Responses of European Pears to 1-MCP

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As with other climacteric fruit, treatment with 1-MCP has been shown to slow ripening of many European pear cultivars. Cultivars tested at this time include 'd'Anjou,' 'Bartlett,' 'Bosc,' and 'Comice.' Typical responses include delays in degreening, softening, and loss of titratable acidity. Also, development of physiological disorders including senescent and superficial scald and internal browning may be delayed, reduced or even prevented by 1-MCP application.

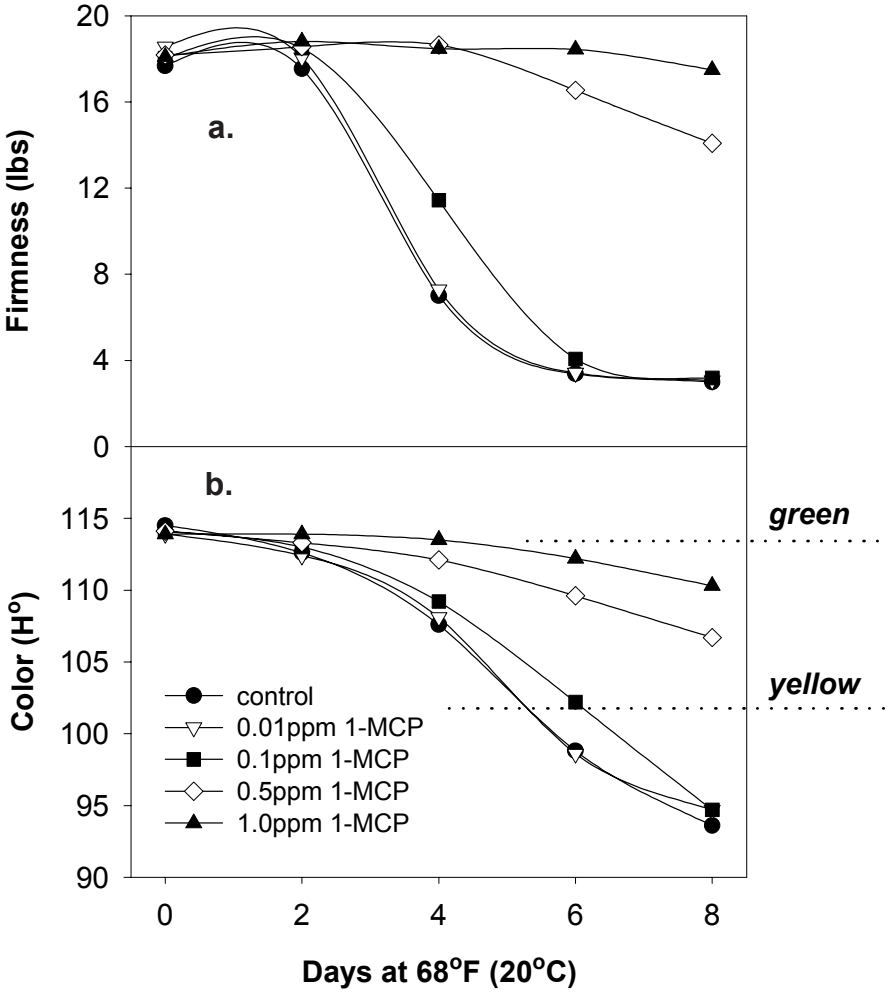
However, 1-MCP does not reduce susceptibility to injuries resulting from exposure to low temperatures or high CO_2. While development of decay is slowed by 1-MCP treatment, fruit that are wounded and then inoculated with pathogen spores are not protected by a pre-inoculation treatment with 1-MCP. This indicates that decay resulting from injuries during harvest and packing may still require the use of other decay control measures.

Perhaps most importantly, unlike products such as apples and broccoli, European pears only reach full dessert quality when they ripen. This means that 1-MCP must be applied in such a way that the effects will, eventually, wear off. Unfortunately, the duration of 1-MCP-induced pear responses is difficult to precisely predict, and the effects of 1-MCP are not readily reversible by exposing treated fruit to ethylene. Factors that influence the duration of the effects of 1-MCP are now being studied. These include;

- treatment concentration,
- treatment time and temperature,
- fruit maturity, and
- the amount of time fruit is stored following 1-MCP treatment.

