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Effect of pre-harvest application of chemicals and pesticide on fruit ripening in mango (*Mangifera indica* L.) under ambient conditions

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Abstract
The pre-harvest study was conducted in an experimental orchard and post-harvest laboratory of the department of Horticulture during 2013–14 with a view to investigate the effect of chemicals and pesticide application on ripening of mango under ambient condition. The maximum delay in ripening was observed with 200ppm Silver nitrate + 0.1% Carbendazim (3.34 days) followed by Silver nitrate (100ppm) + Carbendazim (0.1%). The findings of the present study also reflected maximum delay in ripening with pre-harvest application of silver nitrate. However, post-harvest quality of fruits declined with the treatment. The delay in ripening caused by Silver nitrate may be an important factor for poor fruit quality.

Keywords: Mango (*Mangifera indica* L.), pre-harvest chemicals, ripening

Introduction
Mango is a national fruit of India because of its excellent flavour, delicious taste, delicate fragrance and attractive colour. Mango is a fleshy fruit containing more than 80 per cent water are more prone to spoilage. The glut during peak harvesting season and rapid ripening process i.e. sudden rise in respiration rate and ethylene production are the conditions subjected to spoilage. To avoid glut during peak season of harvesting and provide good returns to orchardist, it becomes essential to store the mango fruits for selling in phased manner. Hence, it is essential to develop some pre and post harvest mechanism to improve the storage life in order to regulate the supply of quality mango fruits for longer period on domestic and distant market.

Fruits stored in modified atmosphere often show undesirable characteristics, i.e. poor colour, poor eating quality and presence of undesirable flavours. So, to solve the problem of short shelf-life of mango fruits, different chemicals are used to delay the ripening (Suhardi, 1992) **[22]**. Several pre and post-harvest methods are known to extend the storage life of mango fruits by minimizing weight loss, reduction in rate of respiration, transpiration and rotting percentage by use of calcium compounds as pre harvest spray and post-harvest dip treatments (Singh *et al*., 1998; Eimer *et al*., 2006 and Lanaouskas and Kvikliene, 2006) [21, 6, 14]. Calcium, as a constituent of the cell wall, plays an important role in forming cross bridges, which influence cell wall strength and regarded as the last barrier before cell separation (Fry, 2004) [7]. Calcium compounds (chloride and nitrate) treatments have been found to have some beneficial effect like prevention of decline in ascorbic acid (Kwon *et al*., 1999) [13], phenol content and reduce softness of pulp adhering stone etc for improving the quality and shelf life of mango fruits.

In mango major postharvest losses is due to the loss of quality due to loss in firmness, physiological weight loss and decay loss. Pre harvest application of different growth regulators and chemicals improve the post-harvest quality of fruit. Pre harvest spray of micronutrients is the common practice to overcome the micronutrients deficiencies in order to improve the fruit quality. Nutrients are generally quickly available to the plants by the foliar application than the soil application. Calcium chloride is also known to play an important role in the quality retention of fruit in maintaining the firmness, reducing respiration rate and ethylene evolution and decreasing rot. There is great role of pre-harvest treatment of some chemicals on shelf life and post-harvest quality of fruits. The increase in loss in weight during storage period and shelf life due to upsurge in respiration rate and transpiration process in fruits and it can be minimized by supplementary application of chemicals and plant growth regulators on fruit for maintaining fruit quality and extending the shelf life of fruit. Calcium is known to be essential plant nutrient involved in a number of physiological processes concerning membrane structure, function and enzyme activity.

Calcium has received considerable attention in recent year due to its desirable effect in delaying ripening and senescence, increasing firmness, reduce respiration, extending storage life, reducing the incidence of physiological disorder and storage rots. Calcium chloride treatment to fruits protects against post-harvest deterioration by binding with hydrolysis such as galacturonase and promotes shelf life. Mango is also seasonal and perishable in nature. Mango is a climacteric fruit generally harvested green, which ripens during the marketing process (transport, storage etc.) with an irregular storage period between harvest and consumption.

