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Paclobutrazol's effect on guava's physio-chemical properties (*Psidium guajava* L.)

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Abstract

A field experiment entitled "Effect of Paclobutrazol on Guava (*Psidium guajava* L.) cv. L-49" was carried out during the 2022-2023 cropping season at the Department of Fruit Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (formerly Faizabad), Uttar Pradesh, India. The study was undertaken to evaluate the influence of different paclobutrazol treatments on the growth, flowering, fruiting, and yield attributes of guava cultivar L-49 under the agro-climatic conditions of the region. The experiment revealed significant findings in various aspects. Treatment T₇, which involved the application of 6 g Paclobutrazol TSLP through soil drenching, exhibited noteworthy results highest fruit weight (235.00 g), fruit length (7.60 cm), fruit width (7.30 cm), fruit volume (228.00 ml), TSS (12.60 °Brix), ascorbic acid (114.00 mg/100gm pulp) and total sugar (10.07%) while minimum result reported in control treatment under plain of northern India.

Keywords: Guava, paclobutrazol, growth regulator, soil drenching, quality parameters

Introduction

Guava (*Psidium guajava* L.) is one of the most important fruit crops cultivated across tropical and subtropical regions of the world. It belongs to the family *Myrtaceae* and possesses a diploid chromosome number of $2n = 22$. The crop is believed to have originated in tropical America, extending from Mexico to Peru, and has since spread to many countries because of its excellent adaptability and economic value. Guava is widely appreciated for its prolific bearing habit, pleasant aroma, attractive flavour, and exceptionally high vitamin C content, making it a commercially important fruit crop. The genus *Psidium* comprises nearly 150 species, although the exact number may vary with ongoing taxonomic revisions. Among these, *Psidium guajava* is the principal cultivated species and has the greatest commercial importance. The fruit is consumed fresh as well as processed into a variety of value-added products, including juices, jams, jellies, beverages, and desserts. In addition to its culinary versatility, guava is recognized as a nutritious fruit due to its rich content of vitamin C, dietary fibre, antioxidants, and other health-promoting phytochemicals.

Psidium guajava L. (common guava) is the most extensively cultivated and economically important species of guava. It is a hardy, evergreen, shrub-like fruit tree valued for its regular bearing habit, pleasant flavour, attractive aroma, and exceptionally high vitamin C content. In northern India, guava generally produces two, and occasionally three, flowering flushes annually. The spring flowering, known as Ambe Bahar, produces fruits that mature from July to September. The monsoon flowering, referred to as Mrig Bahar, results in fruits harvested between November and February. A third flowering, called Hast Bahar, occurs during October, and its fruits ripen during the following spring or summer season.

Guava trees are small to medium-sized with a spreading canopy. They are easily distinguished by their smooth, thin, copper-brown bark, which peels off in flakes to expose the greenish bark underneath. Because of its adaptability to diverse climatic conditions and consistent productivity, guava has become one of the most important fruit crops in tropical and subtropical regions.

Paclobutrazol (PBZ) is a triazole-based plant growth regulator that suppresses gibberellin biosynthesis, thereby restricting excessive vegetative growth.

In addition to reducing gibberellin levels, paclobutrazol influences the endogenous hormonal balance by lowering the concentrations of abscisic acid, ethylene, and indole-3-acetic acid (IAA), while increasing cytokinin activity (Sarkar *et al.*, 2005) [15]. These physiological changes promote flower bud differentiation, improve fruit set, and enhance fruit retention.

The application of paclobutrazol has been widely recognized for its role in orchard management. It helps regulate vigorous vegetative growth, induces early and uniform flowering, promotes precocious bearing, minimizes alternate bearing, facilitates high-density planting, and contributes to the rejuvenation of old orchards (Saran *et al.*, 2008) [14]. Similarly, Singh (2018) [16, 17] reported that higher doses of paclobutrazol significantly increased fruit yield in ber, demonstrating its economic benefits.

Earlier studies by Koodziejczak and Tymoszuik (1992) revealed that soil application of Cultar (paclobutrazol) at 1 g per tree produced the highest cumulative fruit yield (50.2 kg tree⁻¹) during 1986-1989, whereas foliar application resulted in the lowest yield (13.8 kg tree⁻¹). The authors also observed that paclobutrazol had no significant influence on fruit size, while foliar application increased fruitlet drop. Furthermore, the combined application of Alar and Ethrel did not significantly affect tree growth or fruit yield.

