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Effect of Foliar Spray of Micro - Nutrients on Fruit Growth and Yield of Guava (*Psidium guajava* L.) cv. Lalit

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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

Aim: To examine the effect of foliar spray of micro - nutrients on fruit growth and yield of guava (*Psidium guajava* L.) cv. Lalit.

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Study Design: The Randomized Block Design (RBD) experimental design was used.
Place and Duration of Study: An experiment was carried out during Hasth Bahar flowering seasons of 2021-22 and 2022-23 at Horticulture Research Farm of Babasaheb Bhimrao Ambedkar University.
Methodology: There were nineteen treatments with three replication. The variety selected for experiment was Lalit.
Results: The foliar application of Borax 0.2%+Zinc 0.4% was found to be the best treatment in improving the morphological characteristics of guava such as fruit length (8.59 cm), fruit width (8.6cm), fruit volume (169.09 cm), fruit weight (174.99 g), peel weight (17.13g), pulp weight (155.32g),number of seed per fruit (212.49),seed weight per fruit (2.53g), seed weight kg per plant (1.23 kg), pulp and seed ratio (61.29) and specific gravity (1.03 g cc^{-1}) of guava fruit.
Conclusion: On the basis of the result obtained in the present investigation, it is concluded the combined foliar application of Borax 0.2%+Zinc 0.4% (T_{11}). Therefore, combined spray Borax 0.2%+Zinc 0.4% (T_{11}) can be advocated to guava growers for maximum growth and yield parameters of guava.

Keywords: Lalit; foliar application; morphological characters; micro-nutrient; Guava.

1. INTRODUCTION

Guava (*Psidium guajava* L.), a tropical fruit crop, belongs to the Myrtaceae family of fruit plants. Hayes (1970) estimated that there are about 150 species present. Tropical America, from Mexico to Peru, is its native habitat. It has gradually become more economically significant as a fruit crop in many different nations. It was introduced to India in the early 17th century, and it has since proliferated there as a crop used for commercial. Guava is mostly grown in Uttar Pradesh, Madhya Pradesh, Bihar, Gujarat, Karnataka, Andhra Pradesh, and Maharashtra in India. Cultivated approximately two thousand years ago, the trees quickly spread over the world's tropical regions following the Spanish and Portuguese exploration of the new continent. Nowadays, it may be found in many countries' tropical and subtropical areas, including Australia, Israel, Pakistan, Bangladesh, Burma, Myanmar, New Zealand, Philippines, China, Malaysia, Cuba, Sri Lanka and Venezuela. India is the world's top producer of guava. Total cultivated area is 350 thousand hectares, with an annual production of 5327 thousand MT (Ministry of Agriculture and Farmer's Welfare,2022-2023) and a productivity of 15.22 metric tones per ha. Due to their adaptability and ability to grow in both poorly drained and poorly alkaline soil, guavas are notable fruits. It grows well in soil that has a pH between 4.5 and 8.5 without watering. Above 46°C temperatures are favourable for guava. Garur *et al.* 2016 State that guavas grow well in both tropical and subtropical regions. After Barbados cherry (1000–4000 mg/100 g pulp) and Aonla (600 mg/100 g fruit), guava fruit has the third-highest vitamin C content (200–300 mg/100 g of fruit pulp) (*Yadav* et al*.,* 2011). The guava flowering season occurs naturally in three distinct periods: February-March (Ambe Bahar), June-July (Mrig Bahar), and October-November (Hasth Bahar). The corresponding harvest occurs throughout the rainy, winter, and spring seasons, respectively (Mishra et al., 2020).

