

Ministry of Agriculture, Food and Rural Affairs

Harvest and Storage of 'Honeycrisp' Apples

Dr. Jennifer DeEll

Fresh Market Quality Specialist – Hort Crops
OMAFRA, Simcoe, ON

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'Honeycrisp'



- When to harvest?
- Best handling and storage temperatures?
- CA regimes?
- Ethylene inhibition?

Good fruit quality and disorder control starts before storage!

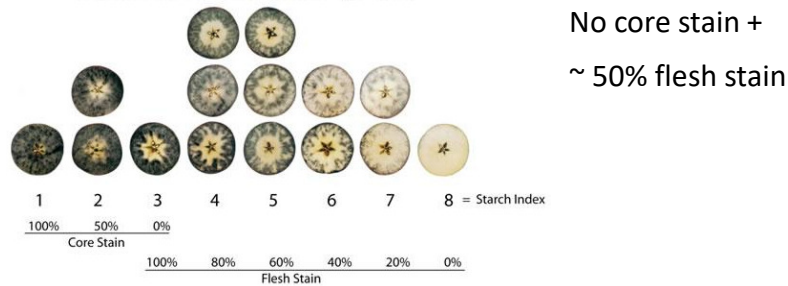


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Fruit Maturity

- **Harvest** should occur when ground color begins to change from green to yellow and starch index nears 6 (Cornell chart) for good storability



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Continued...

- Desired maturity will depend on use/ market
- Differences in maturity do not always exist among apples with varying levels of red color
- Fruit harvested too early do not develop varietal flavor
- Undesirable flavors will develop if harvested too late, plus become more prone to storage disorders
- **Substantial variation** among orchards and trees
... often becomes strongest factor in experiments



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DA Meter ??



[TR Turoni](#)

Measures chlorophyll content

Dr. Renae Moran – University of Maine
Dr. Cindy Tong – University of Minnesota
Dr. Jennifer DeEll – OMAFRA

HortScience 2020

Investigated:

- Relationship between DA readings (I_{ad}) and common apple maturity indices - ethylene, starch, color, soluble solids, acidity
- Consistency among orchards and locations

Found:

- Strongest relationship was with starch, but not great
- Regional similarities in patterns of I_{AD} , but not consistent year-to-year
- An I_{AD} standard should not be used to assess fruit maturity in different regions



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'Honeycrisp'

... is very chilling sensitive

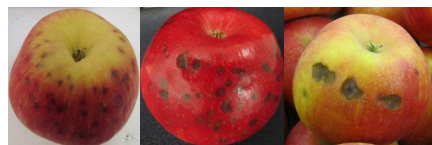
Conditioning at 10°C for ~1 week prior to cold storage at 3°C reduces soft scald, soggy breakdown, chilling-related disorders



These can be found pre-harvest!

- watch orchard temperatures

Conditioning promotes bitter pit, lenticel breakdown, peel blotch

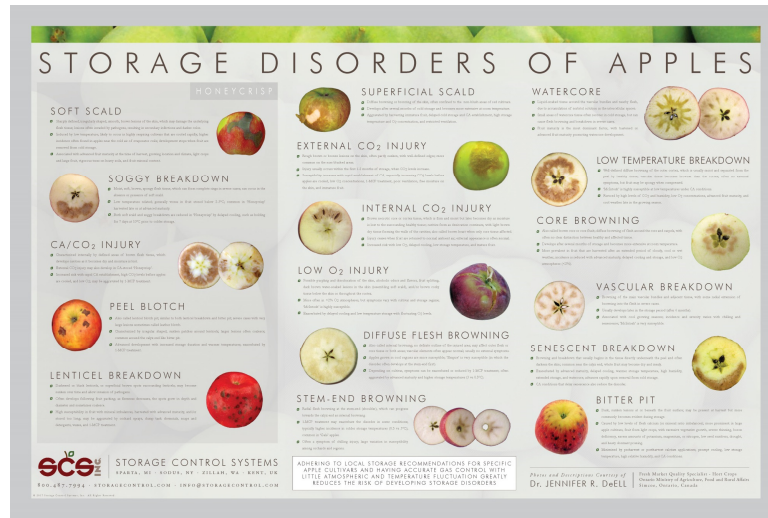


and reduces acidity (physical, sensory) especially >10°C



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[Communiqué \(producteursdepommesduquebec.ca\)](http://producteursdepommesduquebec.ca)

