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Effect of pre-harvest application of potassium nitrate, naphthalene acetic acid and ethephon on ripening and shelf-life of guava cv. Allahabad Safeda

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ABSTRACT

The current study, effect of pre-harvest application of potassium nitrate (KNO_3), naphthalene acetic acid (NAA) and ethephon on ripening and shelf-life of guava (*Psidium guajava* L.) cv. Allahabad Safeda was undertaken at the Fruit Research Farm, Dr B R S Agri at Sri Muktsar Sahib, Punjab. The experiment was carried out on an eight-year-old guava tree of the Allahabad Safeda. The trees were sprayed with various doses of chemicals, KNO_3 (1.0, 1.5, 2.0%), NAA (200, 300, 400 ppm) and ethephon (200, 400, 600 ppm) during the third week of November. The fruits were harvested at the hard ripe stage on 19 December, placed in Corrugated fibre box (CFB) of 4 kg capacity and stored at ambient temperature. In ambient storage, guava fruits were remain acceptable for up to 6 days of storage without any adverse effect on fruit quality. KNO_3 (1.5 and 2.0%), NAA (300 ppm) and ethephon (200 ppm) recorded a reduction in physiological loss of weight and spoilage and KNO_3 (2.0%) maintaining fruit firmness (7.64 kg/cm^2), palatability rating (8.00) throughout the storage period. However, the highest storage life and good-quality fruits was recorded with the application of KNO_3 (1.5, 2%) during ambient storage. At lower concentrations, ethephon also helps to enhance the ripening of fruits, contrast to this fruits treated with NAA delayed the fruit senescense.

Key words: Corrugated fibre box, growth regulators, ambient storage, physiological loss of weight, spoilage.

INTRODUCTION

Guava (*Psidium guajava L.)* belongs to the family Myrtaceae and is commonly referred to as the apple of the tropics. This climacteric fruit is cultivated in tropical and subtropical regions of the world. Nature has generously bestowed upon it the ability to withstand drought and floods, as well as adapt to diverse soil and climatic conditions (Singh *et al*., 15). The guava fruit is highly nutritious and is abundant in vitamin C content, 4 to 5 times higher than that of citrus fruits. India ranks first in guava production in the world followed by China. In India, guava is third important fruit after mango, bananas, and citrus (Anon, 1). At ripening, fruit quality is exceptional, pulp is soft to the point of melting, pulp color white to pink and flavorful with 10 - 12% total soluble solids (TSS) and approximately 310 healthy seeds per fruit. The fruit is perishable in nature and deteriorate very quick after reaching at ripening stage. It suffer massive loss during handling, packaging, storage and marketing due to excessive water loss, bruising, scratching and decay. At ambient conditions, the fruits can only be stored well for 2 to 3 days only (Dapewar *et al*., 4). Several postharvest measures have been used by the researchers to minimise the above losses, over the postharvest measures, preharvest application of plant growth regulators (PGRs) has proven to be more effective in minimizing the losses and extending the shelf-life of guava fruits (Yadava *et al*., 18). Naphthalene acetic acid is a naturally occurring plant hormone belonging to the auxin family. It serves multiple physiological functions, including promoting cell division and expansion. Ethephon plays a crucial role as a hormone by stimulating the fruit-ripening process-increasing ethylene levels within plant cells and adjourning the harvesting process besides enhancing the quality in regards to TSS, total and reducing sugar levels by Yadava *et al.*, (18). With aim to regulate fruit ripening and extend the shelf-life the work was carried out on effect of pre-harvest application of KNO_3, NAA and ethephon on ripening and shelf life of guava cv. Allahabad Safeda.

MATERIALS AND METHODS

The experiment was carried out at Dr B R S Farm at Sri Muktsar Sahib, Punjab during the year 2022-23. Around 30 trees of eight-year-old guava cv. Allahabad Safeda were chosen randomly for the study with three replications. The experiment followed a Factorial Randomized Block Design, comprising ten treatments, namely., T_1- T_3 KNO_3 (1.0, 1.5 and 2.0%), T_4 – T_6 NAA (200, 300 and 400 ppm), T_7 - T_9 ethephon (200, 400 and 600 ppm) and T_{10} control. In mid-November, various applications of PGRs were applied on the plants. The chemicals were appropriately dissolved in a small amount of ethanol

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and then combined with 7 litres of water before being sprayed ont the plants. The fruits were harvested at commercial maturity (fruit colour transitioned to dark green to light green) and stored at ambient conditions followed by measuring different parameters like firmness, palatability rating, fruit colour, physiological loss of weight and spoilage was recorded at 3-day interval. The fruit firmness was measured using a penetrometer (kg/cm^2), and the fruit palatability rating was done by panel of judges across various age groups by evaluating taste, appearance according to fruit colour and overall acceptability using that fancy 9-point hedonic scale. Statistical analysis was performed using WASP Jangam (8) (web agricultural statistical package 1.0) software.

