



Effect of pre-harvest application of NAA and potassium nitrate on storage quality of winter guava (*Psidium guajava*)*

GOUTAM MANDAL¹, H S DHALIWAL² and B V C MAHAJAN³

Punjab Agricultural University, Ludhiana 141 004

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Guava (*Psidium guajava*) is one of the major fruit of India and considered fifth most important fruit occupying an area of 2.2 lakh ha, with an annual production of 17.8 lakh MT (Anon 2005). It is considered to be one of the exquisite, nutritionally valuable and remunerative crops. The fruit is an excellent source of vitamin-C and contain an appreciable amount of minerals such as phosphorus, calcium and iron. The fruit is highly perishable in nature, under ambient conditions become overripe and mealy within a week. Therefore, it needs immediate marketing and utilization after harvesting. During storage, fruits are subjected to physicochemical and biochemical changes that affect their final texture and quality. There is an increasing demand of fruits for fresh as well as processing purpose in domestic and international markets. The share of the guava fruits, export from India is not enough, which can be boosted up with the increasing storability of the fruits.

Pre-harvest sprays of potassium and growth regulators are one of the most important practices of the new strategies applied in the integrated fruit production systems, improving fruit quality (El-hilali *et al.* 2003, Dutta and Banik 2007). Research has revealed that application of NAA extends the shelf-life and reduced the spoilage and improved fruit quality by delaying the on set of senescence during storage (Selvan and Bal 2005).

In guava, there are two crops in a year, i.e. rainy and winter season crops. The fruits of rainy season crop are rough fruit surface, insipid, poor in quality and infested with fruit fly. On the other hand, winter crop is superior in quality, free from fruit fly infestation and fetches higher price as compared to rainy season crops (Lal *et al.* 2000). Therefore, the present studies was conducted in winter crop to evaluate

the influence of pre-harvest foliar application of NAA and potassium nitrate in quality attributes of guava fruits during their harvesting and in different interval of cold storage.

The investigation was conducted on randomly distributed 21 plants of guava cv. 'Sardar' of uniform age, and vigour at the New Orchard of Punjab Agricultural University, Ludhiana (30°55" N latitude, 75°54" E longitude and at an altitude of 247 metres msl) during 2006–07 and 2007–08. The selected plants were sprayed with NAA (50, 75 and 100 ppm) and potassium nitrate (0.5, 1.0 and 1.5%) solutions at colour break stage (15 days before harvest) of fruit during first week of December (2006 and 2007) and control (without any treatment). The sprays were conducted until total saturation of foliage. The experimental plants were also sprayed with 0.1 per cent bavistin to protect the fruits against storage rots. There were three plants for each treatment comprising single plant for each replication.

The fruits were harvested during third week of December at the optimum horticultural maturity. The bruised and diseased fruits were sorted out and only healthy and blemish free fruits were selected for the present studies. The fruits (2.0 kg) were packed in 5 ply corrugated fiberboard boxes (5% ventilations) with newspaper lining. The fruits were kept in the cold storage (6-8°C and 90-95% RH). The fruits were taken out from the cold storage at 10, 20, 30 and 40 days after storage and analysis were done for quality attributes.

The cumulative physiological loss in weight (PLW) of the fruit was determined on the basis of initial weight of the fruit and how much loss in weight occurred and was expressed in percent. The firmness (kg/cm²) of flesh was measured on two paired sides of fruits with the help of 'Penetrometer' (Model FT-327) after removing about one square cm peel on both sides of the fruits. The palatability rating was determined on the basis of colour and taste of the fruits by panel of five judges as per 'Hedonic Scale' (1-9 points) as described by Amerine *et al.* (1965). The spoilage of fruits was assayed by counting the numbers of fruits get spoiled and/or display

*Short note

¹ Senior Scientist (Horticulture) (e mail: gouta_2000@yahoo.com), Directorate of Oil Palm Research, Pedavegi 534 450;

^{2,3} Senior Horticulturist

fungal mycelia or sporulation and were expressed as per cent of total number of fruits.

The total soluble solid (TSS) content of fruits were determined with the help of an Erma Hand Refractometer, Japan and expressed in per cent after making the temperature correction at 20°C. The ascorbic acid and acidity was estimated by the method described by AOAC (2000).

