

Pre- and Postharvest 1-MCP Technology for Apples

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Specific topics...

- Definitions –
SmartFreshSM vs. HarvistaTM
- SmartFresh and disorders,
especially external CO₂ injury
- SmartFresh on ‘Honeycrisp’
- Harvista applications,
‘McIntosh’ and ‘Honeycrisp’

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1-Methylcyclopropene (1-MCP)

- Inhibits ethylene action, delays fruit ripening

SmartFreshSM

- Volatile form
- Postharvest application within an air-tight environment
- Used commercially worldwide


HarvistaTM

- Orchard spray for tree fruit, within 2 weeks of harvest
- Not registered in Canada yet
- Used commercially in WA this season


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SmartFreshSM

- Reduces senescence related disorders
i.e. senescent breakdown



- Increases stress-related disorders
i.e. external CO₂ injury, flesh browning




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External CO₂ Injury

Rough brown or bronze lesions on the skin, often partly sunken, with well-defined edges

More common on non-blush areas

Injury usually occurs early in CA storage



Susceptibility increases with –

- **SmartFresh (1-MCP) treatment**
- rapid establishment of CO₂ levels before apples are cooled
- low O₂ concentrations (with similar O₂ levels)
- poor ventilation
- free moisture on the skin
- immature fruit
- ReTain application

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1999-2000 Québec ‘McIntosh’

Standard CA storage for 2.5 or 5 months


External CO₂ Injury

	Control	1-MCP		
		1	0.5	0.1 ppm
2.5 mo	0	36	55	28%
5 mo	0	25	23	25%

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Preharvest application of **ReTain** further promotes CO₂ injury

Incidence (%) of CO₂ injury in 'Empire' after 4 and 8 months in CA storage (2.5% O₂, 2% CO₂) at 2°C



	- ReTain	+ ReTain
Control	9	30
1-MCP (0.6 ppm)	23	40

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Recommendation...



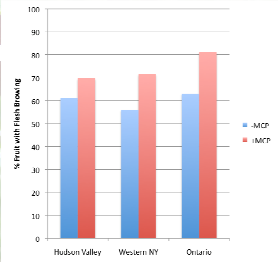
For cultivars susceptible to CO₂ injury e.g. 'McIntosh', 'Empire', 'Cortland'

- Treat with DPA if using SmartFresh (500 ppm ok, Watkins)
- Cool fruit before SmartFresh and CA
- If no DPA, keep CO₂ low (<0.2%) for the first 60 days then gradually increase to standard concentration
- Beware of CO₂ accumulation during room loading (1 hr = 0.8%, overnight = 2.2%)

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Flesh Browning in 'Empire'
Effect of 1-MCP and growing region

Orchard	HV		WNY		ON	
	-MCP	+MCP	-MCP	+MCP	-MCP	+MCP
1	58	73	57	64	67	83
2	66	83	64	79	69	86
3	67	71	76	95	80	88
4	88	85	44	55	37	69
5	57	68	46	52		
6	28	36	49	84		
7	63	71				



CA: 2% O₂, 2% CO₂ - 10 months
WNY: 10/04
HV: 10/03
Ontario: 10/03

Watkins, 2008

- Variation in flesh browning exists between different orchards in the same region
- Overall, little variation between the three regions
- 1-MCP treated fruit consistently have a higher incidence of flesh browning

Flesh Browning

- 'Empire' and 'McIntosh' are very susceptible
- higher incidence in later harvested apples (from the same orchard block)
- higher incidence at lower storage temperatures
- little effect of DPA, CA regimes, or fruit mineral concentrations
- Orchard-to-orchard variation
- Tree-to-tree variation (crop load related?)

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SmartFresh on 'Honeycrisp'

- reduces ethylene and greasiness, but has little effect on firmness (~0.5 lb)
- improves acidity retention and soluble solids
- can increase internal disorders, but effect negated with cooling delay
- little effect on soft scald incidence

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Major Disorders in 'Honeycrisp'

Soft Scald



Higher incidence
- large apples
- light crops
- over mature fruit
- dull, cool, wet summers
- low temperatures

Soggy Breakdown



Soft, brown, spongy tissue
Causes similar to those for soft scald

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CA Storage at 3°C, plus 7 days at 21°C

(~ 2% O₂ + 2% CO₂)

	IEC (ppm)	Firm (lb)	SSC (%)	Acidity (mg malic)	Greasiness (1-3)	Soft scald (%)	Internal disorders (%)
Control	100	15.5	12.2	369	3.0	68	2
+ SmFr	4	15.1	13.4	503	1.0	49	38

* No cooling delay

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Harvista™

1-MCP spray formulation for tree fruit (AgroFresh Inc.)



Applied preharvest, within 2 weeks

- Often do not see an effect on quality at optimum harvest
- Less IEC and firmer fruit during late harvests
- Effects not always the same as SmartFresh after storage
- Success depends on many factors, i.e. spray timing, coverage and concentration, cultivar, maturity at harvest, storage conditions and duration, etc.

