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Research Article

Foliar application of growth regulators and nutrients for enhanced yield attributes of guava *cv* Lalit

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Abstract

The quality of guava (*Psidium gujava* L.) is highly laden by improper crop management, which can only be solved by the use of bio stimulants either through foliar feeding of nutrition or growth regulator application. To carry out this new strategy to sustain the quality of guava through the combination of nutrients and growth regulators, the present study was carried out during 2018-19 in a 20-years-old orchard using the foliar application of zinc sulfate (0.5%), borax (0.5%), GA_3 (50 ppm), and NAA (40 ppm) either alone or in combinations, comprised of 9 treatments and 3 replications under randomized block design. The results revealed that plants treated with 0.5% Borax along with 50 ppm GA_3 significantly increased fruit set (64.16 %), fruit retention (56.32%), fruit yield (65.63 kg/plant), and physical attributes of fruits compared to control.

Keywords borax, foliar application, fruit quality, GA_3, *Psidium guajava*

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Introduction

Guava (*Psidium guajava* L.) has become more popular among consumers during the pandemic due of its great nutritional value and superior vitamin C concentration. Although in India guava ranks 4th position in fruit crops with regard to the area (2.87 mha) and production (43.04 MT ha^{-1}) but the productivity of this crop lacks behind due to improper orchard management [1]. Therefore, it is a priority to increase guava production quality using simple, cost- and environmentally-friendly methods. Which, using bio-stimulants is a sustainable technique to improve the quality of guava output. Any substances or microbes that can promote plant growth and development by affecting a variety of metabolic processes, storing nutrients in leaves to produce biomass, and shielding plants from biotic and abiotic stress are considered bio-stimulants [2]. Apart from the organic plant bio-stimulants (plant growth-promoting rhizobacteria, humic and fulvic substances amino acids, seaweed extracts, yeast, and chitosan), inorganic bio stimulants (essential elements, plant growth regulators, antioxidants, inorganic salts, and phenolic compounds) are gaining popularity in the horticulture sector [2]. The foliar application of growth regulators improves the physical characteristics of fruits, such as fruit weight, fruit volume edible to non-edible ratio, fruit polar diameter, and fruit equatorial diameter, which finally translated into higher fruit production [3]. Guava tends to grow in alkaline soil, where the loss of micronutrients like boron and zinc as the pH raises results in lower yield and inferior quality [4]. Micronutrients and plant growth regulators can be applied foliar to fruit crops, which have been demonstrated to reduce blooming and improve fruit set, retention, and quality [5]. of all the necessary elements, zinc is an important micronutrient because it participates in the metabolism of carbohydrates and proteins through a variety of enzymatic processes [6]. The developmental activity of plants due to zinc is only possible, as it structurally holds up many enzymes or regulates the enzymatic process as a metal component [7]. Similarly, the role of boron in reproductive growth especially in pollen tube formation and its elongation inside the style Singh et al., [8] is well known; however, other activities such as translocation of sugar like mannitol and sorbitol, active salt absorption, hormonal regulation was confirmed by Davis et al., [9]. The role of boron in the dry matter accumulation through cell wall maintenance by forming the B-pectin complex was well established by Lopez-lefebre et al., [10]. Despite all these benefits of bio-stimulants either in form of nutrients or plant growth regulators, literature regarding their combined use is limited Suman et al., [11] and the farmers from Uttar Pradesh are still unaware to use it in guava orchards to fetch a maximum return. Based on the context, this experiment was executed to assess the influence of phyto bio-stimulants on the horticultural performance of guava during the winter season.

Methodology

Material

The experiment was conducted in 20-year-old orchards during the year 2018-19 at the Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh. The experimental site covers a subtropical climate region with temperatures ranging from 12-42°C, annual rainfall of 700-1000 mm, and relative humidity of 50-77% in different seasons of the year. The soil texture of the experimental site was clay loam which is well drained and well aerated with a pH of 8.0 and plant available $KMnO_4$- 171.5 mg/kg, Olsen-P- 12.50 mg/kg, and NH_4OAc-K- 180.9 mg/kg. Twenty-year-old uniform guava (*cv* Lalit) plants spaced 6x6 m apart were chosen for study. The experiment had nine treatments consisting of two nutrients $ZnSO_4$ (0.5%) and borax (0.5%) and two hormones NAA (40 ppm) and GA_3 (50 ppm) and their combinations (0.5% $ZnSO_4$ + 40 ppm NAA, 0.5% Borax + 40 ppm NAA, 0.5% $ZnSO_4$ + 50 ppm GA_3 and 0.5% Borax + 50 ppm GA_3), with three replications and was set up in a Randomized Block Design. The crop received its initial foliar spray of micronutrients and plant growth regulators in the first week of August, which coincided with the fruit set, then the same treatment in the second week of September during the fruit development stage. During the experimental study, the crops were fed with the recommended dose of fertilizers i.e. 600g N, 300g P_2O_5¬, and 300g K_2O.