22 septembre 2021 AFFICHE DES TROUBLES DE CONSERVATION DES POMMES



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'Honeycrisp'

...is very sensitive to CO₂

- Internal cavities symptom of CO₂ injury
- Soggy breakdown resemblance
- Can be found in Air storage too



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'Honeycrisp'

Controlled atmosphere (CA) storage

- Common 3% O₂ + 1.5% CO₂ at 3°C
- CA reduces peel greasiness, maintains acidity, less off-flavors, and can reduce high incidence of soft scald
- Ethylene inhibition (i.e. 1-MCP (pre- or postharvest), AVG/ ReTain) increases susceptibility to CO₂ injury
- CO₂ injury reduced by DPA or delaying CA



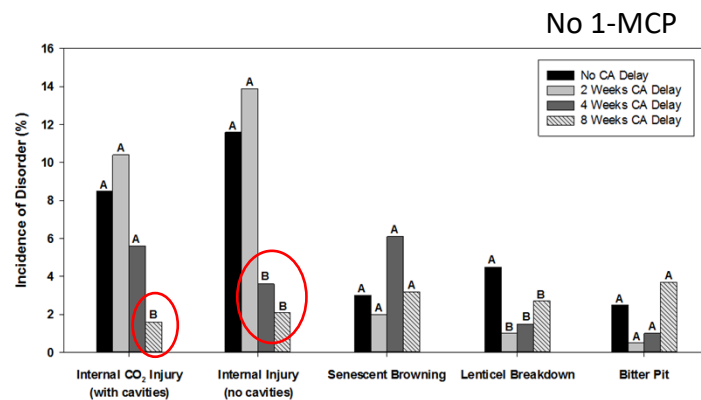
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Delayed CA

DeEll et al. 2016
Can. J. Plant Sci.

to reduce susceptibility to internal CO₂ injury in 'Honeycrisp'



Conditioning (4 days at 12-18°C), CA storage (3% O₂ + 1.5% CO₂) at 3°C, for 7 months total



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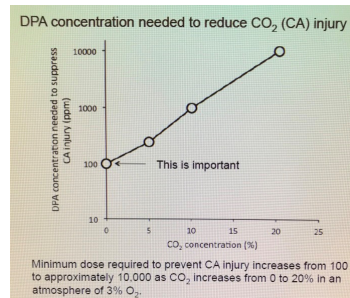
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DPA?

to reduce internal CO₂ / CA injury

Yes.

- More injury with higher CO₂ concentrations
- CO₂ / CA injury decreases as DPA concentration increases



Beaudry et al, 2014-16



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Short-term CA (during Conditioning) to reduce bitter pit in 'Honeycrisp'

Ontario data,
2017-18

	Bitter pit (%)	Greasiness (1-3)
Air	21 ^a	1.5 ^a
1 wk CA	7 ^b	1.3 ^a
2 wk CA	8 ^b	1.0 ^b

7 days at 10°C, then
4 months at 3°C

CA = 2.5% O₂ + 0.5% CO₂
(only for 1 or 2 wk)

Soft scald <1% NS
Soggy breakdown <2% NS

Serban, Kalcsits,
DeEll, and Mattheis
2019 HortScience

Postharvest 1-MCP = more peel blotch, 9 vs 6%
more core browning, 13% vs 0



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Low O₂ Storage

3% vs. <1% O₂ (LabPod) at 3°C

(3% flush, gradual O₂ decrease –
1.5% after 2 mo, and then to 0.9-1%)

Conditioned 5 days at 10°C, No CA delay

6 months storage, 14 days at RT



LabPod/ SafePod measures
real-time fruit respiration

	Firmness (lb)	Greasiness (1-3)	Internal CO ₂ injury (%)	Core browning (%)	Clean fruit (%)
CA (3% O ₂)					
No SmFr	15.2 ^{ab}	1.8 ^a	10 ^b	12 ^b	64 ^b
+ SmFr @harvest	14.4 ^b	1.7 ^a	24 ^a	33 ^a	58 ^b
LabPod (0.9% O ₂)					
No SmFr	14.6 ^b	1.2 ^b	8 ^b	5 ^b	74 ^a
+ SmFr @opening	15.5 ^a	1.2 ^b	5 ^b	2 ^b	70 ^a



