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Effect of pre-harvest chemical spray and bagging on physico-chemical quality of guava (*Psidium guajava* L.) fruits cv. Sardar

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Abstract
The current study reported that fruits were treated with K_2SO_4 (2%) + Butter Paper Bag i.e. T_2 were observed superior quality in physical parameters like maximum average weight (222.83 g), fruit length (11.44 cm), fruit diameter (11.33 cm), fruit firmness (11.60 N), weight of pulp (172.07 g), volume of fruit (225.77 ml), minimum insect damage observed (6.63%) and minimum spotted fruit observed (6.63%). Chemical parameters like total soluble solids (11.67˚Brix), reducing sugar (5.73%), non- reducing sugar (5.40%), total sugar (11.33%), vit C content (225.33%), acidity (0.31%). Overall findings of this investigation revealed that use of K_2SO_4 (2%), KNO_3 (2%) and butter paper bagging provide superior quality fruits.

Keywords: Guava fruits, K_2SO_4, KNO_3, butter paper bags, physical parameters and chemical parameters.

Introduction
Guava (*Psidium guajava* L.) is a berry like fruit belongs to family myrtaceae. It was originated in tropical America (Mexico to Peru) but at present the major guava producing countries are the USA, Cuba, Taiwan, Mexico, Peru, China, Malaysia, India, Pakistan, Thailand, Bangladesh. Guava is often called the 'Apple of tropics' and one of the most common fruits of India. It is widely grown all over the tropics and sub-tropics including India. The importance of guava is due to the fact that it is a hardy fruit crop which can be grown in poor alkaline or poorly drained soils with minimum manuring and irrigation. It can be grown in soil with the pH ranging from 4.5 to 8.2. Guava is one of the richest source of vitamin C, it also contains carbohydrates and materials like calcium and phosphorus and contains water 82.50%, acidity 2.45%, reducing sugar 44.5%, total soluble sugar solids 9.73%, ash 0.48%, and vitamin C 260mg/100g of fruit. It has an excellent digestive and nutritive value with pleasant flavor, palatability and availability in abundance at moderate cost. The fresh and mature guava is taken by chewing. Salad and pudding are prepared from shell of the ripe fruit. Processed products like jam, jelly, cheese, juice, nectar, etc. are prepared commercially from ripe guava fruits. It is rich source of pectin hence suitable for jelly making. Potassium regulates the opening and closing of stomata, the pores through which leaves exchange CO_2, water vapor and O_2 with the atmosphere. The activation of enzymes by K and its involvement in ATP production is more important in regulating the rate of photosynthesis than the role of K in stomatal activity. The function of potassium transport of sugar, water and nutrients, protein synthesis, starch synthesis and crop quality improvement. Pre harvest spraying of calcium directly on the fruit as a means of improving Ca uptake was adopted. Pre harvest spraying was found to improve firmness and shelf life of the fruits. Calcium affects on decay could be due to the formation of cell wall components resistant to degradation by pathogen. It improves the fruit characteristics to minimize fungicides spray towards the end of the harvest period, which in turns improves fruits resistance to brown rot. Application of Ascorbic Acid had many stimulating effects on growth and physiological activities of various plants. Ascorbic acid is good antioxidant that keeps fruit from darkening and improves destruction of bacteria. Antioxidants are used instead of auxins for fruit growth development and fruiting of trees.
The "bagging" technique is effective at keeping fruit flies away from the fruits and preventing moths from laying eggs. Some farmers have created basic paper sacks out of old newspapers that have been folded and stapled together instead of buying bags.

Discovering the most effective bagging resources and techniques involves identifying which combination yields the highest production and net revenue. Additionally, it is essential to assess how these methods impact pest incidence and determine which combination results in the highest fruit quality. Fruit bagging has been shown to enhance various fruit attributes, such as total soluble solids (TSS), total sugars, and the TSS: Acid ratio. The bagging techniques have been found to minimize winter stress under ideal conditions, which led to early fruit maturation and are used to protect a variety of fruits under low temperature conditions. Various packing materials are employed in the guava industry, encompassing options such as black polythene, white polythene, tissue paper, brown paper, and newspaper, as reported by different individuals involved in the industry.

