The Continuing Quest for Optimal Harvest Management & Storage of Apples

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1. New harvest technologies – DA meter
2. Dynamic Controlled Atmosphere (DCA) storage
3. Gala stem end browning
1. DA Meter

- Delta Absorbance (DA) meter
  - Hand held non-destructive measurement
  - Developed from vis/NIR spectroscopy
  - In theory can be used in the field
Essentially an electronic color chart that provides an index representing Chlorophyll a concentrations.

But DA meter is not limited by red coloration of fruit.
Current tools to assess “Maturity” (Harvest indices)

Maturity indices
- Internal ethylene concentration (IEC)
- Starch pattern index (SPI)

Quality indices
- Firmness
- Soluble solids concentration
- Acidity
- Red coloration
- (background color/ground color)

Where does the DA meter fit in?
Honeycrisp separation by DA reading
Honeycrisp separation by DA reading
We have generally found good correlations between $I_{AD}$ values and chlorophyll concentrations.

Depending on cultivar, relationships between $I_{AD}$ values and IEC and/or starch indices are good.

But the greatest concern is that preharvest factors such as PGRs interfere with interpretation of DA meter readings.
IAD values and internal ethylene concentrations (ppm) - Delicious

- Relationships between and IAD values good for untreated fruit
  - lower IAD values = riper fruit and higher IEC.
- Harvista and ReTain trts result in loss of relationship within an given IAD value.
Soft scald (%) in Honeycrisp apples at different $I_{AD}$ value categories: Harvest 2
2. Dynamic Controlled Atmosphere (DCA) storage

New technology widely used in Europe

- Scald control is a driver for DCA, and the technology represents a non-chemical means of disorder control if don’t want to use 1-MCP
The principle underpinning DCA

Lowest respiration rate = maximum storage potential

Not static and we use very safe levels
Three methods available

1. - Fluorescence
2. - Ethanol
3. - Respiratory quotient (CO2/O2 ratio)
HarvestWatch – based on Fluorescence
HarvestWatch containers in storage bins
Using HarvestWatch to determine LOL in apple

LOL = ca. 0.8 kPa O₂

Decreasing O₂

LOL = ca. 0.8 kPa O₂
Varieties

- Delicious – WNY (2013, 2014)
- Empire – WNY (2013, 2014)
- Cortland – WNY (2014)
- Rome – WNY (2014)
- Gala (2015)
- Honeycrisp (2015)
- Gala (2015)
McIntosh (2013) - Flesh firmness (lb-f) day 1

4 months

8 months

Note: Champlain
McIntosh (2013) Flesh firmness (lb-f) day 7

4 months

8 months

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<thead>
<tr>
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<th>4 months</th>
<th>8 months</th>
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<tbody>
<tr>
<td>CA</td>
<td></td>
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<tr>
<td>DCA + SF</td>
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Legend:
- 1
- 2
- 3
- 4
## WNY – Delicious firmness (lb-f) after CA and DCA-CF storage

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<th>Treatment</th>
<th>5 months plus 7 d</th>
<th>8 months + 7 d</th>
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<tbody>
<tr>
<td>CA</td>
<td>13.6</td>
<td>10.5</td>
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<td>DCA-CF</td>
<td>14.0</td>
<td>11.4</td>
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<tr>
<td>DCA-CF + SF</td>
<td>16.3</td>
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Delicious Superficial scald (%)

5 months plus 7 d

8 months plus 7 d

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<tr>
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<tr>
<td>air</td>
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<td>CA</td>
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</thead>
<tbody>
<tr>
<td>air</td>
<td></td>
<td>CA</td>
<td></td>
<td>DCA</td>
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</tr>
</tbody>
</table>

Legend:

1, 2, 3, 4

no SF, SF, air, CA, DCA
DCA represents a non-chemical means of disorder control if don't want to use 1-MCP and/or DPA

Condition, especially firmness, is lost during shelf life without 1-MCP treatment
3. Gala Stem end browning

Courtesy of Matheis
Stem end flesh browning

- Appears to becoming more of a problem, perhaps increasing with higher fruit volumes = longer storage periods

- Orchard block factors are large. (Appears analogous to ‘Empire’ browning)

- Problem also in some Washington Orchards
2013 Harvest date, PGRs, and conditioning

- Commercial block of ‘Gala’ (Fulford strain)
- Untreated, Harvista (1 week before H1), ReTain (half rate 3 weeks before H1)
- Fruit harvest
  1. H1 spot pick
  2. H2 spot pick – week 2 harvest all remaining fruit from 1.
  3. H2 strip pick (week 2 harvest, no harvest in week 1)
- On each harvest date, fruit either untreated or treated with 1 ppm SmartFresh, and then stored at 33°F or 7 days at 50°F before storage at 33°F.
- 4 months CA
Stem end browning (%)

- **Untreated**:
  - No Cond/no 1-MCP: [value]
  - No Cond./1-MCP: [value]
  - Cond./no 1-MCP: [value]
  - Cond./1-MCP: [value]

- **Harvista**:
  - No Cond/no 1-MCP: [value]
  - No Cond./1-MCP: [value]
  - Cond./no 1-MCP: [value]
  - Cond./1-MCP: [value]

- **ReTain**:
  - No Cond/no 1-MCP: [value]
  - No Cond./1-MCP: [value]
  - Cond./no 1-MCP: [value]
  - Cond./1-MCP: [value]
Harvest 2 – week 2: second spot pick

Stem end browning (%)

- Untreated
- Harvista
- ReTain

Conditions:
- No Cond/no 1-MCP
- No Cond./1-MCP
- Cond./no 1-MCP
- Cond./1-MCP
Harvest 2 – week 2: strip pick (all fruit)

Stem end browning (%)

- Untreated
- Harvista
- ReTain

- No Cond/no 1-MCP
- No Cond./1-MCP
- Cond./no 1-MCP
- Cond./1-MCP
Harvest x Field treatment***
2014 experiments

- Two harvests – spot picks
- Untreated and Harvista only
- Plus/minus Conditioning
- 6 months CA

Untrt = 71%; Harvista = 30% ***
Non cond. = 64%; Cond. = 37%***
Take home messages

- ReTain and Harvista can reduce stem end browning, but harvest date effects influence extent of reduction.
- Conditioning can reduce browning but also affected by harvest date.
- Harvista overall strongest effect, both on flesh browning and other quality attributes.
- Conditioning did not result in loss of quality.
2015 harvest – effect of DCA storage
Flesh browning (%) 12 weeks
Internal ethylene and starch pattern indices by color class

Preliminary experiment

IEC (ppm)

SPI
Flesh browning (%) in CA stored fruit - 2 temperatures plus/minus conditioning

FB incidence greater in more mature fruit, and effect of conditioning more marked in fruit stored at 33F
Flesh browning incidence is:

1. Decreased by Harvista treatment, and by ReTain at early harvest, indicating a maturity effect on the disorder.

2. Increased in more mature fruit as indicated by DA meter categories.

3. Decreased by conditioning but effects are inconsistent (and may be affected by harvest maturity). Conditioning probably has little commercial usefulness.

4. Greater at 33 °F than at 38 °F. Maybe Gala is not the 32/33F apple that we have assumed it is!
Acknowledgements

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Thank you