The experiment was carried out in completely randomized block design with three replications and each treatment was replicated thrice. The data were analysed as per the method of Panse and Sukhatme (1985). Least significant difference at 5% level was used for finding the significant differences among the treatment means.

The PLW increased gradually in all treatments at cold storage throughout the storage period (Table 1). The rate of PLW was slow in the beginning but faster pace as the storage period advanced. The mean lowest PLW (3.57%) was

recorded in NAA (75 ppm), followed by NAA (50 ppm) treated fruits within the stipulated storage period of 40 days, whereas, mean maximum PLW (5.01%) was observed in untreated fruits. Although, initially after 10 days of storage, minimum PLW (0.82%) was observed in KNO₃ (1.5%) treated fruits, which increased sharply after 30 days of cold storage. The fruits treated with NAA showed lower PLW. Loss of weight on prolonging storage period might be attributed to rapid loss of moisture through evaporation and respiration. Our observations are in accordance with the studies of Ladaniya *et al.* (2005) and progressive loss in weight in different fruits of following storage may also be due to changes in peel stomatal density as well as texture (Singh *et al.* 2005).

The spoilage of guava fruits started after 20 days of cold storage in all the treatments including control thereafter increased continuously with the advancement of storage period. The highest rotting (19.97%) was observed in fruits

Table 1 Physical characteristics (PLW, firmness, palatability rating and spoilage) of guava fruits (cv. Sardar) in relation to pre-harvest sprays of NAA, potassium nitrate and storage period

Quality attribute	Treatment	Storage period (days)					Mean	CD ($P \geq 0.05$)
		0	10	20	30	40		
PLW (%)	NAA 50 ppm		1.11	2.06	2.74	3.62	2.38	A = 0.08
	NAA 75 ppm		1.16	2.22	2.83	3.57	2.45	B = 0.11
	NAA 100 ppm		1.07	2.06	2.82	3.93	2.47	AxB = 0.22
	KNO ₃ 0.5%		0.93	1.69	2.63	4.15	2.35	
	KNO ₃ 1.0%		0.91	1.79	2.58	4.55	2.46	
	KNO ₃ 1.5%		0.82	1.55	2.86	4.43	2.42	
	Control		1.0	1.93	2.93	5.01	2.72	
Spoilage (%)	NAA 50 ppm			6.35	12.80	15.83	8.75	A = 0.88
	NAA 75 ppm			6.24	11.52	13.83	7.90	B = 1.17
	NAA 100 ppm			5.62	10.60	12.60	7.21	AxB = 2.33
	KNO ₃ 0.5%			6.83	14.65	16.67	9.54	
	KNO ₃ 1.0%			6.95	14.36	17.00	9.58	
	KNO ₃ 1.5%			7.49	16.28	17.67	10.36	
	Control			7.15	17.58	19.97	11.18	
Firmness (kg/cm ²)	NAA 50 ppm	8.10	6.53	5.00	4.03	2.70	5.27	A = 0.19
	NAA 75 ppm	8.67	6.80	5.33	4.97	2.50	5.33	B = 0.22
	NAA 100 ppm	8.17	7.00	5.73	3.73	2.43	5.41	AxB = 49
	KNO ₃ 0.5%	8.36	5.97	5.20	3.83	2.47	5.17	
	KNO ₃ 1.0%	8.26	5.86	5.00	3.40	2.13	4.93	
	KNO ₃ 1.5%	8.23	5.60	4.70	3.13	1.93	4.72	
	Control	8.20	5.80	4.57	3.63	2.23	4.89	
Palatability rating (1–9)	NAA 50 ppm	7.00	7.40	7.60	6.40	5.40	6.76	A = 0.35
	NAA 75 ppm	6.80	7.60	8.00	5.80	5.20	6.68	B = 0.42
	NAA 100 ppm	6.60	7.80	7.40	6.60	5.60	6.80	AxB=NS
	KNO ₃ 0.5%	6.80	8.00	8.20	5.40	4.80	6.64	
	KNO ₃ 1.0%	6.80	8.40	7.80	5.20	5.20	6.68	
	KNO ₃ 1.5%	7.00	8.20	8.00	5.00	5.20	6.68	
	Control	6.40	7.40	6.60	4.60	4.40	5.88	