Materials and Methods

The experiment was conducted at well-established guava orchard of eight years old trees planted at 6m x 6m spacing of Department of Horticulture and P.G. laboratory of Department of Soil Science and Agricultural chemistry, College of Agriculture, Latur. For this experiment selection of tree is based on at least optimum 30 fruit bearing. Trees selected on the basis of Randomized Block Design (RBD). The experiment was conducted in three replication, total 27 plants are selected and 9 treatments are in one replication. Trees were sprayed before 30 days of harvesting with convenient hand pressure pump. Chemicals used for spraying were calcium chloride (2%), potassium sulphate (2%), potassium nitrate (2%), ascorbic acid (400 ppm). Eight treatments of various chemicals and butter paper and brown paper bagging was taken without control treatment. All these treatments trees (T_1 to T_8) will be treated with 1% Bavistin and 3% Neem oil before bagging. Ten fruits was harvested from tree at horticultural maturity. Fruits were stored in P. G. Laboratory, Department of Horticulture, Latur. (M.S).

Observation recorded

A. Physical parameter

1. Average weight of fruit (g)

Five uniform sized fruits were randomly selected from each treatment and were brought to laboratory and the weight of fruits was recorded on the electronic weighing balance and weight was expressed in grams.

2. Fruit length (cm)

The length of the five fruits of each treatment was measured from stalk to styler end with the help of vernier caliper and after computing mean was recorded as average length of fruit in centimeter.

3. Fruit diameter (cm)

The width of five fruits from each treatment were measured with the help of vernier calipers and expressed in centimeter.

4. Fruit firmness (N) / (Kg/CM^2)

The firmness of the was tested by a pocket penetrometer (Fruit Tester FT 327). The probe of the penetrometer was pierced through the fruit pulp and the pressure required was recorded.

5. Pulp Weight (g)

The pulp along with peel was separated from seed mass of ripened fruits and its weight was recorded on digital balance. Average weight was computed and recorded as weight of pulp in grams.

6. Fruit volume (ml)

The volume of ten randomly selected fruits in each treatment was measured by water displacement method. For this purpose, the fruits were dipped in a full filled jar of water and the water displaced by the fruits was collected and measured by graduated glass jar and the recorded reading was mean averaged.

7. Insect damage

The proportion of fruits damaged by insect damage, calculated by dividing the total number of spots by the total number of fruits and multiply the result by 100. Counted the number of marks each fruit had after being individually examined for insect damage.

$$\text{Insect damage (\%)} = \frac{\text{Total number of spots}}{\text{Total number of fruits}} \times 100$$

8. Spotted fruits

Calculated by multiplying by 100 and dividing the number of spotted fruits by the total number of fruits. The intensity or frequency of spotting in the population of fruit under evaluation is indicated by this percentage.

$$\text{Spotted Fruit (\%)} = \frac{\text{Number of spotted fruits}}{\text{Total number of fruits}} \times 100$$

B. Chemical parameter

1. Total soluble solids (TSS) (%)

Total Soluble Solid (TSS) is measured from fruit pulp in terms of percentage by using Erma hand refractometer in the range of 0-32%.

2. Acidity (%)

Titratable acidity was estimated by titrating known value of sample against standard NaOH using phenolphthalein as an indicator. The Titratable acidity was expressed as percent citric acid as per given:

$$\text{Titratable acidity (as \% citric acid)} = \frac{\text{Titre value} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{eq. weight of acid} \times 100}{\text{Weight of sample taken} \times \text{Alliquot taken for estimation} \times 1000}$$

3. Reducing sugars (%)

Reducing sugar in fruit juice was estimated by the method as suggested by Nelson (1994). 5 ml each Fehling's 'A' and 'B' solution were taken in a 300ml conical flask and diluted with 40 ml distilled water. The juice in a burette was added slowly in hot boiling Fehling's solution till the appearance of slight red colour. Now, three drops of methylene blue indicator were added and titration was continued till a brick red precipitate appeared by destroying the blue coloration. The reducing sugar in percentage was calculated with the help of following formula.

$$\text{Reducing sugar (\%)} = \frac{0.25}{\text{Burette reading}} \times 100$$

4. Non-reducing sugars (%)

The amount of non-reducing sugar was obtained by subtracting reducing sugar from the amount of total sugar and multiplying the resultant by factor 0.95.