The significance of micronutrients in plant metabolism and the negative consequences of their lack make them a major factor in crop output. They play a significant part in determining the quality and shelf life of harvested vegetables, a phenomenon that has traditionally received less attention (Raja, 2009). Applying micronutrients through foliar spraying is possible. Because plants only need trace amounts of it, it is more safely which the leaf's stomata are able to absorb and occasionally via the cuticles. As a way of absorbing availability of nutrients via the leaf's stomata is much more quickly than via roots, this is the technique preferred source to supply plants (Stiles, 1982). In order for the fruit sector to remain competitive in both domestic and international markets, producing fruit of a high standard is becoming increasingly difficult. Thus, the new technology that might be used to produce guava of outstanding quality is the foliar management of micronutrients. According to Singh and Chhonkar (1983), guava responds well to applied micronutrients, especially zinc (Zn), boron (B), copper (Cu), and iron (Fe), which improve growth, production, and fruit quality. The creation of auxin, which promotes cell division and development, requires zinc. Guava bronzing is a serious nutritional condition brought on by a zinc deficiency. For pollen germination and pollen tube expansion, which increase the proportion of fruit setting, boron is far more necessary. For photosynthesis to occur, copper is necessary. Iron is necessary for plants to synthesize chlorophyll and to activate a number of enzymes. A study conducted by Sachin et al., (2019) on guava and suggested that farmers use foliar spray containing 1.0 percent zinc sulphate, 1.0 percent borax, and 1.0 percent copper sulphate. According to Singh et al., (2023) research on guava, foliar spraying 0.2% and 0.4% concentrations of zinc and borax caused a noticeable reaction in guava plants.

Thus, in the subtropical humid agroclimatic zone of Utter Pradesh, the aim of the current experiment was to ascertain the effectiveness of micronutrients on plant growth, physicochemical quality of fruits, yield, and yield attributing factors of young guava plants.

2. MATERIALS AND METHODS

The current research investigation entitled "Effect of foliar spray of micro-nutrients on fruit growth, yield and quality of guava (*Psidium guajava* L.) cv. Lalit was conducted at Horticulture Research Farm-1 of Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Rae Bareli Road, Lucknow-226025 (U.P.), India during the year 2021-2022.The soil of the experiment field was medium black with good drainage and uniform texture with medium NPK status. The detail treatment was Control (T_1),Borax 0.1% (T_2), Borax 0.2% (T_3), Zinc 0.2% (T_4), Zinc 0.4% (T_5), Copper Sulphate (CuSO4) 0.2% (T_6), Copper Sulphate (CuSO4) 0.3% (T_7), Borax 0.1%+Zinc 0.2% (T_8), Borax 0.1%+Zinc 0.4% (T_9), Borax 0.2%+Zinc 0.2% (T_{10}), Borax 0.2%+Zinc 0.4% (T_{11}), Borax 0.1%+Copper Sulphate (CuSO4) 0.2% (T_{12}), Borax 0.1%+Copper Sulphate (CuSO4) 0.3% (T_{13}), Borax 0.2%+ Copper Sulphate (CuSO4) 0.2% (T_{14}), Borax0.2%+ Copper Sulphate (CuSO4) 0.3% (T_{15}), Zinc 0.2%+ Copper Sulphate (CuSO4) 0.2%(T_{16}), Zinc 0.2%+ Copper Sulphate (CuSO4) 0.3%(T_{17}), Zinc 0.4%+ Copper Sulphate (CuSO4) 0.2 % (T_{18}), Zinc 0.4%+ Copper Sulphate (CuSO4) 0.3% (T_{19}) were sprayed first spraying of mico-nutrients were done before flowering (first week of October) and second after fruit set (second week of November during 2021 and November 2022. The experiment was conducted on well-established orchard of 18 years old Lalit guava trees which are planted at 6.0 × 6.0 m spacing. The experiment was laid out in R.B.D. with three replications. All minerals were applied through foliar feeding. Observation was recorded for fruit size (length and width), weight, volume, specific gravity, peel weight, pulp weight, no. of seeds per fruit, seed weight per fruit, seed weight per plant, pulp seed ratio and yield. Following the steps outlined by Panse and Sukhatme (1985), the parameters were statistically analyzed using the suitable model of analysis of variance (ANOVA). Using the "F-test" (variation ratio), the significance of the treatment effect was calculated.

