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Effect of preharvest application of calcium nitrate, Topsin-M and Bayleton on postharvest life of aonla (*Emblica officinalis* Gaertn.) fruit

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Abstract

Investigations on the pre-harvest sprays of 1.0% calcium nitrate, 0.1% Topsin-M, 0.1% Bayleton and their combinations were conducted on aonla cv NA-6. The spray treatments were given only at 20 d and 10 d before harvest. Treatment of 1.0% calcium nitrate + 0.1% Topsin-M was the best followed by 1.0% calcium nitrate + 0.1% Bayleton and 1.0% calcium nitrate. This treatment had maximum effect on all the attributes of fruit quality namely increased levels of TSS (8.4%), total sugars (6.93%) and total phenol (13.3%) with low levels of losses in acidity (8.8%), ascorbic acid (22.32%) and reducing sugars (12.8%) along with prolonged shelf-life of fruits upto 20 days as compared to 10 days in control. Thus, this treatment doubled the shelf-life of aonla fruit in storage at ambient temperatures.

Key words: Preharvest, calcium nitrate, fungicide, shelf-life, aonla, *Emblica officinalis* Gaertn

Introduction

Aonla (*Emblica officinalis* Gaertn.) is important fruit crop of saline-alkali soils of India. It is commercially cultivated in Uttar Pradesh particularly in the districts suffering from soil salinity and alkalinity. The fruit is highly nutritive and is second richest source of vitamin 'C' after Barbados cherry (Asenjo, 1953). Generally, it is used for making products namely 'Chavanprash', 'Triphala', hair dyes, etc. A number of pathogens attack aonla fruit during the later stages of its growth and development and many of the pathogens continue to proliferate and damage the fruit after harvest rendering large portion of the fruit unfit for consumption. Some information is available on the keeping quality of aonla cultivars (Ojha, 1987; Pathak, 1988). However, such information is lacking on cultivar NA-6 which is most promising among the latest aonla cultivar in view of its fruit size and bearing. The investigations were, therefore, taken up on pre-harvest sprays of 1.0% calcium nitrate, 0.1% Topsin-M and 0.1% Bayleton to see their effect on the post harvest life of aonla cv NA-6. The effect of these chemicals on calcium content, weight loss of fruit and decay loss caused by pathogens were reported earlier (Yadav and Singh,1999). In the present communication, effect of pre-harvest spray of these chemicals on TSS, sugars, acidity, vitamin C and phenol content of the fruits are reported during storage of fruit at ambient temperature.

Materials and methods

The investigations were carried out in the Department of Horticulture at N.D.U.A.T., Narendra Nagar, Faizabad during 1998-99. Narendra Aonla-6 (NA-6) trees of 12 years age with uniform productivity were used for these studies. The experiment comprised of pre-harvest sprays given 20 and 10 days before harvest, namely, (1) water (control), (2) 1.0% calcium nitrate, (3) 0.1% Topsin-M, (4) 0.1% Bayleton, (5) 1.0% calcium nitrate + 0.1% Topsin-M and (6) 1.0% calcium nitrate + 0.1% Bayleton. These treatments were given to the fruited trees on 10th and 20th November 1998. The fruits were harvested at full maturity on 30th November at the best physiological stage and size. Three kg randomly selected fruits for each treatment were packed in CFB boxes with paper cutting as packing material and stored at ambient temperature (18 ± 5 ^{o}C) from 30th November till spoiled and all the treatments were replicated three times, keeping one box as one replicate. Three fruits per replicate were taken at random at 5 days intervals from each treatments for determination of total soluble solids (TSS), sugars, acidity, ascorbic acid (vitamin C) and total phenols. Total soluble solids were determined by using hand refractometer of 0-32 per cent range and expressed as per cent TSS of the fruit juice. Acidity was determined by titration with 0.1N NaOH and results were expressed as g citric acid per 100 g of fruit pulp. Ascorbic acid content was determined by titration against 2, 6-dichlorophenol indophenol dye and the results were expressed as mg ascorbic acid per 100 g of fruit pulp. Sugars were estimated by Fehling's Solution as described by Lane and Eynon (1943) and the total phenol in fruit pulp was estimated by the method of Swain and Hills (1959). The results were expressed as per cent sugars and per cent phenols in fruit pulp.

