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Effect of Pre-harvest Nutrient Application and Bagging with Different Colours of Polythene on Quality of Rainy Season Guava (*Psidium guajava* Linn.) cv. Allahabad Safeda

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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

An investigation was conducted at Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during 2021-22 and 2022-23. The experiment consisted of sixteen treatments viz T_0- Control, T_1- $Ca(NO_3)_2$ (2%), T_2- K_2SO_4 (2%), T_3- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%), T_4- $Ca(NO_3)_2$ (2%) + Bagging (Red colour polythene), T_5- $Ca(NO_3)_2$ (2%) + Bagging (Green colour polythene). T_6- $Ca(NO_3)_2$ (2%) + Bagging (Yellow colour polythene), T_7- $Ca(NO_3)_2$ (2%) + Bagging (Silver colour polythene), T_8- K_2SO_4 (2%) + Bagging (Red colour polythene), T_9- K_2SO_4 (2%) + Bagging (Green colour polythene), T_{10}- K_2SO_4 (2%) + Bagging (Yellow colour polythene), T_{11}- K_2SO_4 2% + Bagging (Silver colour polythene), T_{12}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Red colour polythene), T_{13}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Green colour polythene), T_{14}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Yellow colour polythene), T_{15}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Silver colour polythene) which were arranged in Randomized Block Design (RBD) with three replications. The foliar application of nutrients was done twice at ten days interval. The foliar application of nutrients was done twice at ten days interval days before Fifty-five days harvesting whereas Bagging of fruits was employed approximately at 30 days before harvesting of fruits using red, yellow, silver and green colours polythene bags. Analysis of the data indicated that treatment T_{14}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Yellow colour polythene) reported to be best for parameters namely Average fruit weight (163.88), Fruit width (cm) (8.37), Fruit length (cm) (6.17),Volume of fruits (cm^3) (172.03) Yield/plant (kg) (5.49), Insect damage fruits (%) (0.68), Organoleptic quality (9.78).

Keywords: Bagging; calcium nitrate; potassium sulphate; guava and quality.

1. INTRODUCTION

Guava (*Psidium guajava* Linn.) is a tropical fruit of high economic importance, particularly in India. Cultivators continuously seek methods to enhance the quality and yield of guava, especially during the rainy season. One promising technique is the use of bagging and foliar application of nutrients. This research aims to assess the effects of different colored bags and foliar applications of nutrients on the quality and yield of guava during the rainy season.

Maintaining optimal nutrient levels in plants is crucial for ensuring high-quality fruit production. Among the essential plant nutrients, calcium nitrate (Ca_2) and potassium sulphate (K_2SO_4) play a significant role in improving fruit quality. Calcium nitrate ($Ca(NO_3)_2$) is an essential macronutrient that supports strong cell walls, improves fruit firmness and enhances the shelf-life of fruits [1]. Potassium sulphate (K_2SO_4) is another important nutrient that contributes to the development of larger, sweeter, and more vibrant fruits [1,2]. Potassium plays a critical role in plant metabolism and growth, and it is particularly important for plants under various abiotic stresses [3].

The practice of using bagging materials has become prevalent for various fruits, including guava, pear, apple, grape, peach, banana, longan, mango, dragon fruit, carambola, litchi, Indian jujube, custard apple and citrus. Bagging serves multiple purposes: it enhances fruit appearance, protects against abrasion and temperature fluctuations, prevents diseases and fruit fly infestations and extends shelf-life by two to three days [4]. This environmentally friendly method reduces the need for insecticide spraying, minimizing consumer hazards. Bagging is effective in controlling diseases and insects, improving fruit aesthetics and reducing chemical residues [5].

Pre-harvest fruit bagging is a usual phytosanitary practice aimed at improving both internal fruit standard and visual appeal by promoting fruit coloration. Widely used for guava and other tropical fruits, this technique involves enclosing each fruit or fruit bunch on the tree or plant for a specified duration to achieve desired outcomes. Different bag types can affect fruit size, maturity period, peel-to-pulp colour, mineral content, flavour and taste.

The theory suggests that bagging makes fruits more light-sensitive, fostering anthocyanin synthesis upon exposure to light after removal. Compared to unbagged fruits, the anthocyanin content and enzyme activity involved in phenolic metabolism increase significantly after the bag is removed, possibly due to accumulated heat causing higher respiration rates. Additionally, the carbon dioxide accumulated in the bags may produce more acetaldehyde, reducing astringency.

