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1-METHYLCYCLOPROPENE DELAYS RIPENING OF THE PERISHABLE 'DONNIE' AVOCADO

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Abstract. **West Indian (WI) avocados generally have a short storage and shelf life, reducing their marketing window. The effect of 1-MCP (1-methylcyclopropene) on fruit firmness, color, and postharvest storage life was investigated using 'Donnie' avocado, a large, WI avocado with a short postharvest shelf life. Fruit were harvested from a commercial orchard in Homestead, Fla. and treated with air or 1 ppm 1-MCP in sealed containers at 7 °C (45 °F) for 24 hours. After treatment, fruit were packed in commercial flats and stored for 7 days at 7 °C (45 °F) and 14 days at 13 °C (55 °F) and then exposed to ambient temperatures for an additional 5 days. During storage, fruit were rated for firmness and color on days 5, 12, 19, and 21; after storage and exposure to ambient temperatures fruit were rated for firmness and color on days 2 and 5. Fruit treated with 1-MCP were significantly firmer and greener after 5 days of storage than non-treated fruit. 1-MCP treated fruit were firmer and greener after storage compared to non-treated fruit. The data show that 1-MCP has potential to extend the useful storage life of 'Donnie' avocado fruit.**

Ethylene is a gaseous plant hormone that promotes petal and leaf abscission, fruit ripening, and senescence (Beaudry, 2003). The growth regulator, 1-methylcyclopropene (1-MCP), has been shown to have significant promise as an ethylene action inhibitor (Blankenship and Dole, 2003). 1-MCP is sold commercially as *Smart Fresh*™ (Agro-Fresh, Inc., a division of Rohm and Haas, Lockport, N.Y.) where 1-MCP is combined with a powdered dextran carrier. The 1-MCP is freed from the dextran as a gas by adding water in a process that takes only a few minutes (Beaudry, 2003). 1-MCP works by binding to the receptor site that normally binds ethylene, thereby blocking ethylene from the binding site and the subsequent cascade of biochemical reactions induced by ethylene.

Several other compounds have been shown to block ethylene perception, thus inhibiting ethylene effects (Sisler, 1991; Sisler et al., 1990). Both 2, 5-norbornadiene and diazocyclopentadiene, act as ethylene binding inhibitors and have been shown to delay the softening and ripening of apples (Blankenship and Sisler, 1989, 1993; Fan et al., 1999; Gong and Tian, 1998). These compounds have not been commercially adopted due to their explosiveness or objectionable odor properties (Sisler and Serek, 1997; 1999). In contrast, 1-MCP is non-toxic.

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Commonly, Florida avocados may be stored at 4 to 13 °C (40 °F to 55 °F) for 10 to 21 d depending on cultivar (Crane et al., 2001). Once removed from storage, the normal shelf life of avocado fruit (*Persea americana* Mill.) at room temperature ranges from 3 to 8 d. Previously, 1-MCP was shown to delay softening and ripening, and decrease green to yellow peel color development of 'Simmonds', 'Tower II' and 'Booth 7' avocados (Huber et al., 2003; Jeong et al., 2002, 2003). The West Indian cultivar used in this experiment, 'Donnie', is known to have a relatively short storage [i.e., 5 to 10 d at 13 °C (55 °F)] and shelf life (i.e., 3 to 5 d). The objective of this research was to determine if 1-MCP would be effective in prolonging the storage life and delaying ripening of 'Donnie' avocados.

Materials and Methods

Avocados were harvested from a commercial orchard in Homestead, Fla., on 9 July 2004 and then transported to the University of Florida's Tropical Research Education Center in Homestead, Fla. The avocados were rinsed in a water bath to remove any dirt and copper residue. Fruit were dried, then 10 fruit were selected at random and placed in individual 19-L plastic containers. The containers were then placed in a cooler at 7 °C (45 °F) and remained in the cooler throughout a storage period of 21 d.

There were two treatments, fruit treated with 1 ppm MCP and air-treated controls. Five containers with 10 fruit each were treated with 1-MCP and 5 containers with 10 fruit each were left untreated. The 1-MCP was applied by mixing in a 125 mL flask 45.1 mg of Smart Fresh (0.14% ai) in 40 mL of deionized water, placing the opened flask into the plastic container and sealing the container for 12 h. Vaseline was applied onto the lids of the containers to reduce the potential for gas leakage. After 12 h, the containers were opened briefly, a new batch of 1-MCP plus water was mixed, placed into the container and the containers re-sealed for an additional 12 h. Both 1-MCP treated and non-treated controls remained in storage (7 °C/45 °F) during application of 1-MCP.