2.1 Method for Preparation of Nutrient Solution

The solutions including borax (1 mg and 2 mg), zinc (2 mg and 4 mg), and copper sulphate (2 mg and 3 mg) were made in accordance with the necessary nutritional concentrations. Using a balance, the necessary amount of nutrients were measured and then dissolved in distilled water in a measuring cylinder to make a volume of 10 liters.

2.2 Methods of Foliar Spray

First spraying of mico-nutrients were done before flowering (first week of October) and second after fruit set (second week of November) during year 2021 and 2022.

2.3 Fruit Length (cm)

When the fruit reached the maturity/harvesting stage, its length was measured. The fruit length was measured with calibrated Vernier Caliper's and expressed in centimeters. The average fruit length of the ten fruits that were taken from the tagged branches was measured (Tiwari et al., 2024).

2.4 Fruit Width (cm)

When the fruit reached maturity or the harvest stage, the width was measured. With the aid of calibrated Vernier Caliper's, the fruit width was measured in centimeters. The average fruit width of the ten fruits that were taken from the tagged branches was measured (Tiwari et al., 2024).

2.5 Volume of the Fruit

Using the water displacement method, the fruit's volume was calculated and expressed in cc (Tiwari et al., 2024).

2.6 Weight of the Fruit (g)

At the point of full maturity, the average fruit weight was measured. The top loading electrical balance was used to weigh the ten fruits that had been tagged from the branches, and the average fruit weight was recorded in grams (Tiwari et al., 2024).

2.7 Pulp Weight (g)

After the pulp was removed from the fruits, its average weight was calculated using physical balance and recorded in grams (Tiwari et al., 2024).

2.8 Pulp: Seed Ratio

The pulp to seed ratio was computed using the following formula once the pulp and seed had been removed from the fruit individually (Tiwari et al., 2024).

Pulp: seed ratio = pulp weight (g)/ stone weight (g)

2.9 Seed Number Per Fruit

The chosen fruits were placed in water for a few days, after which the seeds were taken out and counted (Godage et al., 2013).

2.10 Seed Weight Per Fruit (g)

The seed is weighed individually once the pulp has been removed (Tiwari et al., 2024).

2.11 Specific Gravity (g cc^{-1})

The following formula was used to calculate the specific gravity: fruit weight divided by fruit volume.

Specific gravity = Weight of fruit / Volume of fruit (Tiwari et al., 2024).

3. RESULTS AND DISCUSSION

The data on pooled mean basis is presented in Table 1. The result of present study indicated that the combined application of Borax 0.2%+Zinc 0.4% (T_{11}) produced the fruits with larger size in respect of fruit length (8.59 cm), width (8.63 cm) volume (169 cm^3), weight (174 cm), the maximum fruit pulp weight (155.32gm) and peel weight (17.13 g) which was statistically at par with Borax 0.2%+Zinc 0.2% (T_{10}). The minimum fruit length (5.69 cm), width (6.17 cm), volume (108.07 cm), weight (98.40 cm), the minimum fruit pulp weight (68.48 g) and peel weight (25.38 g) which was found in control (T_1). Fruit size increased as a result of increased cell division and growth rates as well as increased intercellular space from the use of growth agents at greater concentrations. The guava fruit's increased size is caused by endogenous auxin. The fruit's explosive growth occurred with the highest concentration of auxin possible (Sachin et al., 2019). Guava fruits have grown bigger and more rounded, possibly as a result of a combination of micronutrients (copper, zinc, and boron) that appear to directly speed up the process of cell elongation and division, which would have boosted fruit size and weight. The results are in conformity with those reported by guava (Sachin et al., 2019). Similar results have also been reported by Rajput and Chand (1976), Singh et al., (2004), and Pal et al., (2008) in guava.

