‘Gala browning’ and other apple storage issues

Chris Watkins

Hudson Valley Commercial Fruit Growers’ School
Kingston, NY
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Stem end browning in ‘Gala’
Stem end flesh browning

- Appears to be an increasing problem in New York
  - higher fruit volumes = longer storage periods

- Orchard block factors are large
  - Strain effects?

- Problem elsewhere - some Washington Orchards, Brazil
2013

- HARVEST DATE
- SPOT COMPARED WITH STRIP PICK
- CONDITIONING
2013 Harvest date 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 - harvest all remaining fruit from 1.
  3. H2 strip pick (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 (2%/2%) plus 7 days at 68°F
# Harvest 1 – week 1: spot pick

## Stem end browning (%)

<table>
<thead>
<tr>
<th></th>
<th>Untreated</th>
<th>Conditioned</th>
<th>Untreated</th>
<th>Conditioned</th>
<th>Untreated</th>
<th>Conditioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Cond.</td>
<td>62</td>
<td>32</td>
<td>24</td>
<td>9</td>
<td>43</td>
<td>26</td>
</tr>
<tr>
<td>No Cond. + SF</td>
<td>61</td>
<td>35</td>
<td>25</td>
<td>5</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Cond.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cond. + SF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bars represent**
- **No Cond.**
- **No Cond. + SF**
- **Cond.**
- **Cond. + SF**
Harvest 2 – week 2: second spot pick
Stem end browning (%)

<table>
<thead>
<tr>
<th></th>
<th>Untreated</th>
<th>Conditioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>63</td>
<td>56</td>
</tr>
<tr>
<td>Conditioned</td>
<td>47</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Untreated</th>
<th>Conditioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Conditioned</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Untreated</th>
<th>Conditioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>72</td>
<td>50</td>
</tr>
<tr>
<td>Conditioned</td>
<td>75</td>
<td>48</td>
</tr>
</tbody>
</table>

- No Cond.
- No Cond. + SF
- Cond.
- Cond. + SF
Harvest 2 – week 2: strip pick
Stem end browning (%)

<table>
<thead>
<tr>
<th>Untreated</th>
<th>Conditioned</th>
<th>Untreated</th>
<th>Conditioned</th>
<th>Untreated</th>
<th>Conditioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>58</td>
<td>52</td>
<td>51</td>
<td>54</td>
<td>58</td>
</tr>
</tbody>
</table>

- **No Cond.**
- **No Cond. + SF**
- **Cond.**
- **Cond. + SF**

- Untreated
- Conditioned
- Untreated
- Conditioned
- Untreated
- Conditioned
Harvest date/type x Field treatment***

- H1 (spot)
- H2 (strip)
- H2 (spot)
Flesh firmness (lb-f): Harvest 1 – spot pick

- Untreated
- Harvista
- ReTain

Legend:
- No Cond.
- No Cond. + SF
- Cond.
- Cond. + SF
Summary 2013

• No effect of SmartFesh
• Conditioning reduced SEB, but effective mostly at first harvest
• Harvista consistently reduced SEB
• ReTain reduced at week 1, but not at week 2
• Harvista retained flesh firmness greater than fruit untreated or treated with SF, and no effect of conditioning
2014

- Two harvests – spot picks at two harvest dates
- Untreated and Harvista only
- 24 weeks storage in air, CA and DCA
2014 Stem end browning (%)

Harvest 1 (9/9/14)

- Untreated
- Harvista

Legend:
- No Cond.
- No Cond. + SF
- Cond.
- Cond. + SF
2014 Stem end browning (%)

Harvest 2 (9/15/14)

- Untreated
- Harvista

- No Cond.
- No Cond. + SF
- Cond.
- Cond. + SF
Over both harvest dates

- Untrt = 71%
- Harvista = 30% ***
- Non cond. = 64%
- Cond. = 37%***
2014 Core browning (%)

Harvest 1 (9/9/14)
- Untreated
- Harvista

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No Cond.</th>
<th>No Cond. + SF</th>
<th>Cond.</th>
<th>Cond. + SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>42</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Harvista</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Harvest 2 (9/15/14)
- Untreated
- Harvista