After the 24 h of continuous gassing, the avocados were removed from the containers and placed inside commercial flats (boxes); 10 fruit were placed into each box. The boxed fruit was then left in storage at 7 °C (45 °F) for 7 d after which the storage temperature was increased to 13 °C (55 °F) for 14 more days. Raising the storage temperature to 13 °C (55 °F) was done to preclude chilling injury, which may occur on some West Indian avocado cultivars.

Fruit were evaluated for firmness and color prior to and during storage on days 5, 12, 19, and 21. Fruit firmness was determined by gently squeezing the fruit and rated on a scale from 1 to 5, with 1 being very firm (not ripe) and 5 being the least firm (ripe, ready to eat). Fruit color was rated as 1, dark green; 2, medium green; and 3, yellow-green. After 21 d of storage, all fruit were taken out of storage and placed at room temperature 24 to 27 °C (75 to 80 °F) and evaluated for firmness, decay, and color 2 and 5 d after removal from storage. Decay was evaluated by counting the number of fruit with or

Table 1. Effect of 1-MCP on 'Donnie' avocado firmness and peel color ratings and incidence of decay.

	Firmness rating during storage[z]		Color rating during storage[y]		Incidence of fruit showing decay (%)	
Days in storage[x]	Non-1-MCP treated	1-MCP treated	Non-1-MCP treated	1-MCP treated	Non-1-MCP treated	1-MCP treated
5	1.00 a	1.00 a	1.08 a	1.13 a	0	0
12	2.45 a	1.00 b	2.05 a	1.55 b	0	0
19	4.80 a	1.00 b	3.00 a	1.23 b	0	0
21	4.98 a	1.33 b	2.98 a	1.58 b	0	0
	Firmness rating after storage[z]		Color rating after storage[y]		Incidence of decay (%)	
Days in ambient[x]	Non-1-MCP treated	1-MCP treated	Non-1-MCP treated	1-MCP treated	Non-1-MCP treated	1-MCP treated
2	5.00 a	2.75 b	3.00 a	2.10 b	0	0
5	Decayed	5.00	Decayed	3.00	100	0

[z]1, very firm/hard; 2, firm/very slightly soft; 3, firm/slightly soft; 4, moderately soft/softening and; 5, soft/ripe. Treatment means followed by different letters are significantly different from each other by t-test.
[y]1, dark green; 2, light green; 3, yellow.
[x]Fruit was stored at 7 °C (45 °F) for 7 d after which the storage temperature was increased to 13 °C (55 °F) for 14 more days. After 21 d of storage, all fruit were taken out of storage and placed at room temperature 24 ° to 27 °C (75 °-80 °F) for 5 d.

without visible decay symptoms. Decay was expressed as a percentage of the total number of fruit.

The experiment was conducted in a completely randomized design. Statistical procedures were performed using SAS (SAS Institute, Cary, N.C.). Data were subjected to ANOVA using General Linear Model and means were separated by t-test.

Results and Discussion

Fruit firmness. All fruit were firm prior to storage (data not shown). Fruit treated with 1-MCP were significantly firmer after 5 to 21 d of storage compared to control fruit (Table 1). 1-MCP treated fruit began to soften 2 d after storage and were ripe after 5 d at room temperature. A possible reason for prolonged firmness of 1-MCP treated fruit is that 1-MCP binds to all the available ethylene receptor sites and the only way that the fruit can ripen is if new receptor sites are created. Furthermore, when fruit are stored at cool temperatures their metabolism is reduced, presumably reducing the rate of production of new receptors. When fruit are taken out of storage and held at room temperature their metabolism increases and more receptors are created (Beaudry, 2003).

Peel color and decay. All fruit were dark green prior to storage (data not shown). Fruit treated with 1-MCP maintained their green color and were significantly greener during storage than control fruit (Table 1). When fruit were transferred to room temperature conditions, control fruit rapidly turned yellow-green within 2 d, whereas 1-MCP treated fruit maintained a green color. Five days after storage, control fruit began to show signs of rotting whereas 1-MCP treated fruit turned light green. The loss of green color during ripening is due to the catabolism of chlorophyll caused, in part, by the activity of chlorophyllase. The increase in the activity of this enzyme seems to be associated with ethylene action during the ripening process (Tucker, 1993).

1-MCP was effective in delaying the ripening of 'Donnie' avocados during and after storage. 1-MCP treated fruit remained firm and maintained their green color longer than fruit exposed only to air (Table 1). Treating 'Donnie' avocados with MCP may enable producers to extend the storage and useful marketing life of this excellent early season avocado cultivar by 5 to 7 d.

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