Fruit set

Five terminals per direction were randomly tagged and counted the fruit set at the pea stage and subsequently, the fruits were counted at harvesting. The fruit set was expressed percentage. It was calculated by the following formula:

$$\text{Fruit set (\%)} = \frac{\text{Number of fruit set}}{\text{Number of flower appeared}} \times 100$$

Fruit retention

The total number of fruits on the selected branches was counted at the initial stages and the fruits number retained was counted at harvest. Percent fruit retention was calculated as follows:

$$\text{Fruit retention (\%)} = \frac{\text{Total number of fruits retained}}{\text{Total number of fruits set}} \times 100$$

Fruit yield

Every time guava fruits were harvested for each treatment, the weight of the fruits was recorded, and the final harvesting yield per plant was computed.

Fruit length

A digital vernier calliper was used to measure the length of five fruits from each replication. The measurement was given in centimeters (cm).

Fruit width

Using a vernier calliper, the width of five fruits from each replication was measured. The width was given in cm.

Fruit weight

Using a digital weighing balance, the weight of five fruits from each replication was recorded. The weight of each fruit was calculated and expressed in grams.

Fruit volume

The volume of five fruits from each replication was recorded by the water displacement method and the average fruit volume was expressed in terms of cm^3.

Statistical analysis

The experiment was laid out as per randomized block design and data was analyzed using the statistical software SAS 9.4. The interaction means were subjected to analysis of variance and pairwise comparison using LSD ($p \leq 0.05$) were found significant.

Results and Discussion

Results highlighted through Table 1 showed that maximum fruit set (64.16%), fruit retention (56.32%) fruit yield (65.63 kg $plant^{-1}$), fruit length (6.95 cm), fruit width (6.78 cm), fruit weight (134.81 g), and fruit volume (132.35 cm^3) were observed with treatment T_9 (Borax 0.5 % + GA_3 50 ppm) followed by plants take only one dose of boron in the form of borax @ 0.5% (T_3). In contrast, minimum values were observed with control. The findings also revealed that foliar treatments of micronutrients and plant growth regulators are more effective than a single dose of micronutrients and plant growth regulators. Among the two different trace elements ($ZnSO_4$ and Borax), the role of borax was observed as superior in attaining a higher yield in guava. The sole application of micronutrients and plant growth regulators is performed better than the control.

Gibberellins and boron may play a role in the transfer of carbohydrates and auxin production to the sink, as well as enhanced pollen viability and fertilization, resulting in higher fruit set and fruit retention [11]. Priyadarshi et al., [12] observed that foliar application of 0.75% boric acid resulted in increased fruit set and fruit retention in litchi when compared to control, indicating the role of boron in pollen germination and pollen tube growth led to reduced fruit drop and ultimately increased fruit retention. Similar studies were also observed by Das et al., [6] in cauliflower, where borax and Zn played a significant role in improving yield and quality.

The increase in fruit yield owing to foliar feeding of plant bio-regulators and micronutrients by plant leaves could be related to more luxuriant vegetative development at the start, which leads to the production of more metabolites for developing fruits later on [7]. GA_3 promotes cell division activity indirectly through auxin production, which could explain the rise in fruit length [11]. With the application of a higher concentration of growth chemicals, the rate of cell division and cell expansion was enhanced, resulting in more intercellular space and larger fruits. It could be because boron accelerates cell division and elongation, increasing fruit size and weight. GA_3 increased solid deposition, which increased cell size by increasing intercellular water accumulation [13]. El-Otmani and Ait-Oubahou [14] found that applying GA_3, a plant growth regulator, to Washington navel trees at concentrations of 10 and 20 ppm increased the weight of the fruit produced. El-Otmani [15] states that gibberellic acid plays a crucial role in enhancing the formation of fruit and ensuring their proper growth and development. Applying GA_3 to young grapefruit fruits through the leaves has increased the weight of the fruit [16]. Abd El-Migeed [17] on 'picual' olive stated that boric acid spray at 300 mgl^{-1} improved fruit length. Khayyat [18] conveyed that boric acid at

