydrated goods, juice, nectar, pulp, jam, jelly, and slices in syrup. They can also be added to other fruit juices or pulps [9].

The practice of foliar feeding fruit plants with nutrients has gained a lot of attention recently. It is a cost-effective and practical solution to avoid issues with nutrient availability and to supplement soil fertilizers. While micronutrients like zinc, boron, copper and molybdenum have a specific function in the growth and development of plants, the production of high-quality produce and the uptake of major nutrients, macronutrients like nitrogen, phosphorus, and potash are essential for boosting plant vigor and productivity. Deficiencies in macro and micronutrients show up as stunted growth, low yield, dieback, and sometimes even as plant death. Furthermore, applying these nutrients topically could result in better outcomes. The benefits of foliar fertilization include uniform distribution of nutrients, low application rates, and fast nutrient uptake. According to Zaman and Schumann [10], nutrient application through

foliage can be 10–20 times more effective than nutrient application through soil. Key components of plant growth and development are micronutrients. These components are crucial for a number of enzymatic processes, including synthesis. Sometimes their severe deficiencies present an irreversible problem [11].

In addition to aiding in the uptake of major nutrients, micronutrients are involved in every stage of plant metabolism, including the development of cell walls, respiration, photosynthesis, chlorophyll synthesis, enzyme activity, hormone synthesis, nitrogen fixation, and reduction [12]. Rainy season guavas have poor fruit quality, which can be enhanced with foliar application of a more appropriate nutrient schedule. Fruits sprayed with calcium chloride and borax have better quality characteristics in addition to increased size. Micronutrients like boron are part of the cell membrane and are necessary for fruit set, pollen tube growth, ovule development, and cell division.

In extending the shelf life and maintaining the quality of guava, calcium salts like lactate, chloride, and nitrate (0.5–3.5%) have demonstrated encouraging results [13,14,15,16]. While the significance of these components in enhancing plant physiological activities has been established, crop-specific agroclimatic conditions necessitate standardization of dosage, timing and application method. Thus, in order to increase guava fruit yield and quality, the current study was conducted to assess the effects of calcium and boron, both separately and in combination.

2. MATERIALS AND METHODS

The experiment was carried out at Horticultural Research Farm BBAU in Lucknow India, in the years 2018-2019. The climate at the experimental site was subtropical. The orchard's soil was clay loam, which has good airflow and drainage. The loose texture of the soil was ideal for the growth of plant roots. 6 x 6 m apart, uniform 12-year-old guava plants, available in the university's research farm were chosen for the study. The application of nutrients and other orchard management techniques were carried out in accordance with the guava recommended package of practices. 22 treatments total, viz., T₁- Zinc sulphate (0.2%), T₂ (Zinc sulphate, 0.3%), T₃ (Zinc sulphate, 0.4%), T₄ (Copper sulphate, 0.2 %), T₅ (Copper sulphate, 0.3%), T₆(Copper sulphate,0.4 %), T₇(Boric acid,0.2 %), T₈ (Boric acid, 0.3%), T₉ (Boric acid, 0.4%), T₁₀ - Zinc sulphate + copper sulphate (0.2%), T₁₁ -Zinc

sulphate + copper sulphate (0.3 %), T₁₂ Zinc sulphate + copper sulphate (0.4%), T₁₃- Zinc sulphate + boric acid (0.2%), T₁₄ -Zinc sulphate + boric acid (0.3%), T₁₅ -Zinc sulphate + boric acid (0.4%), T₁₆ Copper sulphate + boric acid (0.2%), T₁₇- Copper sulphate + boric acid (0.3%), T₁₈ - Copper sulphate + boric acid (0.4%), T₁₉ Zinc sulphate + copper sulphate + boric acid (0.2%), T₂₀- Zinc sulphate + copper sulphate+ boric acid (0.3%), T₂₁- Zinc sulphate + copper sulphate+ boric acid (0.4%), T₂₂- Control spray of tap water, were sprayed (foliar feeding) during first week of August (fruit initiation) and second week of September (fruit development) during 2018-19. The experiment was conducted in randomized block design (RBD) with three replications. Using a digital hand refractometer, biochemical parameters such as total soluble solids were estimated at room temperature. By titrating the fruit pulp extract with 0.1N NaOH and using phenolphthalein indicator, titratable acidity was determined [17]. By using the technique outlined by Ranganna [17], the ascorbic acid, total sugars, reducing sugars, and non-reducing sugars content in the fruit sample were analyzed, the gathered data were statistically analyzed in accordance with Gomez's (1984) methodology.