RESULTS AND DISCUSSION

Fruit firmness changes over time, as indicated in (Table 1). This reduction in fruit firmness over the storage duration is likely attributed to alterations in cell wall polysaccharides and a decrease in cell wall poly galacturonic acids within guava fruit, as suggested by Mandal *et al.* (12). The maximum mean fruit firmness value was noted in fruits collected from the plants sprayed with KNO_3 @ 2.0% (T_3) (7.64 kg/cm^2), which was at par with fruit collected from plants sprayed with ethephon 200 ppm (T_7) (7.45 kg/cm^2). However, the minimum was recorded in T_{10} (6.24 kg/cm^2). The fruit firmness was between 10.17 kg/cm^2 on the initial day and 5.50 kg/cm^2 on the 12th day during ambient storage with KNO_3 @ 2.0%. Our findings align with previous research, which also reported higher firmness (6.47 kg/cm^2) in Sardar guava sprayed with KNO_3 @ 3% and the lowest under control (Vikrant, 17). Similar study was conducted by Gill *et al*. (7) in Pathernak. Singh *et al.* (14) reported that the maximum firmness of guava fruit was recorded during storage condition in NAA @ 300 ppm immediately after harvest and a minimum was observed in NAA @ 100 ppm on the 9th day of storage.

The maximum palatability rating for winter guava at harvest time was achieved with pre-harvest spray of 2.0 % KNO_3. Similar improved palatability rating was observed in ber fruits sprayed with NAA and KNO_3, where fruits were rated as very acceptable (Kaur *et al*., 9). Potassium has been utilized to enhance fruit quality by improving both its physical and chemical properties. Among the different treatments, T_3 sprayed fruits (KNO_3 @ 2.0%) showed a higher mean palatability rating (8.00), which was at par with the T_9 treatment (7.88, ethephon 600 ppm). On the initial day of storage (at the harvest stage), the T_9 (ethephon @ 600 ppm) fruits recorded the highest palatability rating and declined thereafter up to the 12th day of storage. These findings align with the study of Singh *et al.* (16) in guava. Improvement in the quality

Table 1. Effect of KNO_3, NAA and ethephon application at fruit set stage on firmness and palatability rating of guava during ambient storage.

Treatment	Firmness (kg/cm^2)						Palatability rating					
	Storage (days)						Storage (days)					
	0	3	6	9	12	Mean	0	3	6	9	12	Mean
T_1 KNO_3 1.0%	10.40	8.17	7.03	6.17	5.20	7.39	8.70	7.83	6.83	6.33	5.67	7.07
T_2 KNO_3 1.5%	9.87	8.30	7.25	6.53	5.12	7.41	9.00	8.17	7.50	7.33	6.50	7.70
T_3 KNO_3 2.0%	10.17	8.33	7.47	6.73	5.50	7.64	9.00	8.33	7.82	7.67	7.17	8.00
T_4 NAA 200 ppm	9.53	7.53	6.27	5.27	4.40	6.60	8.87	7.67	6.50	6.17	5.33	6.91
T_5 NAA 300 ppm	9.63	7.57	6.33	5.30	4.83	6.73	9.00	8.17	7.73	6.67	6.33	7.58
T_6 NAA 400 ppm	10.20	8.13	7.13	6.33	5.40	7.44	8.96	8.37	7.83	7.49	6.57	7.84
T_7 Ethephon 200 ppm	9.87	8.53	7.27	6.20	5.37	7.45	8.87	8.00	6.53	6.17	5.40	6.99
T_8 Ethephon 400 ppm	9.90	7.53	6.37	5.30	4.70	6.76	9.00	8.67	7.67	7.17	6.33	7.77
T_9 Ethephon 600 ppm	9.53	7.63	6.30	5.23	4.73	6.69	9.00	8.32	7.76	7.40	6.90	7.88
T_{10} Control	9.43	7.03	5.93	4.43	4.37	6.24	8.67	7.50	6.00	5.33	5.00	6.50
Mean	9.85	7.88	6.74	5.75	4.96		8.91	8.10	7.22	6.77	6.12	
CD@5%												
Treatment	0.21						0.27					
Storage	0.15						0.19					
Treatment × Storage	0.48						0.60					

Note: KNO_3: Potassium nitrate, NAA: Naphthalene acetic acid.

of winter guava sprayed with ethephon recorded an improved palatability rating. The results agree with those of Gill and Bal (6).

