

Canadian Agri-Science Cluster for Horticulture 3



Update to Industry

Semi-Annual – Fall 2021

Activity title: Optimizing Storage and Postharvest Practices to Reduce Apple Loss and Improve Quality

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Names of Collaborators and Institutions: *Ontario Ministry of Agriculture, Food and Rural Affairs, Ontario Apple Growers, Norfolk Fruit Growers' Association, Apple Marketers' Association of Ontario, AgroFresh Inc., Storage Control Systems Inc., Decco US Post-Harvest Inc.

Activity Objectives (as per approved workplan):

- 1) Optimize postharvest practices and storage regimes for rising cultivars (i.e. Honeycrisp, Ambrosia, and Gala strains)
- 2) Evaluate new low oxygen storage and dynamic regimes to reduce apple loss
- 3) Investigate new technology for harvest management and fruit maturity

Research Progress to Date (use plain language):

Apples are currently in storage for 2021-22 season.

Updates from 2020-21 storage season follow.

Objective 1. Optimize postharvest practices and storage regimes for rising cultivars

1.1. 'Honeycrisp' – bitter pit prediction

Three temperature regimes for seven 'Honeycrisp' orchards in Ontario with varying susceptibility to bitter pit were evaluated for the 2020-21 storage season. In collaboration with Dr. Chris Watkins from Cornell University, along with research colleagues in Maine, Maryland, Michigan, Pennsylvania, and Washington state, the *Passive Method* to predict bitter pit in 'Honeycrisp' apples was evaluated for a second season. Data are currently being analyzed and summarized for a scientific paper. There was varying predictability across regions.

1.2. 'Honeycrisp' – postharvest treatments

Temperature conditioning with delayed controlled atmosphere (CA) storage in combination with postharvest 1-methylcyclopropene (1-MCP (1 ppm), SmartFresh™) and/or diphenylamine (DPA) treatments were evaluated in 'Honeycrisp' apples. Data are currently being analyzed, designed as four separate experiments.

1.3. 'Ambrosia' – delayed CA

'Ambrosia' apples were held at 0.5°C while establishment of CA storage (1.7% O₂ + 1.2% CO₂) was delayed for 0, 1, 2 or 4 weeks. After 7 months of storage, internal browning was significantly less in those with the 4-week delay – 5.6% incidence compared to 10-14% in fruit from CA with less delay, respectively. There was also slightly lower firmness (less 0.3-0.4 lb) with the 4-week delay, compared to those with less delay.

1.4. 'Ambrosia' – conditioning at 10°C

'Ambrosia' apples were held at either 10°C or 0.5°C for 1 week after harvest. 1-MCP was applied 1 day after harvest at the respective temperatures and CA (1.7% O₂ + 1.2% CO₂) was established the following day. All apples were at 0.5°C after 1 week. After 7 months of storage, internal browning was significantly less in apples held at 10°C initially – 1.5% incidence compared to 12.6% in those cooled immediately to 0.5°C. There were no significant differences in fruit firmness.

1.5. 'Ambrosia' – O₂ concentration

'Ambrosia' apples with slightly advanced maturity were cooled to 3°C and then treated with 1-MCP the next day. CA storage was established the following day, using either 1.7 or 1.2% O₂ with 1% CO₂ at 0.5°C. After 6 months of storage, there was significantly less internal browning in apples from 1.2% O₂ – 32% incidence compared to 47% in those from 1% CO₂.

1.6. 'Ambrosia' – 1-MCP treatment timing

'Ambrosia' apples with slightly advanced maturity were cooled to 3°C and then treated with 1-MCP the next day and/or 4 days after harvest. One month later the temperature was decreased to 0.5°C. After 4 months of air storage, apples treated with 1-MCP were 3-4 lb firmer regardless of treatment timing. There were no significant differences in storage disorders among treatments with or without 1-MCP. Incidence of internal browning ranged from 20 to 30%.

1.7. 'Gala' – conditioning at 10°C

'Gala' apples with slightly advanced maturity were held at either 10°C or 0.5°C for 1 week after harvest. 1-MCP was applied 1 day after harvest at the respective temperatures and CA (1.5% O₂ + 1% CO₂) was established the following day. All apples were at 0.5°C after 1 week. After 7 months of storage, internal browning was significantly less in apples held at 10°C initially – 10% incidence compared to 22% in those cooled immediately to 0.5°C. There were no significant differences in fruit firmness.

1.8. 'Cortland' – 1-MCP treatment after storage

'Cortland' apples from Quebec arrived in Simcoe (ON) via refrigerated truck ~ 6-8 weeks after harvest. They were most likely treated with 1-MCP at harvest time. Upon arrival at the storage research lab, apples were divided, and half treated with or without 1-MCP. After 7 months of CA storage (2.5% O₂ + 2% CO₂) at 3°C, half of the apples from each group were then treated again with or without 1-MCP. 'Cortland' that were treated with 1-MCP after 7 months were firmer during subsequent holding at room temperature for 2 weeks, regardless of earlier 1-MCP treatments. There were no significant effects on storage disorders, but as the number of 1-MCP treatments increased there was less greasiness.