2. MATERIALS AND METHODS

The present experiment was carried out during 2021-22 and 2022-23 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Naini, Prayagraj, located in the southeastern part of Uttar Pradesh, positioned between 24° 77' to 25° 47' north latitudes and 81° 19' to 82° 21' east longitudes. The region falls under a subtropical climate zone characterized by hot, dry summers, warm and humid monsoons, and fairly cold, dry winters. The experiment was laid out with sixteen treatments which were replicated thrice. The experiment was carried out with the objective to study the effect of bagging and foliar application of nutrients on quality of guava during rainy season. The treatments were T_0- Control, T_1- $Ca(NO_3)_2$ (2%), T_2- K_2SO_4 (2%), T_3- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) T_4- $Ca(NO_3)_2$ (2%) + Bagging (Red colour polythene), T_5- $Ca(NO_3)_2$ (2%) + Bagging (Green colour polythene). T_6- $Ca(NO_3)_2$ (2%) + Bagging (Yellow colour polythene), T_7- $Ca(NO_3)_2$ (2%) + Bagging (Silver colour polythene), T_8- K_2SO_4 (2%) + Bagging (Red colour polythene), T_9- K_2SO_4 (2%) + Bagging (Green colour polythene), T_{10}- K_2SO_4 (2%) + Bagging (Yellow colour polythene), T_{11}- K_2SO_4 2% + Bagging (Silver colour polythene), T_{12}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Red colour polythene), T_{13}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Green colour polythene), T_{14}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Yellow colour polythene), T_{15}- $Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Bagging (Silver colour polythene). The experiment was conducted using a Randomized Block Design (RBD) with three replications. The foliar application of nutrients was done twice, at 10-day intervals, 55 days before harvesting. Bagging of the fruits was employed approximately 30 days before harvesting. The fruits were covered with red, yellow, silver, and green polythene bags. Uniform-sized fruits were marked in all directions of the tree canopy. Each individual fruit was covered with a different-colored polythene bag and tied with a thread on the fruit stalk. The study was carried out over two consecutive seasons, July 2021-22 and July 2022-23. The following observations were recorded: Average Fruit Weight (g): Measured individually for each fruit. Fruit Width (cm): Measured using a digital caliper. Fruit Length (cm): Measured using a digital caliper. Fruit Volume (cm^3): Calculated using the water displacement method. Yield per Plant (kg): Weighed for each plant. Insect Damage Fruits (%): Visually assessed and recorded as a percentage of the total fruits.

3. RESULTS AND DISCUSSION

3.1 Impact of Bagging on Yield and Quality

The results indicated that bagging significantly regulate the yield and quality of guava. Fruits bagged with red and silver polythene exhibited higher yield and improved quality parameters such as colour, firmness and sugar content compared to those bagged with yellow and green polythene.

3.2 Effect of Foliar Nutrient Application

Foliar application of calcium nitrate and potassium sulphate positively affected the fruit size, weight and overall quality. The treatments led to an increase in yield and a reduction in post-harvest physiological loss, aligning with findings from previous studies.

3.3 Combined Effects of Bagging and Foliar Application

The combination of red polythene bagging and foliar nutrient application yielded the best results, with significant improvements in both the yield and quality of the guava fruits. This combination also extended the shelf-life of the fruits under ambient storage conditions.

3.3.1 Average fruit weight (g)

Treatment T_{14}- ($Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Yellow polythene bagging) resulted in the maximum fruit weight **163.88**, significantly outperforming other treatments. T_{13}- ($Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Green polythene bagging) was the second highest **152.33**. The control (T_0) had the lowest fruit weight. Calcium aids in cell division, elongation, membrane integrity and fruit size, while potassium is crucial for cell processes and fruit size. Warmer temperatures in yellow-bagged fruits likely led to earlier harvesting. Bagging impacts light interception, affecting growth. Studies by Meena *et al.* [6] confirm that wrapping and calcium chloride treatments improve fruit weight and size.