Non-reducing Sugar % = (Total Sugar % – Reducing Sugar %) × 0.95

5. Total sugars (%)

For the estimation of total sugars, 20 ml solution was taken in a beaker and 5 ml of concentrated HCl was added and after that solution was boiled on water bath for 5 minutes for the hydrolysis to convert the non-reducing sugar into reducing sugar. After cooling, excess of acid was neutralized by sodium carbonate solution. The solution was transferred in a 100 ml volumetric flask and titrated with the Fehling's solution 'A' and 'B' similar as was done in reducing sugar. The sugar in percentage was calculated with the help of following formula.

$$\text{Total sugar (\%)} = \frac{1.25}{\text{Burette reading}} \times 100$$

6. Ascorbic acid/ Vit c (mg/100g)

The titrimetric method described by (A.O.A.C., 1975) was adopted. Ten grams of the pulp was transferred in 100 ml volumetric flask and volume made up with 3% meta-phosphoric acid solution. After 30 minutes, the suspension was filtered through whatman No. 1 filter paper. Before the actual titration, the 2, 6-dichlophenol indophenol dye solution was standardized by titrating against standard solution of concentrated ascorbic acid and the dye factor was calculated. Five ml of aliquot was taken from the filtrate and titrated against standardized dye solution through a burette. Titration was continued till the light pink color persisted for 15 seconds. Ascorbic acid content was calculated by using the following formula.

$$\underset{\text{(mg/100g)}}{\text{Ascorbic acid}} = \frac{\text{Titre} \times \text{Dye factor} \times \text{vol. made up}}{\underset{\text{Taken for estimation}}{\text{Aliquot of extract}} \times \underset{\text{taken for estimation}}{\text{Weight of sample}}} \times 100$$

Results and Discussion

A. Physical parameter

1. Average Fruit Weight (g): The maximum average weight of fruit (222.83 g) was recorded with the application of treatment K_2SO_4 (2%) + Butter paper Bag (T2), which was statistically at par with the application of treatment (212.23 g) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum average weight of fruit (113.33 g) was observed in control (T9) treatment. The improvement in fruit weight with potassium spray might be due to increased photosynthesis which results in supply of more carbohydrates to the fruits. The results obtained in present study are similar with Kumar *et al*. (2019) [4], Mishra *et al*. (2017) [6].

2. Fruit Length (cm): The maximum fruit length (11.44 cm) was recorded with the application of treatment K_2SO_4 (2%) + Butter paper Bag (T2), which was statistically at par with the application of treatment (10.65 cm) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum fruit length (7.67 cm) was observed in control (T9) treatment. Increase in fruit length with the application potassium is due to increase in entry of water into the cells by osmotic pressure which subsequently increase in cell size. The similar results obtained in present study are in agreement with that reported by Kumar *et al*. (2019) [4], Rahman *et al*. (2018) [7], Islam *et al*. (2019) [3].

3. Fruit Diameter (cm): The maximum fruit diameter (11.33 cm) was recorded with the application of treatment K_2SO_4 (2%) + Butter paper Bag (T2), which was statistically at par with the application of treatment (10.67 cm) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum fruit diameter (8.33 cm) was observed in control (T9) treatment. The diameter of fruits increased with the application of potassium treatments due to the reason of lesser competition between the fruits and the leaves for the available potassium through root uptake and resulted into higher translocation of carbohydrates towards fruit. Also increase in fruit size might be due to the higher accumulation of photosynthesis in response to potassium application. The results obtained in present study are similar with Zai *et al*. (2021) [10]. The above results are very close to the findings of Islam *et al*. (2019) [3], Rahman *et al*. (2018) [7].