One of the desirable characteristics of 1-MCP is its activity at very low concentrations. Pear ripening can be retarded by very low concentrations of 1-MCP, while application of 1 ppm 1-MCP maximizes the effects. To test this, we treated pears with 0.01, 0.1, 0.5 or 1.0 ppm 1-MCP, then exposed the fruit to 100 ppm ethylene for 2 days at 20°C (68°F). Subsequent changes in firmness and color were measured at 2 day intervals. As shown in Figure 1a and b, the effects of 1-MCP on color and firmness are strongly concentration dependent within this range. Application of 0.1 ppm 1-MCP delayed ripening by approximately one day, while fruit exposed to 0.5 ppm softened nearly 3 times more slowly than the control and did not fully ripen for up to two weeks at 20°C (68°F). Exposure to 1 ppm 1-MCP resulted in fruit that still remained hard and green after over two weeks.

Figure 1 - Changes in firmness (a) and color (b) of pears ripened at 20°C (68°F) following treatment with various concentrations of 1-MCP and subsequent exposure to 100 ppm of ethylene.



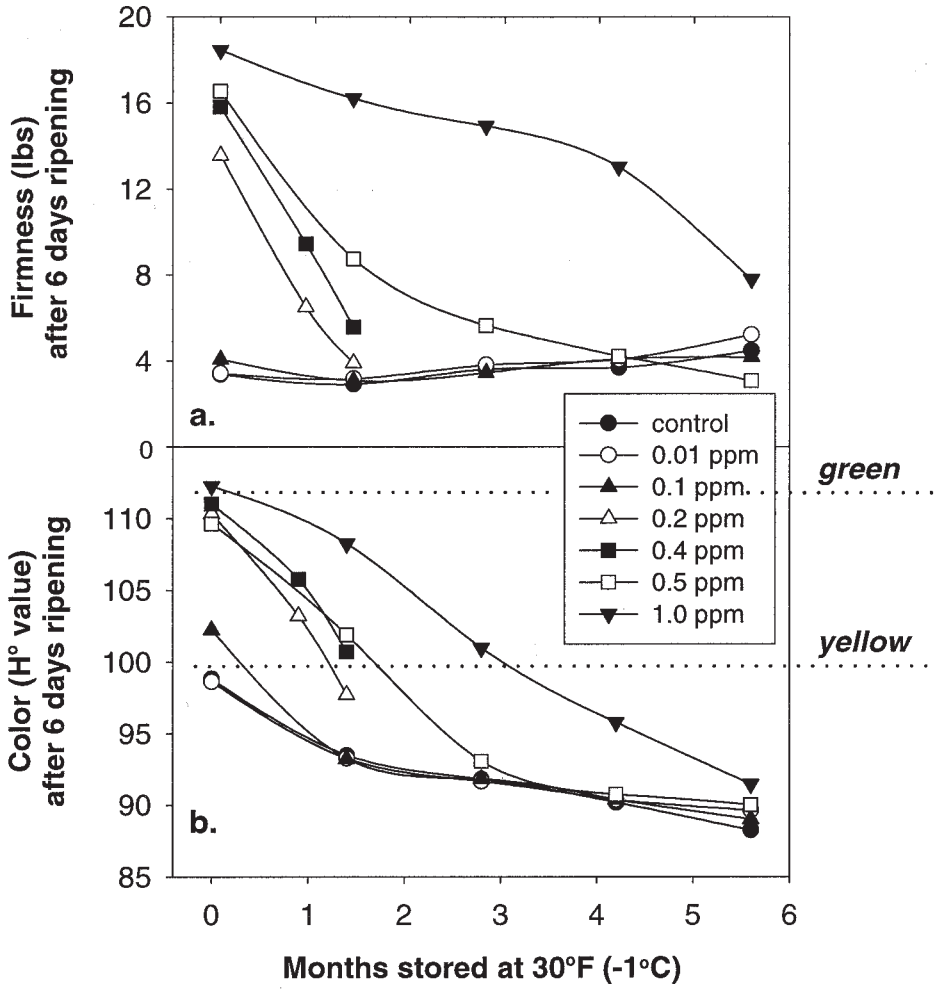
Such responses to 1-MCP can be induced by exposures of as little as an hour under laboratory conditions. However, in large storage rooms, longer treatment times of up to 24 hours should be used to ensure adequate distribution of 1-MCP throughout the room and sufficient contact time with the fruit. Fruit temperature during treatment does not seem to be critical; however, short treatment times are likely to be unsuitable at low temperatures.