Table 1. Impact of pre-harvest nutrition application and bagging on the fruit weight, fruit width and Fruit length of guava during the rainy season

Treatments	Average fruit weight (g)			Fruit width (cm)			Fruit length (cm)		
	1st yr.	2nd yr.	Pooled	1st yr.	2nd yr.	Pooled	1st yr.	2nd yr.	Pooled
T0	98.40	101.09	99.75	6.30	6.17	6.24	3.70	3.63	3.66
T1	112.43	105.63	109.03	6.80	6.66	6.73	4.23	4.15	4.19
T2	124.54	118.54	121.54	6.82	6.68	6.75	4.59	4.5	4.54
T3	124.43	120.77	122.60	6.86	6.72	6.79	4.60	4.51	4.55
T4	127.10	119.00	123.05	7.01	6.87	6.94	4.83	4.73	4.78
T5	143.04	114.74	128.89	7.09	6.95	7.02	5.20	5.10	5.15
T6	144.77	143.15	143.96	7.45	7.30	7.38	5.46	5.35	5.41
T7	124.65	120.71	122.68	7.03	6.89	6.96	4.93	4.83	4.88
T8	135.17	126.10	130.64	7.07	6.93	7.00	5.2	5.10	5.15
T9	137.77	131.81	134.79	7.20	7.06	7.13	5.37	5.26	5.32
T10	153.43	136.25	144.84	7.51	7.36	7.43	5.27	5.16	5.22
T11	142.10	111.77	126.94	7.14	7.00	7.07	5.23	5.13	5.18
T12	152.43	149.43	150.93	7.52	7.37	7.44	5.67	5.56	5.61
T13	154.88	149.77	152.33	7.83	7.67	7.75	6.22	6.10	6.16
T14	168.21	159.54	163.88	8.45	8.28	8.37	6.23	6.11	6.17
T15	151.99	141.21	146.60	7.69	7.54	7.61	5.77	5.65	5.71
S.Ed.(±)	2.037	1.862	1.949	0.432	0.426	0.429	0.334	0.329	0.331
C. D. (P = 0.05)	2.88	2.633	2.757	0.865	0.852	0.859	0.669	0.659	0.664

Table 2. Impact of pre-harvest nutrition application and bagging on the Volume of fruits (cm^3), Yield/plant (kg) and Insect damage fruits (%) of guava during the rainy season

Treatments	Volume of fruits (cm^3)			Yield/plant (kg)			Insect damage fruits (%)		
	1st yr.	2nd yr.	Pooled	1st yr.	2nd yr.	Pooled	1st yr.	2nd yr.	Pooled
T0	100.66	108.50	104.58	3.15	3.09	3.12	25.79	23.41	24.60
T1	118.99	120.83	119.91	3.23	3.17	3.20	9.96	9.27	9.62
T2	127.98	129.82	128.90	3.41	3.34	3.38	6.47	6.27	6.37
T3	131.10	132.94	132.02	3.52	3.45	3.48	6.48	6.37	6.43
T4	131.63	133.47	132.55	3.61	3.54	3.57	1.91	0.81	1.36
T5	139.65	146.82	143.24	3.73	3.66	3.69	1.24	0.82	1.03
T6	149.50	151.34	150.42	4.08	4.00	4.04	1.12	0.83	0.98
T7	149.00	150.84	149.92	3.78	3.70	3.74	1.75	0.82	1.29
T8	147.98	149.82	148.90	3.96	3.88	3.92	1.84	0.85	1.35
T9	153.65	155.49	154.57	4.21	4.13	4.17	1.09	0.86	0.97
T10	159.45	161.29	160.37	5.01	4.91	4.96	1.04	0.87	0.96
T11	149.00	150.84	149.92	4.37	4.28	4.33	1.12	0.83	0.98
T12	160.90	162.74	161.82	4.51	4.42	4.46	1.03	0.88	0.95
T13	163.16	165.00	164.08	5.04	4.94	4.99	0.89	0.80	0.85
T14	**171.11**	**172.95**	**172.03**	**5.55**	**5.44**	**5.49**	**0.57**	**0.79**	**0.68**
T15	161.72	163.56	162.64	5.11	5.01	5.06	1.01	0.83	0.92
S.Ed.(±)	2.48	2.84	2.58	0.28	0.27	0.27	1.36	0.44	0.76
C. D. (P = 0.05)	4.97	5.67	5.15	0.55	0.54	0.55	2.71	0.88	1.53

3.3.2 Fruit width (cm)

Treatment T_{14}- ($Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Yellow polythene bagging) yielded the maximum fruit width (8.45, 8.28 and 8.37 cm) across two years and pooled data. This was comparable to T_{13}- (Green polythene bagging) and T_{15}- (Silver polythene bagging). The minimum fruit width (6.30, 6.17 and 6.24 cm) was observed in the control (T_0), comparable to several other treatments but significantly lower than the rest.