Minimum no. of seed per fruit (212.49), seed weight (2.53 g) were recorded in the treatment of Borax 0.2%+Zinc 0.4% (T_{11}) followed by Borax 0.2%+Zinc 0.2% (T_{10}). The maximum seed no. of seed per fruit (379.16), weight (4.53 g) and peel weight (25.38 g) were observed in the harvested from untreated plants (Table 2). The pulp/seed ratio (61.29) were observed in Borax 0.2%+Zinc 0.4% (T_{11}) spray treatment followed by Borax 0.2%+Zinc 0.2% (T_{10}). Where minimum fruit pulp weight (68.48 g) and pulp/seed ratio (15.08) were observed in control (Table 2). Pulp /seed ratio is the ratio between the weight of pulp and weight of seed. The pulp weight depends on the fruit and seed size, but is affected by the plant nutrition. Boron produced fruits with smaller seed. This may be due to their involvement in IAA metabolism which reduces seed size. The decrease in seed weight may be due to the fact that auxins induced parthenocarpic effect to some extent there by results lesser seed weight. It pertains to the fact that application of boron enhanced the pulp weight and reduced the seed weight which as a consequence gave high pulp/seed ratio. The results are in close conformity with the finding of Kaur, S. (2017) in litchi Adak et al., (2013) in apricot, Meena et al., (2005) in guava, Kumar et al., (2017) in aonla and support the present result.

Table 1. Effect of foliar spray of micronutrients on growth and yield parameters

Treatments	Fruit length (cm)	Fruit width (cm)	Fruit volume (cm^3)	Fruit weight (g)	Pulp weight (g)	Peel weight (g)
Control (Water spray) - T_1	5.69	6.18	108.08	98.40	68.49	25.39
Borax 0.1% - T_2	6.00	6.36	120.57	110.98	83.17	23.51
Borax 0.2% - T_3	6.26	6.53	124.79	115.46	88.50	22.82
Zinc 0.2% - T_4	6.44	6.70	128.26	119.95	93.58	22.36
Zinc 0.4% - T_5	6.57	6.84	130.31	123.17	97.26	22.08
Copper Sulphate (CuSO4) 0.2% - T_6	6.78	7.08	138.33	132.13	107.23	21.30
Copper Sulphate (CuSO4) 0.3% - T_7	6.67	6.92	134.20	127.54	102.12	21.69
Borax 0.1%+Zinc 0.2% - T_8	7.20	7.53	147.56	143.89	121.18	19.42
Borax 0.1%+Zinc 0.4% - T_9	8.21	8.40	166.75	169.22	148.89	17.64
Borax 0.2%+Zinc 0.2% - T_{10}	8.38	8.53	167.67	171.84	151.85	17.38
Borax 0.2%+Zinc 0.4% - T_{11}	8.59	8.64	169.09	174.99	155.32	17.13
Borax 0.1%+Copper Sulphate (CuSO4) 0.2% - T_{12}	7.34	7.70	150.51	147.50	124.91	19.40
Borax 0.1%+Copper Sulphate (CuSO4) 0.3% - T_{13}	7.47	7.83	153.87	151.58	129.34	19.16
Borax 0.2%+ Copper Sulphate (CuSO4) 0.2% -T_{14}	8.06	8.28	164.16	164.96	144.14	18.03
Borax0.2%+ Copper Sulphate (CuSO4) 0.3% - T_{15}	7.64	7.95	155.19	153.64	131.83	18.80
Zinc 0.2%+ Copper Sulphate (CuSO4) 0.2% - T_{16}	7.98	8.14	161.02	161.02	139.91	18.25
Zinc 0.2%+ Copper Sulphate (CuSO4) 0.3% - T_{17}	7.86	7.99	157.29	157.29	135.81	18.54
Zinc 0.4%+ Copper Sulphate (CuSO4) 0.2% - T_{18}	7.05	7.38	145.12	140.06	116.46	20.20
Zinc 0.4%+ Copper Sulphate (CuSO4) 0.3% - T_{19}	6.92	7.22	140.63	135.72	111.70	20.51
C.D.	**0.10**	**0.25**	**4.44**	**3.89**	**5.08**	**0.58**
SE(m)	**0.07**	**0.09**	**1.54**	**1.35**	**1.76**	**0.20**