Materials and Methods

The present study was conducted in an experimental orchard and post-harvest laboratory of Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The experimental orchard which was located in Horticultural Research Centre (HRC) of the University was maintained healthy following proper orchard management practices. The university is situated on Meerut-Roorkee road (Near Modipuram), about 11 km away from the Meerut city. Geographically, experimental field is located at 290 01 North latitude, 770 45' East longitude and at an altitude of 237.75 meter above mean sea level.

Results and Discussion

The data recorded on days to fruit ripening indicated the positive effect of treatments on enhancing and delaying the ripening of mango (Table & fig. 1). The treatments differed with each other for the time required for ripening of the fruits. Among the pre-harvest treatments, Silver nitrate with or without Carbendazim was most effective in delaying the ripening as compared to other treatments. The higher concentration of Silver nitrate with or without Carbendazim was responded better in delaying the ripening as compared to lower concentration. The maximum delayed in ripening was observed with Silver nitrate (200ppm) + Carbendazim (0.1%) followed by Silver nitrate (100ppm) + Carbendazim (0.1%). Calcium chloride with or without Carbendazim was least effective in delaying the ripening of fruits (1.25 to 1.59 days compared to control) as compared to other treatments. In comparison with Calcium chloride, the pre-harvest treatment of dehydrated calcium chloride was more effective in delaying the ripening. The delaying in ripening due to Calcium chloride treatment varied from 6.58 to 7.33 days, while in case of pre-harvest treatment of dehydrated Calcium chloride the delay in ripening was ranged from 7.00 to 7.83 days. A maximum of 3.34 per cent delay in fruit ripening over control was observed with Silver nitrate 200ppm + Carbendazim 0.1%. However, the minimum delay of 1.25 per cent in fruit ripening over control was recorded with Calcium chloride 2%.

Significant delayed in fruit ripening was observed in all treatments containing Carbendazim in comparison with those treatments containing no Carbendazim. While 200ppm Silver nitrate + 0.1% Carbendazim delayed the ripening for more than 3 days, Calcium Chloride (2%) slowed down the ripening only for more than 1 day when compared with control treatment. Per cent delay in fruit ripening over control was maximum (62.66%) with 200ppm Silver nitrate + 0.1% Carbendazim followed by 100ppm Silver nitrate + 0.1% Carbendazim (57.97%) and 200ppm Silver nitrate (56.28%), whereas per cent delay in fruit ripening over control was minimum (23.45%) with 2% calcium chloride followed by 2% Calcium Chloride + 0.1% Carbendazim (29.83%). The lower concentrations of Calcium chloride, Dehydrated Calcium chloride with or without Carbendazim were less effective in delaying the ripening of fruit (0.59 to 1.25 days) in comparison to higher concentration of these treatments. All pre-harvest treatments delayed the ripening in the study, when compared with control fruits.