3. RESULTS AND DISCUSSION

The data presented in table-1 clearly shows that the bio-chemical contents of fruits viz., TSS, sugar acid ratio, acidity, Vitamin C, pectin and total sugars were all significantly impacted by foliar feeding of micronutrients. The 0.4% zinc sulphate treatment had the highest total soluble solids (11.78⁰ Brix), which was higher than the control. It is a well-established fact that zinc plays a specific role in the synthesis of metabolites, the hydrolysis of complex polysaccharides into simple sugars, and the quick transfer of minerals and photosynthetic products from other plant parts to developing fruits. According to Kumar and Bhusan [18], foliar ZnSO₄ application raised the TSS contents by boosting the photosynthetic activity of the plants, which in turn led to an increase in sugar production. Increase in total soluble solids and total sugars might be that Zn helps in the enzymatic reactions like transformation of carbohydrates, activity of hexokinase and formation of cellulose and change in sugar are considered due to its action on zymohexose and boron helps in sugar transport which may be possible to improve TSS and total sugars [21]. With an increase in micronutrient concentration, fruit acidity generally decreased across all treatments. With the application of 0.4% zinc sulphate spray, the lowest fruit acid (0.4%) was observed. Under

0.4% zinc sulfate treatment, the highest reduction in acid content (0.4%) was also achieved, according to Lal and Sen [20], guava fruits acid content decreased when zinc sulphate was applied topically. As a primary substrate for respiration, an increase in membrane permeability that permits the storage of acids in respiring cells may be the cause of the decline in malic acid during fruit ripening [21].

When zinc sulphate is applied topically at a higher concentration than other nutrients and their combinations, the overall sugar content is increased. The present results indicate that, in comparison to all other treatments, the 0.4% concentration of zinc sulphate treatment produced noticeably higher total sugars (6.34%) in guava fruits. Compared to the control, this treatment's increase in total sugars was superior. It agrees with the guava research conducted by Singh and Brahmachari [22] and Kundu and Mitra [23]. The active synthesis of triptophan in the presence of zinc, the precursor of auxin, may be the cause of a significant rise in sugar contents following foliar feeding of zinc sulphate. This, in turn, increases the rate of chlorophyll synthesis, which in turn speeds up photosynthetic activity [24].

It became known that the effects of spraying micronutrients alone or in combination were promising. According to the present study, the trees treated with 0.4% zinc sulphate treatment had the highest sugar/acid ratio (15.91). The sugar/acid ratio increased by 80.44% compared to the control. The current results are further supported by the guava-related research of Kundu and Mitra [23] and Lal and Sen [20].

The pectin content of Allahabad Safeda guava fruits is significantly influenced by micronutrient sprays, either separately or in combination. It was found that when the concentration of micronutrient sprays rose from 0.2% to 0.4%, the pectin content rose as well. The pectin content of the 0.4% boric acid treatment was found to be superior (1.650%), increasing by 163.96% compared to the control. Additionally, Pandey *et al.* [25] reported that foliar application of boron improved the pectin content of guava fruits. According to Lee and Kim [26], boron has been linked to the plant system in a number of ways and has been found to enhance the production of cellulose and pectin in fruits, which may be the cause of the fruits' higher pectin content. Because boron helps photosynthates move from leaves to young fruits, which are partially used for the synthesis of pectic substances, it increases the amount of pectin in the fruits [27].

As the concentration of micronutrient application in all treatments increased, so fruits vitamin C content also increased. The vitamin C content of the fruits of trees treated with boric acid was found to have significantly increased. Under a 0.4% concentration of boric acid treatment, the maximum content of vitamin C (173.3 mg per 100 g) was observed with a 21.22% increase over control. The higher ascorbic acid content was due to the increased in total sugars content owing to the efficient translocation of available photosynthates to fruit pulp rather than to other parts [28]. It might be attributed to the fact that boron directly affects the photosynthesis activity of plant and helps in sugar transport. Besides, the boron also plays an important role in

activating the synthesis of ascorbic acid. These results are in agreement with the findings of Awasthi and Lal [29] and Yadav *et al.*[30] in guava. In guava, Kateet al. [31], Singh *et al.*[32] also observed that fruits treated with boron spray had higher vitamin C contents. An appropriate supply of hexose sugars through photosynthetic activity may be the cause of the higher ascorbic acid (vitamin C) levels during the early stages of fruit growth. The main and active chemical component of guava fruit that gives it its therapeutic qualities is ascorbic acid, or vitamin C. These properties are influenced by temperature, soil, plant nutrition, and genotype [33].