Table 2. Effect of foliar spray of micronutrients on growth and yield parameters

Treatments	Number of seed per fruit	Seed weight per fruit (g)	Pulp/ seed ratio	Specific gravity (g cc^{-1})	Yield per plant (kg)
Control (Water spray) - T_1	379.16	4.53	15.08	0.91	6.29
Borax 0.1% -T_2	359.33	4.29	19.34	0.92	9.41
Borax 0.2% -T_3	346.06	4.14	21.37	0.92	11.84
Zinc 0.2% -T_4	334.83	4.00	23.37	0.94	14.49
Zinc 0.4% - T_5	321.08	3.84	25.34	0.94	16.76
Copper Sulphate (CuSO4) 0.2% - T_6	301.50	3.61	29.76	0.96	23.28
Copper Sulphate (CuSO4) 0.3% - T_7	311.75	3.73	27.40	0.95	19.05
Borax 0.1%+Zinc 0.2% - T_8	275.83	3.30	36.75	0.98	33.06
Borax 0.1%+Zinc 0.4% - T_9	225.42	2.69	55.31	1.01	66.02
Borax 0.2%+Zinc 0.2% - T_{10}	218.66	2.61	58.17	1.02	74.28
Borax 0.2%+Zinc 0.4% - T_{11}	212.49	2.54	61.29	1.04	85.50
Borax 0.1%+Copper Sulphate (CuSO4) 0.2% - T_{12}	266.99	3.19	39.13	0.98	38.26
Borax 0.1%+Copper Sulphate (CuSO4) 0.3% - T_{13}	258.00	3.08	41.93	0.98	41.37
Borax 0.2%+ Copper Sulphate (CuSO4) 0.2% - T_{14}	232.66	2.78	51.86	1.00	60.42
Borax0.2%+ Copper Sulphate (CuSO4) 0.3% - T_{15}	251.41	3.00	43.88	0.99	44.48
Zinc 0.2%+ Copper Sulphate (CuSO4) 0.2% - T_{16}	239.33	2.86	48.93	0.10	54.73
Zinc 0.2%+ Copper Sulphate (CuSO4) 0.3% - T_{17}	245.66	2.94	46.26	1.00	49.08
Zinc 0.4%+ Copper Sulphate (CuSO4) 0.2% - T_{18}	284.49	3.40	34.24	0.96	31.48
Zinc 0.4%+ Copper Sulphate (CuSO4) 0.3% - T_{19}	294.08	3.52	31.78	0.97	26.93
C.D.	**8.25**	**0.10**	**1.14**	**0.03**	**1.21**
SE(m)	**2.87**	**0.04**	**0.39**	**0.01**	**0.42**