A, Cold storage period; B, shelf-life; C, treatment, n = 3

under control after 40 days storage, whereas, fruits treated with NAA (100 ppm) exhibited lowest spoilage (12.60%). Data also revealed an extension of storage life with minimum spoilage throughout the cold storage by NAA (100 ppm) treatment which leads to economical and effective for storage of guava fruits. Fruits treated with NAA recorded lower spoilage during cold storage might be due to retardation of senescence and low temperature effect inside the storage decaying organism find it difficult to establish and grow inside the cold storage. Similar results also reported by Youlin *et al.* (1997) in storability mango.

Fruit firmness, in general followed a declining trend commensurate with advancement in storage period. Fruits treated with NAA (100 ppm) recorded highest mean fruit firmness (5.41 kg/cm²) within the stipulated storage period of 40 days after harvest, which ranged between 8.17-2.43 kg/cm² force. Whereas, control fruits experienced the faster loss of firmness during storage and ranged between 8.20 to 2.23 kg/cm² force, thereby leading to excessive softening and shriveling of fruits. The maintenance of higher firmness in guava fruits due to NAA might be due to delaying senescence, preserving cellular organization and retarding respiration rate. The present results are in agreement with that of Selvan and Bal (2005) in guava and Martinsson *et al.* (2006) in strawberry.

The palatability rating was considerably improved in all the treatments including control after 10 days of storage. However, palatability rating of guava fruits increased in NAA (50 and 75 ppm) and KNO₃ (0.5%) treated fruits up to 20 days of cold storage thereafter gradual declined was noticed. The control fruits recorded lowest score throughout the storage period except after 10 days of storage. The fruits treated with KNO₃ (1.0%) recorded highest score (8.40) followed by KNO₃ (1.5%) and rated as very much desirable after 10 days of storage. The palatability rating of KNO₃ treated fruits scored higher up to 20 days of storage thereafter declined sharply and rated neither desirable nor undesirable. Fruits treated with NAA (100 and 50 ppm) were rated as slightly desirable up to 30 days of storage. The improvement of palatability rating in fruits during storage might be due to the build up of sugars/acids ratio as results of hydrolysis of starch and other complex molecules leading to development of flavour in the fruits. The Results are in consonance with the finding of Mahajan *et al.* (2005) in Kinnow.

The total soluble solid (TSS) (Table 2) content of guava fruits increased initially up to 20 days of cold storage thereafter started declining slowly during the remaining storage period. Among the treatments highest TSS (13.20%) content was recorded in KNO₃ (1.5%) treated fruits after 20 days of storage, whereas they were lowest in control and a sharp

Table 2 Chemical quality attributes (TSS, ascorbic acid and titratable acidity) of guava fruits (cv. Sardar) in relation to pre-harvest sprays of NAA, potassium nitrate and storage period

Quality attribute	Treatment	Storage period (days)					Mean	CD ($P \geq 0.05$)
		0	10	20	30	40		
TSS (%)	NAA 50 ppm	10.60	11.50	12.60	10.70	9.40	10.96	A = 0.16
	NAA 75 ppm	10.57	11.63	12.73	10.83	9.63	11.08	B = 0.19
	NAA 100 ppm	10.40	11.73	12.87	10.50	9.73	11.04	A × B = 0.42
	KNO ₃ 0.5%	10.67	12.03	12.77	10.53	9.43	11.08	
	KNO ₃ 1.0%	10.77	12.40	12.97	10.43	9.33	11.18	
	KNO ₃ 1.5%	10.90	12.50	13.20	10.13	9.20	11.18	
	Control	10.43	10.97	12.37	9.87	9.37	10.60	
Ascorbic acid (mg/100g)	NAA 50 ppm	232.0	222.3	200.7	185.4	159.7	201.4	A = 4.48
	NAA 75 ppm	241.2	230.1	211.0	184.7	162.8	206.0	B = 5.30
	NAA 100 ppm	231.1	224.5	204.7	181.5	153.2	199.0	A×B = NS
	KNO ₃ 0.5%	235.1	223.0	199.6	175.6	146.3	195.9	
	KNO ₃ 1.0%	237.4	218.8	194.6	172.9	140.8	192.9	
	KNO ₃ 1.5%	236.1	216.5	192.4	169.3	134.2	189.7	
	Control	231.4	219.9	197.3	172.3	144.5	193.1	
Titratable acidity (%)	NAA 50 ppm	0.60	0.51	0.45	0.34	0.33	0.44	A = 0.029
	NAA 75 ppm	0.56	0.54	0.47	0.33	0.31	0.44	B = 0.023
	NAA 100 ppm	0.61	0.55	0.49	0.32	0.30	0.46	A×B = NS
	KNO ₃ 0.5%	0.55	0.52	0.46	0.31	0.29	0.43	
	KNO ₃ 1.0%	0.54	0.51	0.45	0.30	0.28	0.42	
	KNO ₃ 1.5%	0.53	0.51	0.42	0.29	0.28	0.41	
	Control	0.55	0.48	0.41	0.27	0.26	0.40	