Results and discussion

Total soluble solids: Calcium nitrate (1.0%) and Topsin-M (0.1%) treatment had best effect on per cent TSS of NA-6 aonla fruits stored at room temperature among all the treatments (Table 1). The effect of pre-harvest spray was visible from the date of harvest. Calcium nitrate (1.0%) and Topsin-M (0.1%) treated fruits had maximum TSS throughout the storage period of aonla among the various chemicals tried. They increased the TSS of fruit (11 to 12%) for 20 days which was highest among the treatments. Calcium nitrate is reported to increase the TSS in

Table 1. Effect of pre-harvest treatments on TSS, reducing , non-reducing and total sugar content of aonla cv NA-6 during storage at room temperature

Treatments	Days after storage						Mean
	0	5	10	15	20	25	
TSS							
Control	10.00	10.40	10.70	10.85	11.15	11.75	10.81
1% Calcium Nitrate	10.75	10.95	11.20	11.60	11.75	11.95	11.37
0.1% Topsin - M	10.55	10.85	11.05	11.55	11.70	11.90	11.27
0.1% Bayleton	9.80	10.45	10.65	10.85	11.35	12.05	10.86
1% Calcium Nitrate + 0.1% Topsin - M	10.90	11.20	11.35	11.60	11.90	12.30	11.54
1% Calcium Nitrate + 0.1% Bayleton	10.70	10.95	11.10	11.55	11.85	12.25	11.40
Mean	10.45	10.80	11.01	11.33	11.62	12.03	
CD (p=0.05) Treatment=0.09, Days=0.09, Days x Treatment = 0.24							
Reducing Sugars							
Control	2.25	2.25	2.18	1.95	1.85	1.66	2.02
1% Calcium Nitrate	2.50	2.65	2.55	2.28	2.20	2.10	2.38
0.1% Topsin - M	2.30	2.45	2.35	2.08	2.00	1.90	2.18
0.1% Bayleton	2.35	2.35	2.30	2.05	1.98	1.93	2.16
1% Calcium Nitrate + 0.1% Topsin - M	2.50	2.60	2.55	2.28	2.18	2.18	2.38
1% Calcium Nitrate + 0.1% Bayleton	2.50	2.60	2.53	2.28	2.15	2.18	2.37
Mean	2.40	2.48	2.41	2.15	2.06	1.99	
CD (p=0.05) Treatment=0.12, Days=0.12, Days x Treatment = NS							
Non Reducing Sugars							
Control	2.01	2.10	2.32	2.60	2.55	2.44	2.34
1% Calcium Nitrate	2.00	2.15	2.43	2.72	2.70	2.60	2.43
0.1% Topsin - M	1.95	2.15	2.40	2.70	2.60	2.50	2.38
0.1% Bayleton	1.93	2.18	2.39	2.65	2.57	2.45	2.36
1% Calcium Nitrate + 0.1% Topsin - M	2.06	2.33	2.61	2.92	2.92	2.72	2.59
1% Calcium Nitrate + 0.1% Bayleton	2.02	2.32	2.53	2.90	2.90	2.70	2.56
Mean	2.00	2.21	2.45	2.75	2.71	2.57	
CD (p=0.05) Treatment=0.10, Days=0.10, Days x Treatment = NS							
Total sugars							
Control	4.26	4.35	4.50	4.55	4.40	4.10	4.36
1% Calcium Nitrate	4.50	4.80	4.98	5.00	4.90	4.70	4.81
0.1% Topsin - M	4.35	4.60	4.75	4.78	4.61	4.40	4.58
0.1% Bayleton	4.28	4.53	4.69	4.70	4.55	4.38	4.52
1% Calcium Nitrate + 0.1% Topsin - M	4.56	4.98	5.16	5.20	5.10	4.90	4.98
1% Calcium Nitrate + 0.1% Bayleton	4.52	4.92	5.13	5.18	5.08	4.88	4.95
Mean	4.41	4.70	4.87	4.90	4.77	4.56	
CD (p=0.05) Treatment=0.16, Days=0.16, Days x Treatment = NS							