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3% O₂ + 1.5% CO₂ at 3°C

Conditioned 4 days at 10°C

+/- CA delay for 1 month, +/- 1-MCP

7 months storage, 14 days at RT

2020-21

	Diffuse Internal Browning (%)	Internal Cavities (%)	Peel Purpling/ Breakdown (%)	Clean (%)
No CA Delay				
No 1-MCP	0 ^B	3 ^B	2 ^B	88 ^A
1-MCP at harvest	5 ^A	11 ^A	11 ^A	75 ^B
1-MCP at opening	1 ^B	3 ^B	2 ^B	92 ^A
CA Delay				
No 1-MCP	0 ^B	1 ^B	1 ^B	93 ^A
1-MCP at harvest	0 ^B	2 ^B	1 ^B	92 ^A
1-MCP at opening	0 ^B	0 ^B	0 ^B	94 ^A

No greasiness until Day 14 = NS



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CA delay for 1 month at 3°C

Conditioned 5 days at 10°C
7 months storage, 14 days at RT

2020-21

	Diffuse Internal Browning (%)	Internal Cavities (%)	Peel Purpling/ Breakdown (%)	Greasiness (%)
CA (3% O₂)				
No 1-MCP	0	1 ^B	1 ^A	98 ^A
1-MCP at harvest	0	3 ^A	1 ^A	98 ^A
1-MCP at opening	0	0 ^B	0 ^A	95 ^A
** LabPod (1% O₂)				
No 1-MCP	0	0 ^B	0 ^A	25 ^B
1-MCP at opening	0	0 ^B	0 ^A	0 ^C

Lower O₂ = higher risk of CO₂ injury = need CA delay



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1-MCP (1-Methylcyclopropene)**Inhibitor of ethylene action****Preharvest**

- Orchard spray
- Applied 3 to 14 days prior to estimated harvest date
- Rate 100 - 300 g/ ha

Postharvest

- Applied after harvest in storage room
- 1 ppm standard rate



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Preharvest ethylene inhibition

- Reduce fruit drop
- Improve apple color and size
- Reduce number of harvests
- Manage harvest labor
- Less variability in fruit maturity at harvest
- More effective postharvest 1-MCP treatments
- Increases susceptibility to CO₂ injury
- Can slow color development



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Preharvest 1-MCP

DeEll et al. 2010
HortScience

- Delays ethylene production
- Improves acidity retention (enhanced flavor profile)
- Often reduces firmness loss in storage
- **Reduces soft scald development *****
 - 9-18 vs. <2% incidence
 - 45-47 vs. 3-11%
- Can reduce high incidence of soggy breakdown
 - 42 vs. 8-9%, P<0.05
 - 11 vs. 4%, NS

Rate very important

Internal browning



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Postharvest 1-MCP

- Reduces greasiness and off-flavors
- Maintains higher acidity and soluble solids
- Inconsistent effects on soft scald
- Bitter pit is sometimes exacerbated, peel blotch
- Increased susceptibility to CO₂ injury
- Increased core browning,
maybe slower watercore dissipation



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'Honeycrisp' Storage ...a compromise

- Fruit maturity at harvest is key
 - ground color begins to change from green to yellow
 - starch index ~5-6 (Cornell chart)
- Pre- and/or postharvest 1-MCP treatment
 - [know marketing plans](#)
- Conditioning for 5-7 days at 10°C
 - [know orchards prone to bitter pit vs. soft scald, etc.](#)



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'Honeycrisp' Storage ...a compromise

- Long-term, maybe 6+ months
 - Delay CA (1-2 months) or DPA
 - CA at 3°C, 3.0% O₂ + 1.5-3% CO₂
 - Low oxygen with fruit monitoring, DCA - SafePod
- Beware of CO₂ accumulation at all times!
- Temperature sequencing needs further investigation



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Ministry of Agriculture, Food and Rural Affairs

Thanks to...

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Apple Marketers' Association of Ontario
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