A, Cold storage period; B, shelf-life; C, treatment, n = 3

decline was noticed after 20 days of storage indicating rapid metabolic breakdown in these fruits.

Fruits treated with NAA (100 ppm) maintained highest mean of TSS (9.73%) upto 40 days of storage. The increase in TSS during the early part of the storage may possibly be due to hydrolysis of insoluble polysaccharides into simple sugars (Brothakar *et al.* 2002) and as on complete hydrolysis of starch no further increase occurs and subsequently a decline in TSS is predictable as they along with other organic acids are primarily substrate for respiration. Similar results were also reported by Selven and Bal (2005) in guava and Mahajan and Dhatt (2004) in pear.

Ascorbic acid content of guava fruits decreased significantly with the advancement of storage period. The highest mean of ascorbic acid content during storage was recorded in NAA (75 ppm) treated fruits, which is ranged from 241.2 to 162.8 mg/100 g of pulp followed by NAA (50 and 100 ppm) treated fruits, whereas, in KNO₃ (1.5%) treated fruits noticed lowest ascorbic acid content throughout the storage period. During storage, oxidizing enzymes like ascorbic acid oxidase, peroxidase, catalase and polyphenol oxidase might be causing decrease in ascorbic acid content of fruits (Mapson 1970, Singh *et al.* 2005). This finding is in agreement with those of Selven and Bal (2005) in guava, Ahmed and Singh (2000) and Singh *et al.* (2008), mango and ber fruits respectively.

A declining trend in titratable acidity with the advancement of storage period was noticed that in all the treatments acidity was higher than the control. In NAA (100 ppm) treated fruits, highest average acidity (0.46%) was recorded and it ranged from 0.61 to 0.30 per cent followed by NAA (50 and 75 ppm). The fruits treated with higher concentration of NAA maintained higher acidity during storage probably due to delay in ripening process and low respiration rate. The decrease in titratable acids during the storage may be attributed to marked increase in malic enzyme and pyruvate decarboxylation reaction during the climacteric period, commensurate with an increase in the rate of respiration and other biodegradable metabolic reaction. Similar finding have been reported by Selven and Bal (2005) and Killadi *et al.* (2007) in guava fruits. Thus on the basis of the spoilage loss, palatability rating and fruit quality attribute it may be concluded that pre-harvest spray of NAA (100 ppm) treatment in combination with cold storage (6-8°C, 90-95% RH) has potential for preserving the commercial quality of the guava fruits cv. Sardar and potassium nitrate has been found to be good practices for improving quality of guava fruits.

SUMMARY

A study was conducted at Punjab Agricultural University, Ludhiana during 2006–08 in winter crop of guava cv. Sardar to evaluate the influence of pre-harvest foliar application of naphthalene acetic acid (NAA) and potassium nitrate on

quality attributes in different interval of cold storage. The plants were sprayed with NAA and potassium nitrate at colour break stage of fruit and harvested at optimum maturity, packed in CFB boxes with newspaper lining and stored at 6-8°C and 90-95% RH. Fruits treated with NAA (100 ppm) effectively reduced spoilage maintained higher fruit firmness, TSS and ascorbic acid and remain slightly desirable after 30 days of storage. Thus, pre-harvest spray with NAA (100 ppm) seems to be effective method for decreasing post-harvest losses and maintaining quality of guava fruits.