Calcium nitrate enhances fruit width by improving carbohydrate production and conversion, reducing abscission, and maintaining cell structure. Potassium sulphate is essential for nitrate reduction and optimal fruit width. The superior performance of yellow bagging may be due to favourable changes in the microclimate, aligning with Tiwari *et al.* [7] findings in guava.

3.3.3 Fruit length (cm)

Treatment T_{14}- ($Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Yellow polythene bagging) resulted in the maximum fruit length (6.23, 6.11, and 6.17 cm) over two years and pooled data, significantly outperforming other treatments and comparable to T_{12}- (Red polythene bagging), T_{13}- (Green polythene bagging) and T_{15}- (Silver polythene bagging). The control (T_0) had the minimum fruit length (3.70, 3.63 and 3.66 cm), comparable only to T_1. Calcium nitrate enhances fruit length by improving carbohydrate formation and conversion, reducing abscission and preserving cell structure. Potassium is essential for reducing nitrate levels and regulating stomatal aperture, contributing to optimal fruit length. Yellow bagging's superiority may result from favourable microclimate changes, consistent with Sharma et al. [8] findings in Apple.

3.3.4 Volume of fruits (cm^3)

Treatment T_{14}- ($Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Yellow polythene bagging) achieved the highest fruit volume (171.11, 172.95 and 172.03cm³), significantly surpassing other treatments. T_{13}- (Green polythene bagging) followed with volumes of 163.16, 165.00 and 164.08 cm³. The control (T_0) had the lowest volume (100.66, 108.50 and 104.58 cm³). The increase in fruit volume due to calcium nitrate is attributed to enhanced photosynthesis and translocation of photo assimilates. Potassium sulphate aids in cell division, elongation, and protoplasmic strengthening, contributing to increased fruit volume. The yellow bag's favourable microclimate likely boosted fruit growth. These results align with findings by Gupta et al. [9] in guava.

3.3.5 Yield/plant (kg)

The pre-harvest application of nutrients and bagging treatments significantly increased yield (kg/plant) during 2020-21 and 2021-22. The pooled analysis showed the highest yield in T_{14}- ($Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Yellow polythene bagging) with 5.55, 5.44 and 5.49 kg/plant, comparable to T_{15}- (Silver polythene bagging) and T_{13}- (Green polythene bagging). The lowest yield (3.15, 3.09 and 3.12 kg/plant) over two years and pooled data was in the control (T_0), similar to several other treatments but significantly lower than the rest. These findings align with results from Omar et al. [10] in date palm and Edirimanna *et al.* [11] in guava.

3.3.6 Insect damage fruits (%)

Pre-harvest treatments significantly influenced insect-damaged fruits (%). The lowest damage (0.57, 0.79 and 0.68%) was recorded in T_{14}- ($Ca(NO_3)_2$ (2%) + K_2SO_4 (2%) + Yellow polythene bagging), comparable to other bagging treatments. The highest damage (25.79% and 23.41%) over two years and pooled data was in the control (T_0).

Calcium nitrate reduces insect damage by altering cell wall polysaccharides and enhancing cell membrane firmness. Potassium sulphate combats biotic stresses by promoting the production of protective compounds and accelerating lignification. Bagging protects fruits from insects, especially during the rainy season, by creating unfavourable microclimates for pests. These findings are consistent with Edirimanna *et al.* [11] and Abbasi *et al.* [12] who found that bagging materials and colors significantly affect guava fruit protection against insect damage.

4. CONCLUSION

The present study demonstrated the significant impact of bagging and foliar nutrient application on the yield and quality of guava fruits. The key conclusions are as follows: Bagging with red and silver polythene resulted in higher yields and improved fruit quality attributes such as colour, firmness, and sugar content compared to yellow and green polythene bags. Foliar application of calcium nitrate (2%) and potassium sulphate (2%) positively influenced fruit size, weight, and overall quality. Among the bagging treatments, yellow polythene bags in combination with foliar calcium nitrate and potassium sulphate application produced the maximum fruit weight, width, length, and volume. This was attributed to the favourable microclimate created by the yellow bags, which enhanced growth and development. The control (unbagged) fruits exhibited the lowest yield, fruit size, and quality parameters, as well as the highest percentage of insect-damaged fruits. The findings of this study provide valuable insights into the integration of bagging and foliar nutrient application as an effective strategy to enhance the productivity and quality of guava fruits. These techniques can be readily adopted by guava growers to improve their crop's yield and marketability.

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 manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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