Several investigations have demonstrated that paclobutrazol positively influences the vegetative growth, flowering, and fruiting behaviour of guava. Its application improves shoot development, increases the number of new shoots per branch, enhances flowering intensity, and promotes better fruit set and overall productivity, making it an effective growth regulator for improving guava production.

Materials and Methods

The present experiment were conducted at the Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) on 10-year-old guava plants during two consecutive years i.e., 2022 and 2023. The Ayodhya district is located at 26.47° N latitude, 80.120° E longitude, and 113 m mean sea level. The location is situated in typical Indo-Gangetic plains soils, which are salty and alkaline.

T₁-Control (untreated plant), T₂-2gm Paclobutrazol per m canopy diameter (ring basin method), T₃-4gm Paclobutrazol per m canopy diameter (ring basin method), T₄-6gm Paclobutrazol per m canopy diameter (ring basin method), T₅-2gm Paclobutrazol per m canopy diameter (Trunk Soil Line Pore method), T₆-4gm Paclobutrazol per m canopy diameter (Trunk Soil Line Pore method), and T₇-6 gm Paclobutrazol per m canopy diameter (Trunk Soil Line Pore method). NOTE-Time of drenching: First week of August 2022

Observation to be recorded

1. Fruit weight (g)

Five randomly selected fruits are selected from each treatment replication, weighed on an electronic balance, and the average fruit weight in grams is reported.

2. Fruit length (cm)

Fruit length (cm) was determined using a Vernier caliper by measuring the distance from the apex to the stem end, and the mean values were recorded

3. Fruit width (cm)

Fruit width (cm) was measured at the widest point using a Vernier caliper, and the average value was recorded.

4. Fruit volume (ml)

Fruit weight was measured at each harvest for every treatment. The cumulative fruit weight obtained from all harvests was used to estimate the total yield per plant, which was expressed in kilograms (kg).

5. Specific gravity

The specific gravity was determined by fruit weight dividing by fruit volume using the following formula.

Specific gravity = weight of fruit/volume of fruit

6. Total soluble solids (TSS °Brix)

The total soluble solids (TSS) content of crushed guava fruit samples was measured using a hand-held refractometer with a measurement range of 0-32%. The readings were standardized to 20 °C and reported as the percentage of total soluble solids in the guava fruits.

7. Acidity

Acidity (%) = Titerate value x Normality of Alkali x 64 x volume made up / Aliquot is taken x volume of sample x 1000 × 100

8. Ascorbic acid (mg/100 gm pulp)

Dye factor = 0.5 Titrant volume of standard ascorbic acid

Ascorbic acid (%) = Titrant value x Dye factor x Volume made up / Aliquot is taken for estimation x Volume of a sample taken × 100

9. Reducing sugars (%)

Reducing sugars (%) = (Blank titrate value - Sample titrate value) x Volume made up (100 ml) / Aliquot taken (3 ml) x Volume of sample taken (5 ml)

10. Non-reducing sugar (%)

Non reducing sugar (%) = {Total invert sugar (%) - Reducing sugar (%)} × 0.95

11. Total sugar (%)

Total sugar (%) = Reducing sugar (%) + Non Reducing sugar (%)

Statistical analysis

The data obtained were statistically analyzed in Randomised Block Design (RBD). The significance of treatment effects was tested using F-test and critical differences (CD) at a 5% probability level were calculated for comparison among treatment means. The experimental data were analysed statistically with the analysis of variance method given by Panse and Sukhatme (1985) [13].

Results and Discussion

Paclobutrazol application had a significant effect on fruit quality attributes, including fruit weight (g), fruit length (cm), fruit width (cm), fruit volume (ml), total soluble solids (TSS, °Brix), acidity, ascorbic acid (mg/100 g pulp), reducing sugars (%), non-reducing sugars (%), and total sugars (%). Among the treatments, the application of paclobutrazol at 6 g per metre of canopy diameter through the Trunk Soil Line Pore Method (TSLPM) (T₇) produced the most favorable results for all evaluated fruit quality parameters.