other tropical fruits like ber (Gupta *et al.,* 1987), Kinnow mandarin (Kumar and Chauhan, 1989), guava (Bhadu, 1983), grape (Subburamu *et al*., 1990) and Baramasi lemon (Sidhu and Singhrot, 1996).

Sugars

(a) Reducing sugars: The level of reducing sugars was higher on the date of harvest in NA-6 aonla fruit which were given pre-harvest treatments of 1.0% calcium nitrate, 0.1% Topsin-M, 0.1% Bayleton and their combinations (Table 1). Calcium nitrate (1.0%), 1.0% calcium nitrate + 0.1% Topsin-M or 1.0% calcium nitrate + 0.1% Bayleton and 0.1% Topsin-M slightly increased reducing sugars upto 5 days without any such increase in Bayleton and control treatments. Reducing sugar levels after 10 days was almost similar to the date of harvest in control fruits. However, reducing sugar decreased after 10 days of storage at room temperature in a similar manner in all the treatments. On 20th day of storage, calcium nitrate treatment with or without Topsin-M or Bayleton maintained reducing sugars level in the fruit at par with the date of harvest and 1.0% calcium nitrate alone preserved high levels of reducing sugars upto 20 days of harvest which was also at par with the 0 day of storage. Calcium nitrate is reported to protect reducing sugars of guava (Singh, 1985) and grapes (Kumar, 1982).

(b) Non reducing sugar: Non-reducing sugar did not differ in fruits significantly at harvest. Non-reducing sugar in all the treatments increased during storage for 15 days (Table 1). Pre-harvest spray of 1.0% calcium nitrate + 0.1% Topsin-M and 1.0% calcium nitrate + 0.1% Bayleton maintained highest level of non-reducing sugar followed by 1.0% calcium nitrate, 0.1% Topsin-M, 0.1% Bayleton and control in the decreasing order. The decrease in non-reducing sugar in control was much faster than that of calcium nitrate, Topsin-M, Bayleton and their combinations. Thus, best result was obtained with 1.0% calcium nitrate + 0.1% Topsin-M and 1.0% calcium nitrate + 0.1%

Bayleton in NA-6 aonla fruit during storage at room temperature for 25 days. Calcium has also been reported to protect non-reducing sugar in guava (Singh, 1985).

(c) Total sugars: Treatments *viz*., calcium nitrate, Topsin-M, Bayleton and their combinations increased total sugars in NA-6 aonla fruits when used as pre-harvest sprays (Table 1). Calcium nitrate (1.0%) with Topsin-M (0.1%) or Bayleton (0.1%) also had maximum protection on total sugar content during storage period with an increase of more than 11 and 12% after 10 and 15 days, respectively. However, total sugars levels decreased after 15 days in all the treatments but levels remained higher than the date of harvest upto 25 days except control. Therefore, 1.0% calcium nitrate with 0.1% Topsin-M or Bayleton were most effective treatments. Calcium is reported to protect total sugar in guava (Singh, 1985).