4. Fruit Firmness (N): The maximum fruit firmness (11.60 N) was recorded with the application of treatment K_2SO_4 (2%) + Butter paper Bag (T2), which was statistically at par with the application of treatment (10.50 N) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum fruit firmness (7.93 N) was observed in control (T9) treatment. The lowest firmness value was recorded in control. Softening of fruits either by breakdown of insoluble proto-pectin into soluble pectin or cellular disintegration leading to membrane permeability. The similar results are presented by Zai *et al*. (2021) [10], Mishra *et al*. (2017) [6].

5. Weight of pulp (g): The maximum weight of pulp (172.07 g) was recorded with the application of treatment K_2SO_4 (2%) + Butter paper Bag (T2), which was statistically at par with the application of treatment (163.63 g) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum weight of pulp (97.07 g) was observed in control (T9) treatment. The better effect on pulp characters of fruits showed under bagging. Bagging might enable very good light movement or allow the light intensity and or quality light which had very good effect on development of fruit pulp. The similar finding were also reported by Meena *et al*. (2016) [5], Saxena *et al.* (2021) [9], Kumar *et al* (2019) [4].

6. Volume of fruit (ml): The maximum volume of fruit (225.77 ml) was recorded with the application of treatment K_2SO_4 (2%) + Butter paper Bag (T2), which was statistically at par with the application of treatment (217.63 ml) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum volume of fruit (107.67 ml) was observed in control (T9) treatment. Cell division results in increasing fruit size results in cell expansion. Increase in fruit size might be due to the higher accumulation of photosynthesis in response to potassium application results in increase in volume. The similar results obtained in present study are previously reported by Saxena *et al*. (2021) [9], Zai *et al*. (2021) [10].

7. Insect Damage (%): The maximum insect damage (11.30%) was recorded with the control (T9) treatment, which was statistically at par with the application of treatment (7.30%) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum insect damage (6.33%) was observed in K_2SO_4 (2%) + Butter paper Bag (T2) treatment. The highest insect damage, infested fruits were recorded in control. Insect damage were mainly occurs due to fruit fly during rainy season due to availability of congenial micro climate. The similar finding were also reported by Gethe *et al.* (2021) [2], Mishra *et al.* (2017) [6].

8. Spotted fruits (%): The maximum spotted fruits (11.30%) was recorded with the control (T9) treatment, which was statistically at par with the application of treatment (7.30%) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum spotted fruits (6.63%) was observed in K_2SO_4 (2%) + Butter paper Bag (T2) treatment. Spots on the fruits occurs mainly due to high humidity condition creating congenial conditions for pathogen attack. This can only be minimized by protecting the fruits from adverse environment. Bagging creates a micro-environment safe for fruits and also avoids pathogen attack and spot formation. The similar results were reported by Mishra *et al* (2017) [6].

B. Chemical parameter

1. Total Soluble solids (˚Brix): The maximum total soluble solids (11.67 ˚Brix) was recorded with the K_2SO_4 (2%) + Butter paper Bag (T2) treatment, which was statistically at par with the application of treatment (9.67 ˚Brix) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum total soluble solids (7.67˚Brix) was observed in control (T9) treatment. The TSS content of fruits increased during the ripening and storage due to hydrolysis of insoluble starch into soluble sugars and loss of moisture. The similar results were reported by Kumar *et al*. (2019) [4], Abbasi *et al*. (2014) [1].

2. Reducing Sugar (%): The maximum reducing sugar (5.73%) was recorded with the K_2SO_4 (2%) + Butter paper Bag (T2) treatment, which was statistically at par with the application of treatment (5.47%) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum reducing sugar (3.43%) was observed in control (T9) treatment. It might be happened due to the different climatic condition, variety and different poly bags. When fruits become mature, acids are converted into sugar making guava sweeter. But due to low concentration of O_2 in the bag hampered the acid to sugar conversion process. This might be cause for lowering the sugar content in bagged fruits. The results related reports was founded similar with Rahman *et al*. (2018) [7], Mishra *et al*. (2017) [6], Kumar *et al.* (2019) [4].