Fruit weight (g), Fruit length (cm), Fruit width (cm), and Fruit volume (ml)

The data presented in Table 1 and Figure 1 demonstrate that the application of paclobutrazol significantly influenced the physical characteristics of guava fruits (cv. L-49) during the 2022-2023 experimental period. Among all the treatments, T₇ (6 g paclobutrazol applied through the Trunk Soil Line Pore method) produced the most favourable results, recording the highest fruit weight (235.00 g), fruit length (7.60 cm), fruit width (7.30 cm), and fruit volume (228.00 cm³). The next best performance was observed under T₄ (6 g paclobutrazol applied through the Ring Basin method), which recorded a fruit weight of 225.00 g, fruit length of 7.40 cm, fruit width of 7.10 cm, and fruit volume of 218.00 cm³. In contrast, the untreated control (T₁) produced the smallest fruits, with a fruit weight of 185.00 g, fruit length of 5.40 cm, fruit width of 5.90 cm, and fruit volume of 183.20 cm³.

The improvement in fruit size and weight following paclobutrazol application may be attributed to its ability to regulate vegetative growth and enhance the partitioning of assimilates towards developing fruits. Suppression of excessive shoot growth likely reduced competition for carbohydrates, thereby increasing the availability of photosynthates for fruit development. Enhanced nutrient utilization and improved source-sink relationships may also have contributed to the observed increase in fruit weight and volume.

The present findings are consistent with earlier reports on the beneficial effects of paclobutrazol in fruit crops. Kumar *et al.* (2020) [11] reported that paclobutrazol effectively regulated canopy growth and promoted flowering in mango, thereby improving fruit development. Similar observations were made by Singh and Kaur (2018) [16, 17], who reported that paclobutrazol significantly enhanced fruit size and related physical attributes in guava. Comparable responses have also been documented in avocado by Adato (1990) [1], where paclobutrazol increased fruit weight through improved assimilate distribution. Furthermore, studies by Brar (2010) [6] in guava and Burondkar *et al.* (2013) [7] in mango also demonstrated positive effects of paclobutrazol on fruit growth and quality. These findings support the results of the present investigation, indicating that the application of 6 g paclobutrazol, particularly through the Trunk Soil Line Pore method, is effective in improving the physical characteristics of guava fruits under the experimental conditions.

Total soluble solids (TSS °Brix), Ascorbic acid (mg/100 gm pulp), Reducing sugars (%), Non-reducing sugar (%), Total sugar (%) and Acidity

A critical analysis of Table 4.1 and Fig. 1 revealed that paclobutrazol treatments significantly influenced the biochemical quality attributes of guava cv. L-49 during the 2022-2023 experimental period. Significant variation was observed in total soluble solids (TSS), ascorbic acid, reducing sugars, non-reducing sugars, total sugars, and fruit acidity among the different treatments.

Among all the treatments, application of paclobutrazol at 6 g per metre canopy diameter through the Trunk Soil Line Pore (TSLP) method (T₇) produced the most favourable fruit quality. This treatment recorded the highest total soluble solids (12.60 °Brix), ascorbic acid content (114.00 mg/100 g pulp), reducing sugars (5.30%), non-reducing sugars (4.77%), and total sugars (10.07%), while the lowest acidity (0.17%) was also observed under this treatment.

In contrast, the untreated control (T₁) exhibited the lowest values for most quality parameters, including total soluble solids (8.40 °Brix), ascorbic acid (70.60 mg/100 g pulp), reducing sugars (3.82%), non-reducing sugars (3.44%), and total sugars (7.26%). The highest acidity (0.32%) was recorded in the control, indicating comparatively inferior fruit quality.

The results suggest that increasing the dose of paclobutrazol improved the accumulation of soluble solids, sugars, and ascorbic acid while reducing fruit acidity. The enhancement in sugar content may be attributed to improved carbohydrate synthesis, translocation, and accumulation in developing fruits, resulting in better fruit quality.

The present findings are consistent with earlier reports. Faizan (2000) [9] also observed that paclobutrazol application enhanced reducing sugar content in litchi. Similarly, Blanco *et al.* (1998) [5] reported an increase in non-reducing sugars in peach following paclobutrazol treatment. Comparable improvements in fruit quality attributes have also been documented in acid lime by Baskaran *et al.* (2011) [3] and in mango by Nafees *et al.* (2010) [12]. Ahmed *et al.* (2000) [2] reported that paclobutrazol had little effect on fruit acidity in litchi, whereas Jindal and Chandel (1996) [10] observed a reduction in acidity with increasing paclobutrazol concentration in Santa Rosa plum. These variations among crops may be associated with differences in genotype, environmental conditions, and application methods.

Table 1: Paclobutrazol's Effect on Guava's Physio-Chemical Properties (*Psidium guajava* L.)