Maturity is another factor that can reduce the response to 1-MCP. For example, control of storage scald of 'Bartlett' and 'd'Anjou' pears is significantly reduced if 1-MCP treatment is delayed for 2 or more weeks after harvest. This effect is particularly important for 'Bartlett' where rapid ripening can occur. Partially ripe fruit are likely to be unresponsive even to high concentrations of 1-MCP. Storing treated fruit under a controlled atmosphere before and/or after 1-MCP treatment can reduce the effect of delays in application after harvest, as well as enhance the response to 1-MCP.

Whatever concentration of 1-MCP is used, the fruit must be stored for a sufficiently long period to allow it to recover its ability to ripen. To examine the rate at which fruit regains sensitivity to ethylene, pears were treated with various concentrations of 1-MCP and stored for up to 6 months at –1°C (30°F) before ripening in air at 20°C (68°F). As shown in Figure 2, increasing the concentration of 1-MCP significantly increased the time taken before the fruit would ripen. For example, the effects of 0.2 ppm 1-MCP were lost after 6 weeks in cold storage and 0.4 ppm retarded ripening for around 8-10 weeks. While color development was reduced for up to 12 weeks in fruit treated with 0.5 ppm, the effects on softening were more persistent, lasting for 18 weeks.

Yellowing was also reduced in fruit treated with 1 ppm 1-MCP and stored for 12 weeks at –1°C (30°F). Fruit kept for longer than this were essentially yellow when they were removed from storage. However, the treated fruit failed to become soft even after 24 weeks of storage and 10 days of ripening in ambient conditions. In other words, the fruit appeared ripe, but remained firm and inedible. This loss of coordination between yellowing and softening also occurs with untreated fruit stored for an extended period, but was increased by exposure to 1-MCP.

Figure 2 - Effect of different concentrations of 1-MCP on firmness (a) and color (b) after various storage times at –1°C (30°F) followed by 6 days ripening at 20°C (68°F)



A potential disadvantage of 1-MCP treatment is that, by eliminating sensitivity to ethylene, the production of volatile compounds is also reduced. These compounds contribute significantly to pear flavor and aroma. This is similar to the effects of long term CA storage, which also reduces the capacity of the fruit to produce volatiles. However, our work with 'Bartlett' and 'd'Anjou' indicates that when the effects of 1-MCP begin to fade volatile production resumes, occurring at higher rates than in fruit stored in CA. Because 1-MCP has not yet been approved for use on food, the effect of treatment on pear flavor has not been fully examined. Consumer acceptability needs to be considered when designing any commercial protocol.

One of the most significant potential benefits of 1-MCP treatment of pears is the reduction of physiological disorders. For example, application of 1 ppm 1-MCP prevented the development of storage scald for 6 months, by which time around 80% of untreated fruit were moderately to severely scalded. Even after fruit has ripened, presumably indicating that the effects of 1-MCP have dissipated, it remains markedly less sensitive to skin browning and bruising. This effect could be useful during the marketing of ripening pears, when handling by consumers has the potential to cause significant losses.

Research to date indicates that the use of 1-MCP can be an effective management tool for storage of European pears. Based on these results, several potential benefits of 1-MCP use are likely. The low concentration at which 1-MCP is effective assures low fruit residues. The reduction in firmness and titratable acidity loss following 1-MCP treatment is comparable to that resulting from short to mid term CA storage. Control of superficial scald and other physiological disorders following 1-MCP treatment may allow reduced use or elimination of other scald control technologies.

More work is needed to establish treatment conditions that maximize the benefits of 1-MCP treatments while retaining management flexibility for marketing. For example, one possibility is that pears could be treated with very low concentrations of 1-MCP, and these applications repeated if longer storage is necessary. Preliminary trials using this method have given some encouraging results. Pears treated with 1-MCP have an increased risk of moisture loss

compared to CA stored fruit. However, proper humidity management can manage this risk.

In conclusion, application of 1-MCP to European pears is likely to require some precision if fruit are to remain able to ripen normally in a reasonable time following storage. Dosages may need to be changed according to the expected storage time. However, if treatment regimes can be developed, the positive effects of 1-MCP in extending storage life and reducing physiological disorders may justify this additional effort.