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No Cond.</th>
<th>No Cond. + SF</th>
<th>Cond.</th>
<th>Cond. + SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>42</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Harvista</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
DYNAMIC CA (DCA) storage

Measure stress point with a number of methods:
- Fluorescence
- Ethanol
- Respiratory quotient (CO2/O2 ratio)
Using HarvestWatch to determine LOL in apple

LOL = ca. 0.8 kPa $O_2$

Decreasing $O_2$

LOL = ca. 0.8 kPa $O_2$
DCA
– Stem end browning (%) at 12 weeks

<table>
<thead>
<tr>
<th>Trt</th>
<th>Air</th>
<th>CA</th>
<th>DCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>30</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Control + SF</td>
<td>15</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Harvista</td>
<td>25</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Harvista + SF</td>
<td>23</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>
### DCA

**– Stem end browning (%) at 24 weeks**

<table>
<thead>
<tr>
<th>Trt</th>
<th>Air</th>
<th>CA</th>
<th>DCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>75</td>
<td>67</td>
<td>24</td>
</tr>
<tr>
<td>Control + SF</td>
<td>69</td>
<td>67</td>
<td>18</td>
</tr>
<tr>
<td>Harvista</td>
<td>48</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>Harvista + SF</td>
<td>62</td>
<td>44</td>
<td>7</td>
</tr>
</tbody>
</table>
MATURITY
Delta absorbance (DA) meter (Sintéleia, Bologna, Italy)

- Non-destructive measurement
- Developed from vis/NIR spectroscopy
- Difference of Absorbance (DA or $I_{AD}$) between 670 and 720nm

\[ I_{AD} = A_{670} - A_{720} \]
Flesh browning related to DA meter
2014/15

<table>
<thead>
<tr>
<th>DA</th>
<th>IEC (ppm)</th>
<th>Firmness (lb)</th>
<th>SSC (%)</th>
<th>TA (%)</th>
<th>SPI</th>
<th>Wt (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.194</td>
<td>18.1</td>
<td>13.2</td>
<td>0.345</td>
<td>5.4</td>
<td>1.60</td>
</tr>
<tr>
<td>0.01-0.1</td>
<td>1.931</td>
<td>20.0</td>
<td>12.8</td>
<td>0.344</td>
<td>4.0</td>
<td>1.40</td>
</tr>
<tr>
<td>0.1-0.2</td>
<td>0.674</td>
<td>20.5</td>
<td>11.3</td>
<td>0.319</td>
<td>3.1</td>
<td>1.45</td>
</tr>
<tr>
<td>0.2-0.3</td>
<td>0.489</td>
<td>21.0</td>
<td>11.3</td>
<td>0.313</td>
<td>2.3</td>
<td>1.35</td>
</tr>
<tr>
<td>0.3-0.4</td>
<td>0.422</td>
<td>21.0</td>
<td>10.9</td>
<td>0.280</td>
<td>1.9</td>
<td>1.40</td>
</tr>
<tr>
<td>0.4-0.5</td>
<td>0.420</td>
<td>22.5</td>
<td>11.1</td>
<td>0.310</td>
<td>2.6</td>
<td>1.30</td>
</tr>
<tr>
<td>0.5-0.6</td>
<td>0.491</td>
<td>19.6</td>
<td>10.7</td>
<td>0.293</td>
<td>2.5</td>
<td>1.40</td>
</tr>
</tbody>
</table>
Stem end 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
Stem end browning (%) in CA stored fruit - 2 temperatures plus/minus conditioning
Summary

Flesh browning incidence is:

- decreased by Harvista treatment, indicating a maturity effect on the disorder.
- Usually decreased by conditioning but effects are inconsistent.
- No major effects of SmartFresh
- DCA delayed browning development

- Maturity appears to be a critical factor
- Is 32-33F the right temperature for NY-grown Gala?
Current experiments in storage

- Untreated and Harvista
- CA and DCA at 33° and 38°F with different carbon dioxide concentrations
- DA meter and dry matter (F750 meter) relationships with browning
Acknowledgements

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Gilang Sutano
Jinwook Lee
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Thank you!
Questions?