REFERENCES

- Ahmed M S and Singh S. 2000. Studies on extension of storage life of 'Amrapali' mango. *The Orissa Journal of Horticulture* **28**: 73–6.
- Amerine M A, Pangborn R M and Roessler E B. 1965. *Principle of Sensory Evaluation of Food*, p 5. Academic Press, London.
- Anonymous. 2005. Area and production of major horticultural crops. <http://www.ficciagroindia.com/indian-agriculture/indian-agriculture.htm>.
- AOAC. 2000. *Official Methods of Analysis*, edn 17. Association of Official Analytical Chemists, Washington DC.
- Brothakar P K, Ranjit Kumar and Kumar R. 2002. Effect of plant extracts on size and rind thickness of Baromasi lemon fruits (*Citrus lemon*) during storage. *Journal of Agricultural Science Society of North-East India* **15**: 98–103.
- Dutta P and Banik A K. 2007. Effect of foliar feeding of nutrients and plant growth regulators on physico-chemical quality of Sardar guava grown in red and lateritic tract of West Bengal. *Acta Horticulturae* **735**: 407–11.
- El-hilali F, Ait-Oubahou A, Remahl A and Akhayat O. 2003 Chilling injury and peroxidase activity changes in "Fortune" mandarin fruit during low temperature storage. *Bulgarian Journal of Plant Physiology* **29**: 44–54.
- Killadi B Singh M D, Singh B P and Singh R A. 2007. Shelf life evaluation of guava (*Psidium guajava* L.) cultivars. *Acta Horticulturae* **735**: 603–7.
- Ladaniya M S, Singh S and Mahalle B. 2005. Sub-optimum low temperature storage of Nagpur mandarin as influenced by wax coating and intermittent warming. *Indian Journal of Horticulture* **62**: 1–7.
- Lal S, Tiwari J P and Misra K K. 2000. Effect of plant spacing and pruning intensity on fruit yield and quality of guava. *Progressive Horticulture* **32**: 20–5.
- Mahajan B V C and Dhatt A S. 2004. Studies on post-harvest calcium chloride application on storage behaviour and quality of Asian pear during cold storage. *Journal Food Agriculture and Environment* **2**: 152–9.
- Mahajan B V C, Dhatt A S and Sandhu K S. 2005. Effect of different post harvest treatment on storage life of kinnow. *Journal of Food Science and Technology* **42**: 296–9.
- Mapson C W. 1970. Vitamins in fruits: Stability of L-ascorbic acid. (*in*) *Biochemistry of Fruits and their Products*, p 376–7. Academic Press, London.
- Martinsson M, Kwast A, Cieslinski G and Treder W. 2006. Impact of production systems and fertilizer application on yield and quality of strawberries. *Acta Hort.* **708**: 59–64.
- Panse V G and Sukhatme P V. 1985. *Statistical Methods for*

- Agricultural Workers*, edn 4. ICAR, New Delhi.
- Selvan M T and Bal J S. 2005. Effect of different treatments on the shelf life of Sardar guava during cold storage. *Journal of Ressearch, Punjab Agricultural University* **42**: 28–33.
- Singh S, Singh A K and Joshi H K. 2005. Prolong storability of Indian gooseberry (*Emblica officinalis* Gaertn.) under semiarid eco-system of Gujarat. *Indian Journal of Agricultural Sciences* **75**: 647–50.
- Singh S, Singh A K, Joshi H K, Bagle B G and Dhandar D G. 2008. Storability of ber (*Zizyphus mauritiana* Lamk) fruit in semi arid environment. *Journal of Food Science and Technology* **45**: 65–9.
- Youlin T, Yuchan Z, Xiaoping P, Tang Y L, Zhou Y C and Pan X P. 1997. Effect of plant growth regulators and prochloraz on post-harvest diseases of Zhihua mango fruits. *Acta Phytopathology Sinica* **24**: 110–3.