FINAL REPORT
WTFRC Project # PH-01-117 **Organizational Project # 58-1275-1-001**

Project Title: Optimizing 1-MCP effects on fresh market apples

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Objectives:
1) Evaluate potential of treatment of preclimacteric 'Golden Delicious' apples with gaseous mixtures of 1-MCP and ethylene to delay but not prevent ethylene-mediated ripening processes. In year 1, the effective range of ethylene/1-MCP ratios will be determined, and in year 2, the optimal ratio of the two gases will be identified.

2) Determine whether or not 1-MCP/ethylene treatments are more effective than 1-MCP treatment at maintaining fruit resistance to decay caused by postharvest pathogens. In year 1, fruit resistance to *P. expansum* was evaluated, and in year 2, resistance to *B. cinerea* (and *P. expansum* time permitting) will be evaluated.

The presence or intentional inclusion of ethylene during MCP treatment can reduce the risk of overdosing (fruit never ripen) or underdosing (fruit ripen faster than desired) preclimacteric apples with 1-MCP and potentially increase fruit resistance to fungal decay through MCP-delayed ripening and ethylene-induced expression of plant defense-related processes. During 2001-2002, the effect concentration range of ethylene during MCP treatment was optimized to delay but not prevent fruit ripening and to maintain MCP-induced disease resistance during prolonged storage. MCP treatment was combined with other strategies (heat, biocontrol) to control decay during storage and potentially to reduce the dependence of the apple industry upon postharvest use of synthetic fungicides.

Significant findings:
1. Low (3-33 ppm) ethylene during MCP (0.5-1.0 ppm) treatment does not significantly reduce treatment responses.
2. Moderate (65-190 ppm) ethylene during MCP treatment effectively delayed but did not prevent fruit ripening and protected against MCP.
3. High (300-1000 ppm) ethylene during MCP treatment strongly inhibited or negated treatment responses including MCP-induced decay control during prolonged storage.
4. MCP treatment has no effect on decay severity and increased lesion incidence caused by *P. expansum* when inoculation occurred within days after MCP treatment.

Methods:
'Golden Delicious' fruit were obtained from commercial orchards in PA. The standard protocol for prestorage MCP treatment was 0.5 or 1.0 ppm MCP for 17 hours at 68 °F without and with added ethylene. Packing volume was about 50 % of the treatment chamber volume. Apples were held for 0, 2.5 and 5 months at 32 °F and 7 to 9 days at 68 °F prior to analyses. The timing of wound inoculations with pathogens relative to MCP treatment is important with regards to decay control and generally occurred after 32 °F and before 68 °F storage.

Results and Discussion:

Presence of elevated ethylene during MCP treatment (Saftner)

The ethylene concentration during MCP treatment increased by about 1 ppm for every 4 hours of treatment. In addition to the apple-evolved ethylene, ethylene added at concentrations between 3 and 33 ppm during MCP treatment had essentially no effect on MCP-induced inhibition of respiration (>50 %), ethylene production rate (>95 %), flavor-associated volatile abundance (>80 %), or on MCP-induced maintenance of firmness, titratable acidity, and green peel color during storage. Ethylene concentrations between 65 and 190 ppm during MCP treatment moderated the MCP response to allow for gradual ripening during storage without excessive loss of fruit quality characteristics. However, >300 ppm ethylene during MCP treatment strongly inhibited or even negated MCP responses except for MCP-induced inhibition of volatile production which was still inhibited at ethylene concentration of 3000 ppm.

Conclusions: The effect of 0.5-1 ppm MCP can be optimized if treatments are conducted in the presence of 65-190 ppm ethylene and essentially negated if ethylene concentrations exceed 300 ppm

Effect of MCP treatment on incidence and severity of decay (Saftner, Conway, Janisiewicz)

When preclimacteric apples are treated with MCP at harvest or left untreated, cold stored for 2.5 or 5 months followed by wounding and inoculation with high levels (CFU at 10^6/mL) of *P. expansum, B. cinerea,* or *C. acutatum* (causative agent for bitter rot), lesion incidence is unaffected and lesion severity is decreased in MCP-treated compared to non MCP-treated fruit. The MCP-induced protection against decay development following cold storage is similar to that observed in CA-stored fruit. At the concentrations used, MCP has no direct effect on the pathogens, but rather can be explained by MCP's ability to delay ripening and maintain the natural disease resistance present in the fruit at the time of treatment. However, if preclimacteric or climacteric fruit are wounded and inoculated with any one of the above mentioned pathogens within a short time (1 to 3 days) after MCP treatment, lesion incidence for *P. expansum* is increased and lesion severity is similar or slightly increased in MCP-treated compared to non MCP-treated fruit. In these cases, the beneficial effects of MCP on maintenance of fruit quality relative to non MCP-treated fruit had not been established but MCP had strongly inhibited respiration and with that the possibility of MCP-treated fruit not being able to respond as well to pathogenic infections as non MCP-treated fruit.

When low to moderate (10-200 ppm) ethylene is present during MCP treatment at harvest, it has no effect on lesion incidence or severity caused by wounding and inoculation with *P. expansum* or *B. cinerea* following 2.5 or 5 months cold storage in air. However, high (³1000 ppm) ethylene essentially negates any disease resistance induced by MCP treatment, and may increase lesion severity compared to non MCP-treated fruit.

Conclusions: MCP treatment can increase, have no effect or decrease lesion incidence and/or severity depending upon the time interval between MCP treatment and wounding/pathogen inoculation. The presence of high ethylene during MCP treatment negates disease resistance induced by MCP.

Other observations

Peel injury caused by MCP plus heat (4 days at 38 °C) treatment in 1999-harvested 'Golden Delicious' fruit was investigated over a range of MCP concentrations, heat durations, and with or without MCP outgassing from the fruit between MCP and heat treatments. None of the treatments injured fruit from the 2000 or 2001 harvests. MCP increased the growth of heat-resistant biocontrol agent in 'Golden Delicious' apples.

BUDGET:
Optimizing 1-MCP effects on fresh market apples
Robert Saftner
Project duration: **2000-2001**
Project total – 2 years: **$24,152**
Budget request:

Year	Year 1 (2000)	Year 2 (2001)
Total	11,652	12,500

Current year breakdown:

Item	Year 1 (2000)	Year 2 (2001)
Salaries	11,652	12,500[z]
Benefits	0	0
Wages	0	0
Benefits	0	0
Equipment	0	0
Supplies	0	0
Travel	0	0
Miscellaneous	0	0
Total	11,652	12,500