Acidity: Pre-harvest spray of calcium nitrate, Topsin-M, Bayleton and their combinations also influenced acidity of the aonla fruit during their maturation on the tree and thereafter in storage at ambient temperature (Table 2). The increase in per cent acidity of NA-6 aonla fruit was more when treated with 1.0% calcium nitrate + 0.1% Topsin-M followed by 1.0% calcium nitrate + 0.1% Bayleton and 1.0% calcium nitrate than other treatments and control. Among them, 1.0% calcium nitrate + 0.1% Topsin-M was best treatment which increased per cent acidity from 1.75 to 1.80% after 5 and 10 days of storage and maintained acidity levels above 1.6%. This was higher than other treatments, expect 1.0% calcium nitrate + 0.1 Bayleton and equal to the acidity of control fruit on the date of harvest. Thus, 1.0% calcium nitrate +0.1% Bayleton appear to be equally effective on maintaining acidity of aonla fruit above or on the level of control fruits for 20 days in storage at room temperature. Calcium nitrate has been reported to increase and maintain high acidity in other fruits such as banana (Srivastava *et al.,* 1972), guava (Singh, 1985), and Kinnow mandarin (Kumar and Chauhan, 1989). Similarly Topsin-M has been reported to increased acidity in Baramasi lemon (Singh and Singhrot, 1996).

Ascorbic acid: On the date of harvest, fruit which were given two pre harvest sprays of 1.0% calcium nitrate + 0.1% Topsin-M or 1.0% calcium nitrate alone had more ascorbic acid content (717 mg/100gm) than other treatments (Table 2). The ascorbic acid content slowly decreased in all the treatments without any significant change in the rate of decrease of the treatments. Maximum ascorbic acid content was retained by pre harvest treatment of 1.0% calcium nitrate + 0.1% Topsin-M followed by calcium nitrate alone. Thus, loss of 208.03 mg ascorbic acid occurred in 1.0% calcium nitrate + 0.1% Topsin-M treatment during 25 days storage as compared to more than 208 mg ascorbic acid loss in other treatments during this period. Calcium nitrate (1.0%) + Topsin-M (0.1%) as pre-harvest spray, therefore,

Table 2. Effect of pre-harvest treatments on acidity, ascorbic acid and total phenol content of aonla cv NA-6 during storage at room temperature

Treatments	Days after storage						Mean
	0	5	10	15	20	25	
Acidity							
Control	1.57	1.74	1.68	1.53	1.48	1.44	1.57
1% Calcium Nitrate	1.66	1.86	1.75	1.55	1.51	1.47	1.63
0.1% Topsin - M	1.64	1.74	1.66	1.63	1.52	1.42	1.60
0.1% Bayleton	1.65	1.76	1.59	1.52	1.49	1.44	1.58
1% Calcium Nitrate + 0.1% Topsin - M	1.70	1.88	1.88	1.60	1.55	1.51	1.69
1% Calcium Nitrate + 0.1% Bayleton	1.76	1.87	1.77	1.62	1.59	1.55	1.69
Mean	1.66	1.81	1.72	1.58	1.52	1.47	
CD (p=0.05) Treatment=0.04, Days=0. 0.04, Days x Treatment = .09							
Ascorbic acid							
Control	666.16	628.44	580.62	502.21	440.28	425.80	540.59
1% Calcium Nitrate	717.39	698.91	664.12	606.89	522.54	484.43	615.71
0.1% Topsin - M	709.98	692.31	658.98	599.94	514.09	473.15	608.08
0.1% Bayleton	684.08	654.05	614.07	567.29	474.69	409.14	567.22
1% Calcium Nitrate + 0.1% Topsin - M	716.26	704.31	674.43	624.87	556.32	508.23	630.74
1% Calcium Nitrate + 0.1% Bayleton	704.05	689.84	652.64	594.05	513.40	446.33	600.05
Mean	699.65	677.98	640.81	582.54	503.55	457.85	
CD (p=0.05) Treatment=3.85, Days=3.85, Days x Treatment = 9.43							
Total phenols							
Control	144.00	151.00	159.00	166.00	174.00	183.00	162.83
1% Calcium Nitrate	168.00	176.00	182.00	189.00	197.00	204.00	186.00
0.1% Topsin - M	159.00	168.00	171.00	178.00	186.00	194.00	176.00
0.1% Bayleton	158.00	164.00	174.00	178.00	185.00	192.00	175.17
1% Calcium Nitrate + 0.1% Topsin - M	174.00	181.00	188.00	196.00	202.00	209.00	191.67
1% Calcium Nitrate + 0.1% Bayleton	169.00	176.00	182.00	190.00	198.00	205.00	186.67
Mean	162.00	169.33	176.00	182.83	190.33	197.83	
CD (p=0.05) Treatment=4.44, Days=4.44, Days x Treatment = NS							

appear to be best treatment for protecting ascorbic acid loss in aonla during storage at ambient temperature.