Table 1. Effect of phyto bio-stimulants on yield attributing parameters of guava *cv* Lalit

Treatments	Fruit set (%)	Fruit retention (%)	Fruit yield (kg plant^{-1})	Fruit length (cm)	Fruit width (cm)	Fruits weight (g)	Fruit volume (cm^3)
T_1: Control	49.15 ± 1.22^{d}	40.47 ± 1.03^{d}	44.36 ± 1.02^{d}	4.87 ± 0.05^{f}	4.61 ± 0.05^{f}	82.63 ± 1.00^{d}	89.29 ± 1.20^{c}
T_2: $ZnSO_4$ 0.5 %	56.08 ± 1.40^{bcd}	46.45 ± 1.18^{cd}	48.75 ± 1.12^{cd}	5.65 ± 0.06^{de}	4.93 ± 0.05^{e}	107.88 ± 1.31^{c}	111.42 ± 1.50^{b}
T_3:Borax 0.5 %	61.69 ± 1.54^{ab}	53.68 ± 1.37^{ab}	60.70 ± 1.39^{ab}	6.37 ± 0.07^{b}	6.54 ± 0.06^{a}	130.81 ± 1.59^{ab}	129.96 ± 1.74^{a}
T_4: NAA @ 40 ppm	53.04 ± 1.32^{cd}	48.24 ± 1.23^{bc}	43.24 ± 0.99^{d}	5.57 ± 0.06^{de}	5.20 ± 0.05^{cde}	125.47 ± 1.53^{b}	126.16 ± 1.69^{a}
T_5: GA_3 @ 50 ppm	50.67 ± 1.26^{d}	48.30 ± 1.23^{bc}	48.72 ± 1.12^{cd}	5.82 ± 0.06^{cde}	5.04 ± 0.05^{de}	126.77 ± 1.54^{b}	129.57 ± 1.74^{a}
T_6: $ZnSO_4$ 0.5 % + NAA @ 40 ppm	59.52 ± 1.48^{abc}	50.66 ± 1.29^{abc}	54.59 ± 1.25^{bc}	5.54 ± 0.06^{e}	5.36 ± 0.05^{c}	123.91 ± 1.50^{b}	125.98 ± 1.69^{a}
T_7: Borax 0.5 % + NAA @ 40 ppm	59.78 ± 1.49^{abc}	51.99 ± 1.33^{abc}	58.38 ± 1.33^{b}	5.91 ± 0.06^{cd}	5.26 ± 0.05^{cd}	125.96 ± 1.53^{b}	126.83 ± 1.70^{a}
T_8: $ZnSO_4$ 0.5 % + GA_3 @ 50 ppm	60.86 ± 1.52^{ab}	52.32 ± 1.33^{abc}	59.22 ± 1.36^{b}	6.11 ± 0.07^{bc}	5.91 ± 0.06^{b}	129.81 ± 1.58^{ab}	129.48 ± 1.74^{a}
T_9: Borax 0.5 % + GA_3 @ 50 ppm	64.16 ± 1.60^{a}	56.32 ± 1.44^{a}	65.63 ± 1.50^{a}	6.95 ± 0.08^{a}	6.78 ± 0.07^{a}	134.81 ± 1.63^{a}	132.35 ± 1.77^{a}
Tukey HSD ($p \leq 0.05$)	**7.11**	**6.34**	**6.17**	**0.35**	**0.30**	**7.35**	**8.20**

*Means with the same letter are not significantly different at ($P < 0.05$).

1500 mgl^{-1} on 'Shahany' date palm has better pulp weight, pulp/seed ratio; fruit length, and diameter.

Conclusion

The study showed that applying borax and GA_3 via foliar sprays on guava crops led to notable improvements in fruit set, fruit retention, and yield. The most effective treatment for enhancing guava fruit yield and physical characteristics in the field involved applying the recommended amount of fertilizers to the soil and using 0.5% borax and 50 ppm GA_3 in a foliar spray.

Authors' Contribution

Conceptualization and design of research work (MLM, AKS, DD); Execution of field/lab experiments and data collection (DD, VS, VK); Analysis of data and interpretation (DD, DH, VS); Preparation of the manuscript (DD).

Declaration

The authors do not have any conflict of interest.

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