Fruit colour is of significant importance in terms of quality, influencing both its appearance and consumer reception in the market. In fruits sprayed with KNO_3 @ 2.0% retained the light green colour up to 6th day of storage, as seen in Table 2. The fruit changed into yellow-green (151 D) and light yellow (5 C) from the 9th day to the 12th day of storage. Among the NAA treatments, 200 ppm concentration maintained the same light green colour (142 A) on the initial day and light-yellow green colour (154 B) up to the 9th day of storage and yellow colour (4 B) was observed on the 12th day of storage. The yellow colour (6 C) was noted on the 12th day of storage. Ethephon @ 400 and 600 ppm showed a similar colour change trend up to the 12th day of storage. In guava cultivar, fruit colour transforms from light -green/ light yellow green to to a visually appealing medium in ethephon and control groups. The outcomes of our study on winter guava by Brar *et al.* (3), also noted that ethephon enhances the colour of guava fruits during the rainy season. Additionally, Lester *et al.* (10) demonstrated that the most significant improvement in fruit colour was associated with the effects of potassium.

The data in Table 3 represent that mean physiological loss in weight (PLW) gradually increased from the 3rd day to the 12th day of ambient storage of guava fruits of cv. Allahabad Safeda. Among the different treatments, T_3 trees sprayed with KNO_3 @ 2.0% recorded the lowest PLW mean (5.46%), which was followed by T_7 (5.58%) and T_5 (5.71%). The control trees (without any sprays) recorded the highest PLW (8.17%) as compared to other treatments. Foliar applications of nutrients led to a decrease in PLW, possibly attributed to enhancements in the phloem layer, increased presence of crystals within phloem cells, and dispersed starch granules in parenchyma cells. These changes likely contributed to a reduction in transpiration rate, ultimately aiding in improved fruit storage by minimizing weight loss. Vikrant (17) did a similar study on different guava varieties and found that foliar sprays made a big difference in preventing weight loss in L-49 and Shweta at room temperature. KNO_3 @ 3% recorded the lowest PLW (7.96% in L-49 and 8.14% in Shweta) and in control recorded the highest weight loss (11.5% in L-49 and 12.17% in Shweta) over the rest of the treatments. Gangle *et al.* (5) revealed that minimum PLW (14.21%) on the 12th day in guava during storage was recorded with NAA @ 400 ppm. Ethephon @ 500 ppm recorded

Table 2. Effect of KNO_3, NAA and ethephon application at fruit set stage on fruit colour of guava during ambient storage.

Treatment	Fruit colour				
	Storage (days)				
	0	3	6	9	12
T_1 Control	144 C (Light yellow-green)	150 C (Light yellow-green)	151 D (yellow-green)	151D (Yellow- green)	3B (Yellow)
T_2 KNO_3 1.0%	140 C (Light green)	142 D (Creamy green)	149 C (Light yellow-green)	154 C (Light yellow- green)	4B (Yellow)
T_3 KNO_3 1.5%	140 B (Light green)	149 A (Light green)	150 A (Light yellow-green)	154 B (Light yellow- green)	6C (yellow)
T_4 KNO_3 2.0%	141 D (Light green)	N144 C (Light green)	149 A (Light green)	151 D (Yellow-green)	5 C (Light yellow)
T_5 NAA 200 ppm	142 A (Light green)	150 A (Light yellow-green)	151 B (Light yellow-green)	154 B (Light yellow-green)	4 B (Yellow)
T_6 NAA 300 ppm	141 D (Light green)	149 A (Light green)	150 C (Light yellow-green)	154 C (Light yellow-green)	4 B (Yellow)
T_7 NAA 400 ppm	142 A (Light green)	149 C (Creamy green)	150 A (Light yellow-green)	154 C (Light yellow-green)	5 C (Light yellow)
T_8 Ethephon 200 ppm	142 D (Light green)	N144 B (Light yellow-green)	151 D (yellow-green)	154 C (Light yellow-green)	6 C (yellow)
T_9 Ethephon 400 ppm	142 A (Light green)	151 D (Yellow-green)	150 C (Yellow-green)	154 B (Light yellow-green)	6 D (Light yellow)
T_{10} Ethephon 600 ppm	144 C (Light yellow-green)	149 A (Light green)	151 C (Yellow-green)	154 B (Light yellow-green)	3 B (Yellow)

Table 3. Effect of KNO_3, NAA and ethephon application at fruit set stage on physiological loss in weight and spoilage of guava during ambient storage.