Symbols used	Treatments	Fruit weight	Fruit length	Fruit width	Fruit volume	TSS	Ascorbic acid	Reducing sugars	Non-reducing sugar	Total sugar	Acidity
T ₁	Control (Untreated plant)	185.00	5.40	5.90	183.20	8.40	70.60	3.82	3.44	7.26	0.32
T ₂	2 gm Paclobutrazol per m canopy diameter (RBM)	212.00	5.80	6.10	191.00	12.10	98.70	4.83	4.35	9.18	0.29
T ₃	4 gm Paclobutrazol per m canopy diameter (RBM)	217.00	6.00	6.60	199.00	12.35	103.70	5.10	4.59	9.69	0.26
T ₄	6 gm Paclobutrazol per m canopy diameter (RBM)	225.00	7.40	7.10	218.00	12.45	105.80	5.25	4.73	9.98	0.23
T ₅	2 gm Paclobutrazol per m canopy diameter (TSLPM)	216.00	5.80	6.40	194.00	12.22	104.30	5.00	4.50	9.50	0.20
T ₆	4 gm Paclobutrazol per m canopy diameter (TSLPM)	224.00	6.40	6.90	208.00	12.46	110.00	5.20	4.68	9.88	0.19
T ₇	6 gm Paclobutrazol per m canopy diameter (TSLPM)	235.00	7.60	7.30	228.00	12.60	114.00	5.30	4.77	10.07	0.17
Sem(±)		9.23	0.26	0.31	7.57	0.25	1.98	0.10	0.11	0.20	0.00
C.D.(P = 0.05)		28.44	0.81	0.95	23.31	0.76	6.11	0.32	0.32	0.61	0.01

RBM = Ring basin method, TSLPM = Trunk Soil Line Pore method

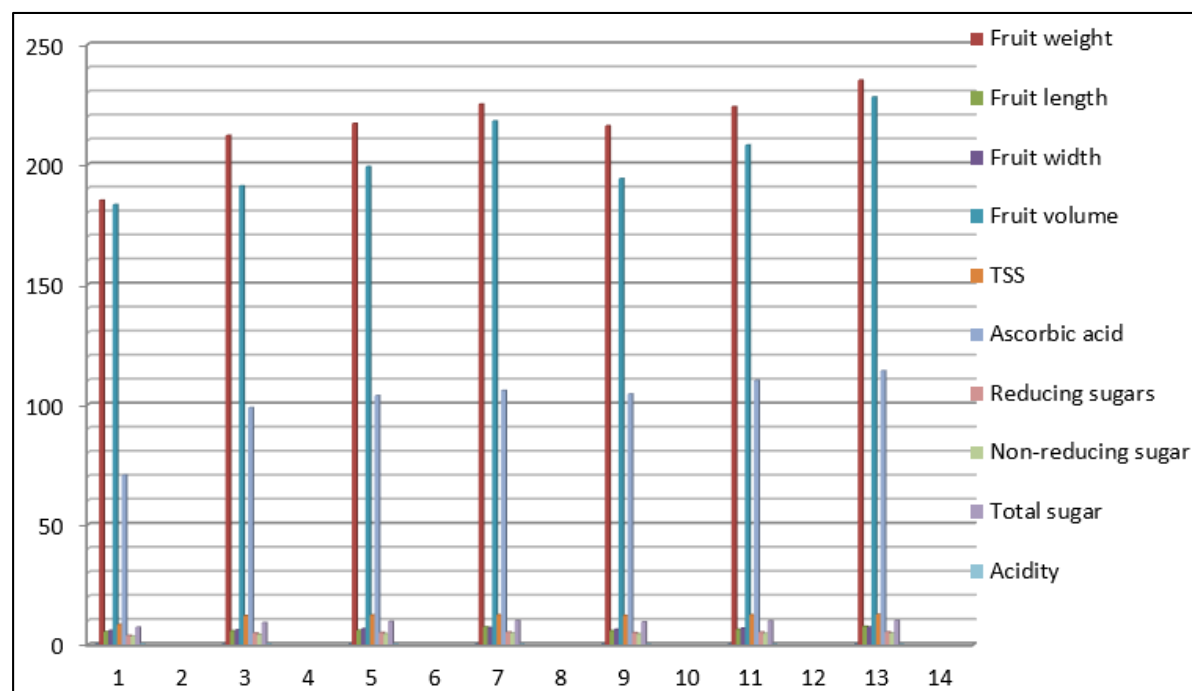


Fig 1: Paclobutrazol's Effect on Guava's Physio-Chemical Properties (*Psidium guajava* L.)

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