Table1.Bio-chemical attributes of various treatment on guava tree

Treatments	TSS (°Brix)	Acidity (%)	Total sugars (%)	Sugar/acid ratio	Vitamin C (mg/100 g)	Reducing sugars (%)	Non Reducing sugars (%)	Pectin (%)
Zn (0.2%)	10.48	0.43	5.56	13.00	148.36	3.40	2.05	1.03
Zn (0.3%)	11.26	0.42	5.85	14.00	153.30	3.33	2.39	1.16
Zn (0.4%)	11.78	0.40	6.34	15.91	156.40	3.43	2.76	1.21
Cu (0.2%)	10.30	0.44	5.26	11.81	156.03	3.40	1.77	0.82
Cu (0.3%)	10.40	0.44	5.56	12.54	162.40	3.40	2.05	0.84
Cu (0.4%)	10.58	0.44	5.73	12.95	166.04	3.36	2.25	0.95
B (0.2%)	10.48	0.43	5.54	12.81	165.28	3.34	2.09	1.24
B (0.3%)	11.00	0.43	5.64	12.14	168.54	3.35	2.18	1.62
B (0.4%)	11.52	0.42	5.85	13.99	173.37	3.43	2.30	1.65
Zn+Cu (0.2%)	10.26	0.48	5.23	10.92	148.15	3.40	1.74	0.81
Zn+Cu (0.3%)	10.40	0.46	5.33	11.52	151.16	3.41	1.82	0.83
Zn+Cu (0.4%)	10.45	0.46	5.64	12.31	154.15	3.34	2.19	0.92
Zn+B (0.2%)	10.40	0.45	5.43	11.98	153.21	3.34	1.99	1.02
Zn+B (0.3%)	10.53	0.45	5.62	12.46	157.28	3.32	2.19	1.13
Zn+B (0.4%)	11.25	0.44	5.80	13.15	161.42	3.35	2.33	1.16
Cu+B(0.2%)	10.40	0.51	5.12	10.07	160.62	3.37	1.66	0.95
Cu+B (0.3%)	10.33	0.48	5.22	10.69	167.02	3.41	1.72	0.97
Cu+B (0.4%)	10.26	0.46	5.44	11.76	170.40	3.40	1.94	1.02
Zn+Cu+B(0.2%)	10.26	0.44	5.32	13.09	163.10	3.36	1.86	0.99
Zn+Cu+B(0.3%)	10.53	0.39	5.61	12.83	168.08	3.32	2.18	1.06
Zn+Cu+B(0.4%)	10.93	0.43	5.75	13.33	170.24	3.34	2.29	1.11
Control	9.53	0.55	4.86	8.83	143.18	2.84	1.92	0.62
S Em. ±	0.09	0.0080	0.008	0.143	0.077	0.011	0.01	0.007
CD at 5%	0.258	0.022	0.024	0.260	0.221	0.031	0.028	0.012

4. CONCLUSION

Foliar application of zinc sulphate@ 0.4% was the best treatment among the all treatments for improving quality of guava fruits viz., TSS (11.78⁰ Brix), Acidity(0.4%), Total Sugar(6.34%) , Sugar Acid Ratio (15.91) and the application of Borax@ 0.4% improved qualities with ascorbic acid173.373mg/100g pulp and pectin 1.650)in the environmental conditions of Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow (India). Therefore, it may be concluded that foliar spray of zinc sulphate (0.4%) and borax (0.4%) can be recommended to the guava growers for obtaining better quality of winter season guava fruits.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