3. Non-Reducing Sugar (%): The maximum non reducing sugar (5.40%) was recorded with the K_2SO_4 (2%) + Butter paper Bag (T2) treatment, which was statistically at par with the application of treatment (5.27%) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum non reducing sugar (4.20%) was observed in control (T9) treatment. It might be happened due to the different climatic condition, variety and different poly bags. When fruits become mature, acids are converted into sugar making guava sweeter. But due to low concentration of O_2 in the bag hampered the acid to sugar conversion process. This might be cause for lowering the sugar content in bagged fruits. The results related reports was founded similar with Rahman *et al*. (2018) [7], Mishra *et al*. (2017) [6].

4. Total Sugar (%): The maximum total sugar (11.13%) was recorded with the K_2SO_4 (2%) + Butter paper Bag (T2) treatment, which was statistically at par with the application of treatment (9.84%) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum total sugar (7.63%) was observed in control (T9) treatment. The total sugar content is the combination of reducing sugar and non-reducing sugar and other molecules. During ripening process, non-reducing sugar converted to reducing sugar and sweetness increases. Therefore, during biochemical analysis reducing sugar is higher to non-reducing sugar. The similar findings regarded with total sugar also reported by, Islam *et al*. (2019) [3], Vani *et al.* (2020) [8], Rahman *et al*. (2018) [7].

5. Vit C Content (Ascorbic Acid) (mg/100g pulp): The maximum ascorbic acid content (225.33%) was recorded with the K_2SO_4 (2%) + Butter paper Bag (T2) treatment, which was statistically at par with the application of treatment (214.13%) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum ascorbic acid content (183.33%) was observed in control (T9) treatment. Rainy season guava are low in acid content because of leaching loss which causes very poor taste in fruits. The decrease of vitamin-C content is attributed to the oxidation of ascorbic acid by the enzyme ascorbic acid oxidase. The present investigation found similar with Mishra *et al.* (2017) [6], Islam *et al.* (2019) [3], Rahman *et al.* (2018) [7].

6. Acidity (%): The maximum acidity (0.31%) was recorded with the K_2SO_4 (2%) + Butter paper Bag (T2) treatment, which was statistically at par with the application of treatment (0.28%) KNO_3 (2%) + Butter paper Bag (T3). While, the minimum acidity (0.22%) was observed in control (T9) treatment. The decrease of titratable acidity might be attributed to the utilization of organic acids in respiration process and other bio-degradable reaction. The acidity goes on decreasing day by day during storage of guava fruits. It might be caused by a chemical inhibiting impact on an enzyme that break down and converts acid into sugar when the fruit ripen. The similar results were founded by Rahman *et al.* (2018) [7], Mishra *et al*. (2017) [6].

Table 1: Effect of pre harvest chemical spray and bagging treatments on physical parameters of fruits

Treatment No.	Treatment Details	Average Fruit Weight (g)	Fruit Length (cm)	Fruit Diameter (cm)	Fruit Firmness (N)	Weight of pulp (g)	Volume of Fruit (ml)	Insect Damage (%)	Spotted Fruits (%)
T 1	$CaCl_2$ (2%) + Butter paper Bag	124.50	7.13	9.00	8.03	110.03	115.47	7.37	7.37
T 2	K_2SO_4 (2%) + Butter paper Bag	222.83	11.44	11.33	11.60	188.73	225.77	6.33	6.63
T 3	KNO_3 (2%) + Butter paper Bag	212.23	10.65	10.67	10.50	183.63	217.63	7.30	7.30
T 4	Ascorbic acid 400 ppm + Butter paper Bag	116.80	8.42	10.00	8.87	108.50	110.57	7.87	7.87
T 5	$CaCl_2$ (2%) + Brown paper Bag	119.50	8.78	9.00	8.90	105.90	106.15	8.53	8.53
T 6	K_2SO_4 (2%) + Brown paper Bag	139.07	10.55	10.33	10.23	136.63	136.50	7.43	7.40
T 7	KNO_3 (2%) + Brown paper Bag	133.43	10.09	9.67	9.70	127.67	131.33	8.50	9.70
T 8	Ascorbic acid 400 ppm + Brown paper Bag	130.70	9.44	9.33	9.37	103.57	124.00	9.37	9.37
T 9	Control treatment	113.33	7.67	8.33	7.93	89.73	107.67	11.30	11.30
	SE(m)	7.42	0.21	0.34	0.36	1.82	1.42	0.37	0.39
	C.D	21.56	0.60	0.98	1.06	5.28	4.13	1.08	1.12