Treatment	Physiological loss in weight (%)						Spoilage (%)					
	Storage (days)						Storage (days)					
	0	3	6	9	12	Mean	0	3	6	9	12	Mean
T_1 KNO_3 1.0%	0.00	4.17	5.56	8.58	11.46	5.95	0.00	0.00	6.25	14.28	21.41	8.39
T_2 KNO_3 1.5%	0.00	4.00	5.50	8.38	11.40	5.86	0.00	0.00	5.50	11.90	19.53	7.39
T_3 KNO_3 2.0%	0.00	3.37	4.40	8.25	11.26	5.46	0.00	0.00	3.55	11.90	18.18	6.73
T_4 NAA 200 ppm	0.00	4.67	5.93	9.67	12.22	6.50	0.00	0.00	6.82	18.73	22.48	9.61
T_5 NAA 300 ppm	0.00	2.71	4.70	8.81	12.35	5.71	0.00	0.00	4.44	14.28	18.79	7.50
T_6 NAA 400 ppm	0.00	3.26	5.16	9.14	12.15	5.94	0.00	0.00	6.38	17.25	19.45	8.62
T_7 Ethephon 200 ppm	0.00	2.64	4.60	8.31	12.35	5.58	0.00	0.00	2.67	14.65	20.87	7.64
T_8 Ethephon 400 ppm	0.00	4.50	5.59	9.34	12.22	6.33	0.00	0.00	6.25	14.65	23.06	8.79
T_9 Ethephon 600 ppm	0.00	4.47	5.43	9.24	12.14	6.26	0.00	0.00	6.66	16.88	18.73	8.45
T_{10} Control	0.00	5.43	7.35	12.35	15.73	8.17	0.00	0.00	15.45	25.11	32.01	14.51
Mean	0.00	3.92	5.42	9.21	12.33		0	0	6.4	15.96	21.45	
CD @ 5%												
Treatment	0.22						0.99					
Storage	0.15						0.70					
Treatment × Storage	0.48						2.22					

the lowest physiological loss in guava fruits (Mahajan *et al.* (11).

The study revealed that fruits treated with different chemical concentrations of KNO_3, NAA and ethephon had a lower spoilage score than fruits of the control treatment. Guava fruits treated with KNO_3 @ 2.0%, ethephon @ 200 ppm and NAA @ 300 ppm showed lower spoilage, on the last day of observation. NAA @ 200 ppm and ethephon @ 600 ppm treatments had higher fruit spoilage than other concentrations of these chemicals as seen under (Table 3). Significant differences were found among the days of storage from the 3rd day to the 12th day of storage on the spoilage of guava fruits. The reduction in guava fruit spoilage can be attributed to their ability to delay senescence by maintaining cell wall integrity, thereby decreasing spoilage. The mean maximum spoilage percentage (14.51%) was recorded in the control, which was way more than those treated with chemicals, with similar findings reported by Mishra *et al.* (13). Fruit decay in guava during ambient storage is primarily caused by water loss and of pulp breakdown at room temperature as noted by Singh *et al.* (16). The impact of ethephon was investigated on guava cv. L-49 during both rainy and winter seasons. The spraying guava with ethephon 500 ppm seriously improved fruit quality (Brar and Bal, 2). Likewise, Mahajan *et al.* (11) concluded that ethephon at 1000 ppm showed the least spoilage, followed by ethephon at 500 ppm, between 4 to 6 days of storage, with no spoilage observed up to 2 days under ambient conditions.

It is concluded that the winter guava fruit quality was maintained in acceptable condition up to the 6th day of the ambient storage period. The present study suggested that sprays of KNO_3 @ 2.0%, NAA @ 400 ppm and ethephon @ 200 ppm during November may be gainfully utilized for improving fruit quality and also helpful for improvement in the shelf-life of fruit which provides a longer marketability period.

AUTHORS' CONTRIBUTION

Conceptualization (AS), designing of experiments, data analysis and interpretation (AS, NK), field experiment, data collection and writing manuscript (NK).

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DECLARATION

The authors do not have any conflict of interest.

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