We 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 this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Agnihotri BN, Kapoor KL, God KR. Guava. In: Chattopadhyay TK, editor. A Textbook on Pomology. New Delhi: Kalyani Pub. 1962;II:277.
2. Mora R, Rana GS, Kumar S, Jat ML. Influence of foliar application of boron, iron and magnesium on quality attributes and leaf nutrient status of guava cv. Hisar Surkha. J Plant Nutr. 2023. Available: <https://doi.org/10.1080/01904167.2023.2278658>
3. Thind SK, Mahal JS. Package of practices for cultivation of fruits. Ludhiana, India: Additional Director of Communication for Punjab Agricultural University. 2021;1-188.
4. Saroj NL, Verma RS, Prakash S, Kumar V, Kumar V. Studies on the effect of foliar spray of micronutrients and plant growth regulators on chemical parameters of guava (*Psidium guajava* L.) cv. Allahabad Safeda. IJCS. 2019;7(3):1102-3.
5. Mohammed S. Aneuploidy in guava. Biol Plant. 1974;16(5):382-8.
6. Sachin AJ, Ramteke V, Bharath KR. Flower regulation in guava and pomegranate. Pop Kheti. 2015; 3:53-4.
7. Chen H, Sheu M, Lin, Wu C. Nutritional composition and volatile compounds in guava. Fresh Procedure. 2007;1:132-9.
8. Mahmud MK. Indonesia's Food Composition (in Bahasa Indonesia). Jakarta: PT Elex Media Komputindo; 2009. Zulfianto N, editor.
9. Leite BMSC, Tadiotti AC, Baldochi D, Oliveira OMMF. Partial purification, heat stability and kinetic characterization of the pectin methylesterase from Brazilian guava, Paluma cultivars. Food Chem. 2006;94:565-72.
10. Zaman Q, Schumann AW. Nutrient management zones for citrus based on variation in soil properties and tree performance. Precis Agric. 2006;7:45-63.
11. Kumar P. Managing micronutrient deficiency in ornamental crops. Indian Horticult. 2002;46:30-1.
12. Das DK. Micronutrients; Their behaviors in soils and plants. 2nd ed. Kalyani Publication; Ludhiana. 2003;1-2.
13. Hiwale SS, Singh SP. Prolonging shelf life of guava (*Psidium guajava* L.). Indian J Hort. 2003; 60:1-9.
14. Selvan MT, Bal JS. Effect of post-harvest chemical treatments on shelf life of guava during ambient storage. Haryana J Hort Sci. 2005;34:33-5.
15. Mahajan BVC, Ghuman BS, Harsimrat KB. Effect of postharvest treatments of calcium chloride and gibberellic acid on storage behavior and quality of guava fruits. J Hort Sci Ornament Plants. 2011;3:38-42.
16. Barche S, Nair R, Kirad KS. Effect of wax emulsion and packaging material in combination with calcium salts on the shelf life of guava (*Psidium guajava* L.) cv. Allahabad Safeda, at room temperature. The Ecocan. 2015; Special Issue, VIII:273-6.
17. Ranganna S. Manual for analysis of fruits and vegetable products. New Delhi: Tata McGraw Hill Co. Pvt. Ltd.; 2010.
18. Kumar S, Bhushan S. Effect of zinc, manganese and boron applications on quality of Thompson Seedless grapes. Punjab Hort J. 1980; 20:62-5.
19. Mahesh, Devputra R. Effect of Foliar Spray of zinc, iron and boron on quality of guava. Trends Biosci. 2017;10(39):8109-11.
20. Lal G, Sen NL. Effect of N, Zn and Mn fertilization on fruit quality of guava (*Psidium guajava* L.) cv. Allahabad Safeda. Haryana J Hort Sci. 2001;30(3-4):209-10.
21. Kliewer WM. The effect of day temperature and light intensity on concentration of malic

- and tartaric acids in *Vitis vinifera*. J Amer Soc Hort Sci. 1971; 97:372.
22. Singh UP, Brahmachari VS. Effect of potassium, zinc, boron and molybdenum on the physico-chemical composition of guava (*Psidium guajava* L.) cv. Allahabad Safeda. Orissa J Hort. 1999;27(2):62-5.
 23. Kundu S, Mitra SK. Response of guava to foliar spray of copper, boron and zinc. Indian Agric. 1999;43(1-2):49-54.
 24. Skoog F. Zinc-auxin in plant growth. HortAbst. 1940;11:332.
 25. Pandey DK, Pathak RA, Pathak RK. Studies in foliar application of nutrients and plant growth regulators in Sardar guava (*Psidium guajava* L) effect on yield and fruit quality. Indian J Hort. 1988;45(3-4):197-202.
 26. Lee SS, Kim KR. Studies on the internal browning of apple fruits caused by excessive boron application. J Korean Soc Hort Sci. 1991;32(1):43-51.
 27. Whiting GC. "Sugars." Biochemistry of Fruits and Their Products. 1970;1:1-31.
 28. Baranwal D, Tomar S, Singh JP, Maurya JK. Effect of foliar application of zinc and boron on fruit growth, yield and quality of winter season guava (*Psidium guajava* L.). Int J Curr Microbiol App Sci. 2017;6(9):1525-9.
 29. Awasthi P, Lal S. Effect of calcium, boron and zinc foliar sprays on the yield and quality of guava (*Psidium guajava*). Pantnagar J Res. 2009;7:223-5.
 30. Yadav HC, Yadav AL, Yadav DK, Yadav PK. Effect of foliar application on micronutrients and GA3 on fruit yield and quality of rainy season guava (*Psidium guajava* L.) cv. L-49. Plant Arch. 2011;11(1):149.
 31. Kate PA, Kadam AS, Shinde SB, Shriram JM. J Pharmacogn. Phytochem. 2020;9(6):1647-50.
 32. Singh HK, Srivastava AK, Dwivedi R, Kumar P. Effect of foliar feeding of micronutrients on plant growth, fruit quality, yield and internal fruit necrosis of aonla (*Embllica officinalis*). Prog Hort. 2001;33(1):80-3.
 33. Poojan S, Pandey D, Trivedi AK, Pandey AK, Pandey M. Efficacy of foliar application of nutrients on yield and quality of guava. J Environ Biol. 2020;41:1061-7.

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