Objective 2. Evaluate new low oxygen storage and dynamic regimes to reduce apple loss

2.1. 'Ambrosia' – LabPod™ technology, <1% O₂

1-MCP orchard spray (Harvista™) was applied to 'Ambrosia' apples 6 days prior to harvest. Postharvest 1-MCP treatments before or after storage were evaluated in combination with low oxygen regimes (1.2 vs <1% O₂) at 0.5°C. The low O₂ regime of <1% was based on fruit respiration measurements using dynamic LabPod™ technology. After 8 months of storage, apples held in <1% O₂ were firmer (+0.6 lb) and had less internal browning than those held in 1.2% O₂ (16 versus 58%, respectively).

2.2. 'Ambrosia' – CO₂ concentration with low O₂

'Ambrosia' apples were cooled to 0.5°C and then treated with 1-MCP on the same day as harvest. CA storage was established the following day, using 1.2% O₂ with either 1 or 2% CO₂. After 6 months of storage, there was significantly more internal browning in apples from 2% CO₂ – 8% incidence compared to 1% in those from 1% CO₂.

2.3. 'Honeycrisp' – LabPod™ technology, <1% O₂

'Honeycrisp' apples were held at ~15-19°C for 4 days and then cooled to 3°C. CA storage was established after ~ 1 month from harvest time. 1-MCP treatments before or after storage were evaluated in combination with CA and low O₂ regimes (3 vs <1% O₂) at 3°C. The low O₂ regime of <1% was based on fruit respiration measurements using dynamic

LabPod™ technology. After 7 months of storage, apples held in <1% O₂ had much less greasiness and fewer internal disorders than those held in 1.2% O₂. These data are currently being analyzed in more detail and no final conclusions have been made.

2.4. 'Gala' – low O₂

'Gala' apples with slightly advanced maturity were cooled to 0.5°C overnight and treated with or without 1-MCP before or after CA storage. Low oxygen levels of 1.5, 1.0, and 0.5% O₂ were evaluated with 0.5% CO₂. After 8 months of storage and 2 weeks at room temperature, apples held in lower O₂ had less internal browning – 85, 73, and 55% incidence in those from 1.5, 1.0, and 0.5% O₂, respectively. There were no significant differences in browning due to 1-MCP, but firmness retention was better with 1-MCP treatment upon opening of CA storage.

Objective 3. Investigate new technology for harvest management and fruit maturity

3.1. Preharvest 1-MCP, Harvista™

Orchard spray trials using different rates of 1-MCP and various application timings were investigated for 'McIntosh', 'Honeycrisp', 'Gala', and 'Ambrosia' apples during several past seasons. There were comparisons of full and half rates of 1-MCP, or split application timings using two low rates, and some late applications after harvest began. These data are currently being analyzed and years compared.

3.2. I_{AD} readings from DA meter

Delta Absorbance measurements (I_{AD} from DA meter) for 'Honeycrisp', 'Gala', and 'Ambrosia' apples in association with other fruit maturity indices have been collected during several past harvest seasons. These data are currently being compiled and analyzed for a scientific paper. There is notable lack of consistency in the I_{AD} readings across years.

Extension Activities (presentations to growers, articles, poster presentations, etc.):

Presentations - invited

2021. 1-MCP and storage of 'Honeycrisp' apples. University of Massachusetts, Winter Tree Fruit Webinar series, hosted by University of Maine Extension Program, via Zoom.

2021. Effects of Harvista and ReTain on apple ripening and storability. Journées annuelles sur la recherche et l'innovation technologique du Réseau-pommier (Québec), via GoToWebinar.

2021. Pre- and postharvest plant growth regulators on apple ripening, quality, and storability. American Society for Horticultural Science, Postharvest Professional Interest Group Webinar.

2021. Harvest timing and storage of 'Ambrosia' apple. Ontario Apple Growers Webinar.

Articles

DeEll, J. 2020. Lenticel breakdown in apples: from the orchard to storage. Orchard Network 24(4):22-23.

DeEll, J. 2020. Risk of storage disorders in apples for 2020-21 storage season. Orchard Network 24(4):23-24.

DeEll, J. 2021. High quality 'Ambrosia' apples depends on harvest maturity. Orchard Network 25(1):22.

DeEll, J. 2021. Low oxygen storage reduces internal browning in 'Ambrosia' apples. Orchard Network 25(1):23.

DeEll, J. 2021. Factors influencing internal browning in 'Gala' apples during storage. Orchard Network 25(3):28-29.

DeEll, J. 2021. Recommandations d'entreposage 2021. Communiqué, Les producteurs de pommes du Québec, Édition du 22 septembre 2021.

DeEll, J. 2021. Harvest timing and storage of 'Ambrosia' apples. The Grower 71(10):14.

COVID-19 Related Challenges:

More local apples were used in experiments due to limited travel.

Key Message(s):

- Ultra-low O₂ (<1%) storage is very effective at reducing internal browning.
- Efficacy of pre-harvest 1-MCP sprays is very dependent on rate and application timing.
- DA meter (I_{AD} measurements) should not be used alone to judge fruit maturity (especially for 'Honeycrisp'), and I_{AD} standards are not consistent among orchards and harvest times.

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