Table 2: Effect of pre harvest chemical spray and bagging treatments on chemical parameters of fruits

Treatment No.	Treatment Details	TSS (%)	Reducing Sugar (%)	Non-Reducing Sugar (%)	Total Sugar (%)	Ascorbic acid (Vit C Content) (mg/100 g)	Acidity (%)
T 1	$CaCl_2$ (2%) + Butter paper Bag	10.00	3.50	4.33	7.83	223.67	0.24
T 2	K_2SO_4 (2%) + Butter paper Bag	11.67	5.73	5.40	11.13	225.33	0.31
T 3	KNO_3 (2%) + Butter paper Bag	9.67	4.57	5.27	9.84	214.00	0.28
T 4	Ascorbic acid 400 ppm + Butter paper Bag	9.67	4.33	4.33	8.66	213.00	0.26
T 5	$CaCl_2$ (2%) + Brown paper Bag	8.67	4.40	4.47	8.87	182.33	0.26
T 6	K_2SO_4 (2%) + Brown paper Bag	10.67	4.50	4.67	9.29	214.33	0.27
T 7	KNO_3 (2%) + Brown paper Bag	8.67	4.33	4.33	8.66	212.33	0.24
T 8	Ascorbic acid 400 ppm + Brown paper Bag	8.33	4.50	4.50	9.15	212.67	0.24
T 9	Control treatment	7.67	3.43	4.20	7.63	183.33	0.22
	SE(m)	0.35	0.18	0.08	0.11	11.38	0.01
	C.D	1.01	0.52	0.24	0.32	33.07	0.02

Conclusion

The present investigation entitled with "Effect of pre harvest chemical spray and bagging on post-harvest quality of guava (*Psidium guajava* L.) fruits cv. Sardar" application of K_2SO_4 (2%) + Butter paper Bag one month before harvesting was found superior and followed by KNO_3 (2%) + Butter paper Bag in physical parameter like average fruit weight (g), fruit length (cm), fruit diameter (cm), fruit firmness (N), weight of pulp (g), volume of fruit (ml), Physiological loss in weight (%), insect damage, spotted fruits. Chemical parameters such as TSS (%), reducing sugar (%), non-reducing sugar (%), total sugar (%), Vit C Content (Ascorbic Acid) (mg/100g pulp), acidity (%) and the organoleptic quality parameter such as taste, colour, aroma, texture and over all acceptance.

K is recognized to affect fruit yield overall and quality specifically among the other important compounds and plant nutrients. Potassium (K) is referred to as a quality element since it affects fruit quality-related traits.

Fruits in bags have a longer shelf life, which is crucial for fruits of export-worthy quality. Fruits are protected from diseases, pest infestations, mechanical harm, sunburn, fruit breaking, pesticide residues on the fruits, and bird damage by this simple and safe method. Both bags demonstrated their ability to withstand significant insect pest and disease attacks.

It is concluded that the best and similarly effective technique for the crucial is to apply K_2SO_4 (2%) and KNO_3 (2%) topically. Consequently, in order to meet the demand for high-quality guava fruits both domestically and internationally, producers may employ these chemicals and bagging in their commercial guava fruit production.

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