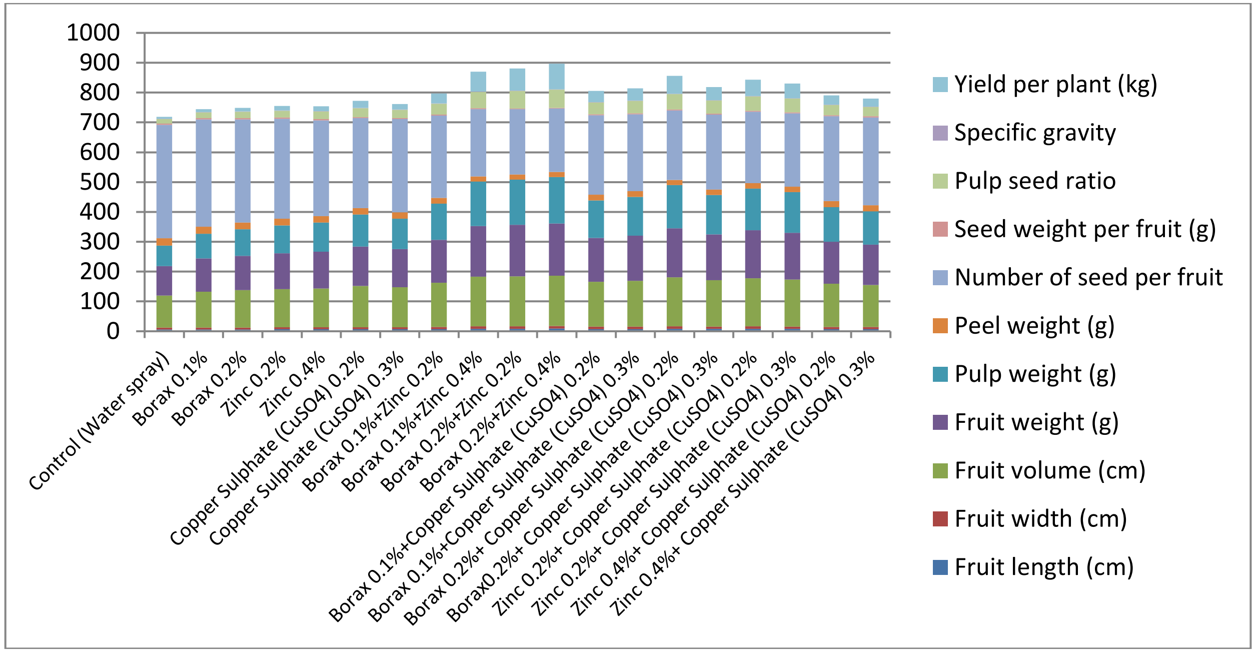

Fig. 1. Effect of foliar spray of micronutrients on growth and yield parameters

The data pertaining to specific gravity of guava as presented in Table 2 clearly indicated that the foliar application of growth regulators and nutrients significantly increased specific gravity of guava fruit over control (T_1). The critical observation of the data showed that maximum specific gravity (1.03) was found in treatment Borax 0.2%+Zinc 0.4% (T_{11}) followed by (1.02) Borax 0.2%+Zinc 0.2% (T_{10}). The minimum specific gravity was noticed in control (T_1). The results are in close conformity with the finding of Banik et al., (1997) in mango.

A perusal of pooled mean basis data in Table 2 show that significantly response in the fruit yield was found in treated plants as compared to control the maximum fruit yield (85.50 kg per tree) was recorded in Borax 0.2%+Zinc 0.4% (T_{11}) followed by Borax 0.2%+Zinc 0.2% (T_{10}) (Kumar et al., 2014, Adak et al., 2023, Anonymous, 2021]. While minimum fruit yield was recorded in control (T_1). The fruit yield increased gradually with the increase in the dose of combined foliar spray of zinc sulphate, borax, and copper sulphate (Chaudhry et al., 2018). This is because plants receive boron from the borax treatment. By forming a complex molecule, boron was thought to cause the inactivation of unnecessary growth hormone (Mondal et al., 2023). It is uncertain if this element had a direct or indirect impact on the improved physiological activities of the plant after it was discharged. Fruit from these actions will eventually have greater length and breadth, which will increase fruit production. Further findings showed that applying both nutrients (B & Zn) at the same time improved the fruit production (Raipuriya et al., 2024). It may be the result of a considerable rise in fruit length, fruit diameter, and seed cavity diameter, which may be related to their stimulatory influence on auxins synthesis and plant metabolism Kumar et al., (2014). These results are in close conformity with the finding of Kumar et al., (2019) in guava (Singh, et al., 1983, 22].

4. CONCLUSION

The combined foliar spray of Borax 0.2%+Zinc 0.4% (T11) was determined to be the most appropriate in terms of fruit length (cm), fruit width (cm), fruit volume (cm3), fruit weight (g), pulp weight (g), and peel weight (g), no of seed per fruit, seed weight per fruit (g) and specific gravity (g cc-1) based on the results of the current experiment. Thus, it can be recommended to guava producers for guavas with maximum development and yield criteria.

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 this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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