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Harvista

Drops – 'McIntosh' 2006

	Sept. 5 th	12 th	19 th	26 th
Control	29	111	375	543
Harvista	20	23	45	46
ReTain	21	94	200	391

(Note – harvests 1 & 3, and 2 & 4 from the same trees)

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'McIntosh' 2006



Control

Harvista reduced excessive ripening and decay development in the drops

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Commercial Spray Trial - 2008

'McIntosh' apples

Sprayed on Sept. 2nd
8 trees harvested each time
2¼ - 2½ bins total each time
Maturity delayed with Harvista



Harvest Date	Treatment	% Fancy + (> 30% red)	% C-Grade (<30% red)	Total Fruit #
Sept. 9 th	Control	66.5	33.5	6014
Sept. 17 th	Harvista	78.4	21.6	5793
Sept. 17 th	Control	83.5	16.5	5213
Sept. 29 th	Harvista	97.3	2.7	4441

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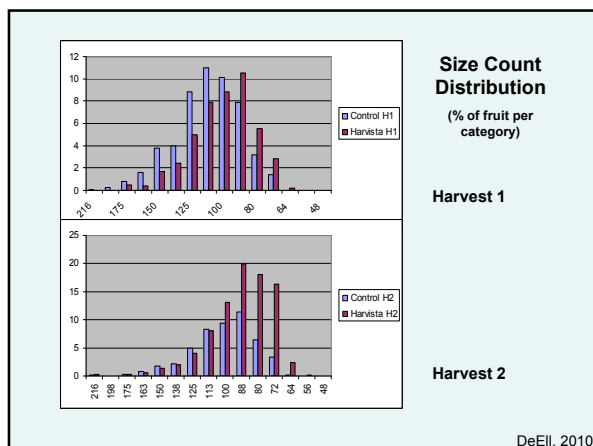
Commercial Spray Trial - 2008



Control - H1 (top), H2 (bottom)
Sept. 9 Sept. 17

Harvista - H1 (top), H2 (bottom)
Sept. 17 Sept. 29

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Commercial Spray Trial - 2009
'McIntosh' (commercial harvest 9 days after spray)
3 months in air storage at 0°C, plus 1 or 7 days at 21°C

	IEC (ppm)	Firm (lb)	TA (mg)
1 Day			
Control	549 ^b	9.7 ^{de}	704 ^e
Spray	382 ^c	10.2 ^d	738 ^d
SmFr	49 ^d	13.2^b	838 ^a
Spray + SmFr	13 ^d	14.2^a	805 ^b
7 Days			
Control	697 ^a	8.9 ^f	604 ^f
Spray	709 ^a	9.3 ^{ef}	738 ^d
SmFr	2 ^d	12.3^c	771 ^c
Spray + SmFr	2 ^d	13.2^b	-

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6 months in CA storage at 3°C, plus 1 or 7 days at 21°C

	IEC (ppm)	Firm (lb)	TA (mg)
1 Day			
Control	43 ^{cd}	<u>12.7^d</u>	671 ^c
Spray	27 ^{cd}	13.9 ^{ab}	-
SmFr	1 ^d	13.7 ^{bc}	637 ^d
Spray + SmFr	1 ^d	14.4 ^a	771 ^a
7 Days			
Control	956 ^a	9.8 ^e	604 ^e
Spray	883 ^a	<u>10.2^e</u>	671 ^c
SmFr	141 ^c	13.2 ^{cd}	637 ^d
Spray + SmFr	365 ^b	13.4 ^c	704 ^b

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9 months in CA storage at 3°C, plus 1 or 7 days at 21°C

	IEC (ppm)	Firm (lb)	TA (mg)
1 Day			
Control	203 ^c	<u>11.5^c</u>	570 ^b
Spray	160 ^c	13.8 ^b	570 ^b
SmFr	7 ^d	<u>13.6^b</u>	570 ^b
Spray + SmFr	17 ^d	14.7 ^a	604 ^a
7 Days			
Control	1119 ^b	9.0 ^e	469 ^d
Spray	1328 ^a	8.9 ^e	536 ^c
SmFr	883 ^c	9.7 ^d	536 ^c
Spray + SmFr	1096 ^b	9.3 ^{de}	570 ^b

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- Harvista on 'Honeycrisp'**
- little effect on firmness (~0.5 lb)
 - less effect on greasiness than SmartFresh
 - improves acidity retention and soluble solids
 - internal disorders not increased like with SmartFresh, and soggy breakdown is often reduced
 - **lower soft scald incidence****
- DeEil, 2010

- Harvista on 'Honeycrisp'**
- HortScience, March 2010**
- Year 1 = No cooling delay, 5 months in air storage at 3°C
Average: 17% vs. <1% soft scald with Harvista
 - Year 2 = No cooling delay, 6 months in air storage at 3°C
Late harvest: 46% vs. 8 or 22% soft scald
Harvista sprayed 11 or 15 days before harvest, respectively
- Past storage season**
- No cooling delay, 6 months in air storage at 0°C
 - Investigated effect of 1-MCP concentration because of new 60 g/ acre commercial Harvista rate
- DeEil, 2010

Harvista on 'Honeycrisp'

2009 Harvest, 6 months of storage in air at 0°C

Incidence of soft scald (%)

No spray	23
4 day 120 g	6
4 day 60 g	13
8 day 120 g	2
8 day 60 g	12

- Spray 4 or 8 days prior to Harvest
- No cooling delay

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Application of Harvista

- Earlier trials used CO₂-based back-pack sprayer
- Later trials used tractor-drawn commercial sprayer
- Past season – investigated aerial application
 - Application using a helicopter
 - 1st trial in the Northeast
 - Commercial 'McIntosh' orchard
 - Compared to tractor-drawn sprayer

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Helicopter compared to tractor?

- Similar fruit maturity
- Similar range of ethylene
- Similar fruit drop control



Apples are currently in storage...

Bottom line = aerial application was less troublesome than originally anticipated

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Acknowledgements

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Thank You!

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