In the present study out of different chemical and pesticide treatments, maximum delay in ripening was observed in fruits treated with pre-harvest application of Silver nitrate (8.08to 8.67 days) followed by Dehydrated Calcium chloride (7.00 to 7.83 days) and Calcium chloride (6.58 to 7.33 days). Ripening in mango is caused due to endogenous synthesis of ethylene in fruits during maturity (Abeles *et al.* 1992) [2]. On the other hand ethylene generating chemicals such as ethephon when apply to fruits as pre and post-harvest treatments enhance the ripening (Clendennen, 1997) [5]. Ethylene as a hormone is well known for its triple action i.e. growth inhibition, abscission at higher concentration and growth promotion at lower concentration. Ethrel or ethephon (which is an ethylene generating chemical) is known to be as extremely active ripening hormone (Halfarce and Barden 1979) [9]. The findings of present study therefore suggest that ripening is delayed in Dashehari mango as a result of pre-harvest application of Silver nitrate due to the ethylene inhibition action of silver ion (Ag^+) of silver nitrate. Silver nitrate has been well recognised as an inhibitor of ethylene biosynthesis (Beyer and Elomo 1976; Lelyvald and Oostrum, 1978; Abeles *et al.* 1972 [4, 15, 2]; Beyer 1979) Silver nitrate application by inhibiting ethylene production also delays softening in mango fruits (Hatton *et al.* 1965) [10]. It blocks ethylene receptors and prevents ethylene effect in plant tissues for extended period which indicates the possible role of the chemical in delaying metabolism activity of fruits during ripening and storages (Kumar *et al.* 2009; Bairwa and Dashora, 2002) [12, 3]. In the present study application of Calcium chloride and Dehydrated Calcium chloride also slowed down the ripening process. Delay in ripening by pre-harvest application of Calcium chloride was also reported by Karemera *et al.* (2014) [11] who had reported significantly delay of ripening of Alphonso fruit with 1.50% Calcium chloride application at 30 days before harvest (19.22days). Their findings further suggest that pre-harvest application is more useful in the early development of fruit rather than when applied late. Similar observations were also noted by Penter and Stassen, (2000) and Gill *et al.* (2005) [17, 8]. Inhibitory effect of ethylene inhibitors and other chemicals on fruit ripening as reported in the present study was also observed by various workers not only in mango but also in other fruits (Theologis *et al.* 1992; Yang 1995; Nagata *et al.* 1995) [23, 24, 16]. The positive effect of Calcium salts especially Calcium chloride to delay the ripening may be because of the fact that Calcium salts application retard the ripening and senescence in fruits by lowering the respiration (Singh *et al.* 1993) [18]. It was further supported by the fact that the treatments of Calcium salts retarded the physico chemical changes feasible for manifestation of ripening quality features and certainly helped considerably in delaying the ripening (Singh *et at.* 2007) [19].

Of the different pre-harvest treatments applied 35 days before harvesting, the maximum delayed in ripening was observed with 200ppm Silver nitrate + 0.1% Carbendazim (3.34days) followed by Silver nitrate (100ppm) + Carbendazim (0.1%). Among the calcium salts treatments, the dehydrated calcium chloride was more effective in delaying the ripening (2.50days) than calcium chloride (2.00days).

Table 1: Effect of pre-harvest application of chemicals and pesticide on fruit ripening in mango under ambient condition.

Treatments	Days to fruit ripening	Days to delay (-) or days to enhance (+) fruit ripening over control	Percent delay(-) or percent enhance (+) in fruit ripening over control
Control (Fresh water)	5.33	-	-
Calcium Chloride 2%	6.58	(-) 1.25	(-) 23.45
Calcium Chloride 3%	7.17	(-) 1.84	(-) 34.52
Calcium Chloride 2% + Carbendazim 0.1%	6.92	(-) 1.59	(-) 29.83
Calcium Chloride 3% + Carbendazim 0.1%	7.33	(-) 2.00	(-) 37.52
Dehydrated Calcium Chloride 2%	7.00	(-) 1.67	(-) 31.33
Dehydrated Calcium Chloride 3%	7.25	(-) 1.92	(-) 36.02
Dehydrated Calcium Chloride 2% + Carbendazim 0.1%	7.58	(-) 2.25	(-) 42.21
Dehydrated Calcium Chloride 3% + Carbendazim 0.1%	7.83	(-) 2.50	(-) 46.90
Silver Nitrate 100 ppm	8.08	(-) 2.75	(-) 51.59
Silver Nitrate 200 ppm	8.33	(-) 3.00	(-) 56.28
Silver Nitrate 100 ppm + Carbendazim 0.1%	8.42	(-) 3.09	(-) 57.97
Silver Nitrate 200 ppm + Carbendazim 0.1%	8.67	(-) 3.34	(-) 62.66
LSD (<0.05%)	0.570		

Fig 1: Bearing trees of Dashehari mango selected at HRC for pre-harvest study

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