Ojha (1987) has reported 10 per cent loss in ascorbic acid content after 10 days of storage, whereas Pathak (1988) recorded 7 per cent loss in ascorbic acid after 6 days of storage. In the present investigation 12.84 per cent loss in ascorbic acid was recorded after 10 days, 24 per cent loss after 15 days and 33.9 per cent loss after 20 days storage at room temperature without any pre-harvest treatments (control). However, pre-harvest sprays of 1.0% calcium nitrate +0.1% Topsin-M decreased ascorbic acid loss than other treatments and losses in ascorbic acid content were 5.8, 12.75 and 22.22% after 10, 15 and 20 days, storage at room temperature, respectively. Thus, both calcium nitrate and Topsin-M appear to protect loss of ascorbic acid during storage of aonla fruit. Other workers have also reported that calcium nitrate protects the loss in ascorbic acid in Kinnow mandrin (Kumar and Chauhan, 1990), oranges (Rana *et al.,* 1992). Topsin-M also protects ascorbic acid of the lemon fruit (Sindhu and Singhrot, 1996).

Total phenol: Total phenol content in fruits of aonla cv NA-6 was more than control in all the treatments at harvest and continued to increase on the same rate during the storage of fruit for 25 day without any major change in the phenol content under each treatment (Table 2). One per cent calcium nitrate and 0.1% Topsin-M treated fruits contained 30.25 mg/100gm higher total phenol at harvest than the control and content was also higher (26.25 mg/100gm) upto 25 days of storage. Total phenol content was significantly higher in treatments containing calcium nitrate, Topsin-M and Bayleton than control at harvest and this difference continued upto 25 days of storage. Thus, 1.0% calcium nitrate + 0.1% Topsin-M was best treatment followed by 1.0% calcium nitrate alone or 1.0% calcium nitrate + 0.1 Bayleton on the total phenol content of NA-6 aonla fruit during storage. Total phenol is reported to increase during storage of aonla fruit by Gupta and Mukherjee (1982). In other fruits like grape (Medhi and Singh, 1983), guava (Singh, 1985) and peach (Salunkhe *et al.,* 1968), total phenol content increased during storage. Increase in phenol content by Topsin-M and Bayleton treatment may be due to protection of aonla fruits from pathogens and physiological loss in fruit weight.

It is evident from foregoing discussions on the data that aonla fruits treated with 1.0% calcium nitrate + 0.1% Topsin-M had slight loss in ascorbic acid (1.66%) with increased percentage of TSS (2.6%), total sugars (8.43%), acidity (9.5%) and total phenol (3.86%) for 10 days in storage. However, on 20th day fruits under this treatment had increased levels of all the attributes of fruit quality namely TSS (8.4%), total sugars (6.93%) and total phenol (13.3%) with tolerable losses in acidity (8.8%), ascorbic acid (22.32%) and reducing sugars (12.8%). Thus, out of all the treatments tried, 1.0% calcium nitrate + 0.1 Topsin-M appears to be the best followed by 1.0% calcium nitrate + 0.1% Bayleton or 1.0% calcium nitrate alone as pre-harvest spray on aonla cv NA-6. The present investigation, therefore, suggest that no treatment is required for storing NA-6 aonla fruits for 5 days at room temperature and 1% calcium nitrate + 0.1% Topsin-M should be used as pre-harvest spray for storing 20 days at room temperature.

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