Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Semi-Annual – Spring 2022

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 being evaluated or still 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 with varying susceptibility to bitter pit were evaluated for the 2020 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 from the past 2 years are being analyzed, but these predictions were not consistent among regions or orchards.

1.2. 'Honeycrisp' – postharvest treatments

Delayed controlled atmosphere (CA) storage in combination with postharvest 1-methylcyclopropene (1-MCP, SmartFresh™) or diphenylamine (DPA, Decco No Scald) treatment were evaluated in 'Honeycrisp' apples for a second season. After 6 months of storage at 3°C, there were more disorders than in the previous year. Data from the past 2 years are being analyzed.

1.3. 'Gala' – conditioning at 10°C

'Gala' apples treated with 1-MCP at harvest time were held in CA storage (1.5% O_2 + 1% CO_2) at 0.5°C for 8 months. Half of the apples were held at 10°C for the first week of CA storage, while the other half went immediately into 0.5°C. Initial temperature conditioning at 10°C significantly reduced internal and stem-end browning to 9.9% incidence, compared to 21.6% with no temperature conditioning (immediate 0.5°C). There were no effects on fruit firmness and other quality attributes.

1.4. 'Ambrosia' – conditioning at 10°C

'Ambrosia' apples treated with 1-MCP at harvest time were held in CA storage (1.7% O_2 + 1.2% CO_2) at 0.5°C for 5 and 8 months. Half of the apples were held at 10°C for the first week of CA storage, while the other half went immediately into 0.5°C. Initial temperature conditioning at 10°C significantly reduced internal and stem-end browning to 1.5% incidence, compared to 12.6% with no temperature conditioning (immediate 0.5°C). There were no effects on fruit firmness and other quality attributes.

1.5. 'Ambrosia' – delayed cooling to 0.5°C

'Ambrosia' apples treated with 1-MCP at harvest time were held in CA storage (1.7% O_2 + 1.2% CO_2) at 0.5°C for 8 months. Apples were initially held at 3°C for 0, 1, 2, or 4 weeks prior to 0.5°C. Delayed cooling at 3°C for 4 weeks significantly reduced internal and stem-end browning to 5.6% incidence, compared to 10-14% with no delayed cooling (immediate 0.5°C). All delayed cooling regimes reduced fruit firmness by 0.2-0.4 lb, while 4 weeks at 3°C also slightly increased greasiness severity and reduced titratable acidity.

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

2.1. 'Honeycrisp' – SafePod™ technology, ~1% O_2

Postharvest 1-MCP treatment before or after storage was evaluated for 'Honeycrisp' apples in combination with low oxygen (3 vs ~1% O_2) at 3°C, plus holding for 14 days at room temperature. Low oxygen at ~1% was based on fruit respiration measurements using dynamic SafePod™ technology. After 8 months of storage, apples held in ~1% O_2 had no internal storage disorders versus 9% incidence in those held in 3% O_2. Furthermore, apples held in ~1% O_2 had less greasiness (8 vs 65% incidence, respectively). 1-MCP treatment at harvest time resulted in more internal storage disorders and ~0.5 lb. greater firmness, compared to apples not treated with 1-MCP or treated upon removal from storage.

2.2. 'Ambrosia' – SafePod™ technology, <1% O_2

Postharvest 1-MCP treatments before or after storage were evaluated for 'Ambrosia' apples in combination with low oxygen storage (1.2 vs <1% O_2) at 0.5°C, plus holding for 14 days at room temperature. This was the second year of study and a lower oxygen comparison was used, 1.2% instead of 1.7% as in the past year. Low oxygen at <1% was based on fruit respiration measurements using dynamic SafePod™ technology. After 8 months of storage, apples held in <1% O_2 (low of 0.6%) had significantly less internal browning than those held in 1.2% O_2 (16 vs 58%, respectively). Furthermore, 1-MCP treatment at harvest time resulted in significantly higher incidence of browning (60%), compared to fruit not treated or those with 1-MCP after storage (37 and 44%, respectively). Apples held in <1% O_2 had ~ 0.6 lb. greater firmness than those held in 1.2% O_2.

2.3. 'Ambrosia' – low O_2 concentration

Following along with 2.2 above, oxygen concentrations of 1.7 vs 1.2% were compared for 'Ambrosia' apples stored at 0.5°C with 1% CO_2 for 6 months. Apples held in 1.2% O_2 had greater firmness (+ ~1 lb.) and less internal browning than those held in 1.7% O_2 (31 vs 47%, respectively). There was also slightly less greasiness in 1.2% O_2, compared to 1.7%.

2.4. 'Ambrosia' – CO_2 concentration with low O_2

Similar to 2.3 above, concentrations of 1 vs 2% CO_2 were compared for 'Ambrosia' apples stored at 0.5°C with 1.2% oxygen for 6 months. Apples held in 1% CO_2 had significantly less internal browning than those held in 2% CO_2 (1.5 vs 8%, respectively). There were no effects on fruit firmness or other quality attributes.

2.5. 'Gala' – low O_2

'Gala' apples with or without preharvest 1-MCP application (Harvista™) were treated with or without postharvest 1-MCP (SmartFresh™) before or after CA storage with low oxygen (1.5 vs 0.6% O_2) at 0.5°C. Data from the past two storage seasons were analyzed and a scientific paper composed – *Timing of ethylene inhibition affects internal browning and quality of 'Gala' apples in long-term low oxygen storage*. This has been accepted for publication in the journal Frontiers in Plant Science.

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

3.1. I_{AD} readings from DA meter

Collaboration with research colleagues at the University of Minnesota and University of Maine, to investigate the use of Delta Absorbance measurements (I_{AD} from) for evaluating 'Honeycrisp' maturity and associated storage disorders, continued into 2021 with further analyses of data from past seasons. This led to an additional scientific paper titled *'Honeycrisp' apple maturity, quality and storage disorders according to interior and exterior tree canopy position*, which has been submitted to the Journal of the American Pomological Society for publication. Soft scald and soggy breakdown incidence did not vary between the tree canopy positions, but bitter pit was greater in the interior canopy compared to the exterior fruit in Ontario.

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

DeEll, J. 2021. Risk of storage disorders in apples for 2021-22 season. Orchard Network 25(4):17-18.

DeEll, J. 2022. Timing of postharvest 1-MCP treatment affects greasiness in 'Ambrosia' apples. Orchard Network 26(1):26-27.

COVID-19 Related Challenges:

More local apples were used in experiments due to restricted travel because of COVID-19.

Key Message(s):

- Lower O_2 concentrations result in less internal browning during storage, but minimum safe gas levels vary with cultivar and growing season.
- DA meter (I_{AD} measurements) should not be used alone to judge fruit maturity and I_{AD} standards are not consistent among regions, orchards and harvest times.

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