Interpreting Apple Maturity Reports to Optimize Harvest Decisions

Randy Beaudry
Michigan State University
Mesopotamia ~2200 BC
Mesopotamia ~2200 BC

Date palm
“So God expelled them from the Garden of Eden and sent them to work the ground, the same dirt out of which they’d been made. He threw them out of the garden and stationed angel-cherubim and a revolving sword of fire east of it, guarding the path to the Tree-of-Life.” (Book of Genesis 3:23-24)
Bounty from Eden
Be fruitful
...and multiply
A program for maturation and ripening
Mcintosh should be picked for CA storage in the average starch staining in flesh tissue changes from 30% and 40 percent; i.e., at starch iodine index 5 and 6. Empire are usually at the best stage of fruit development for CA harvest when the average starch iodine index for several blocks is 4.5 to 5.5. The harvest windows for CA Delicious and CA Island usually occur when the starch iodine indices are between 2.8 and 3.5.

Starch iodine indices for the harvest windows of other varieties have not yet been determined. If you do not have these fruit varieties to estimate the harvest windows for intervarietal varieties, the usefulness of the starch iodine index is limited to comparisons of the current season with previous seasons.
Apple Harvest Order

Ginger gold
Mn1914 (SweetTango)
Paulared
Gala/McIntosh
Honeycrisp
Jonathan
Jonagold
Empire
Golden Delicious
Delicious
Rome
Idared
Mutsu
Late Fuji

Late August
Mid October
Predicting Apple Maturity

- Based on history for each variety
- Days needed to mature from bloom

<table>
<thead>
<tr>
<th>Variety</th>
<th>Normal date</th>
<th>2010</th>
<th>2009</th>
<th>2008</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paulared</td>
<td>24-Aug</td>
<td>24-Aug</td>
<td>31-Aug</td>
<td>24-Aug</td>
<td>14-Aug</td>
</tr>
<tr>
<td>Gingergold</td>
<td>26-Aug</td>
<td>26-Aug</td>
<td>2-Sep</td>
<td>26-Aug</td>
<td>14-Aug</td>
</tr>
<tr>
<td>Gala</td>
<td>10-Sep</td>
<td>29-Aug</td>
<td>17-Sep</td>
<td>11-Sep</td>
<td>28-Aug</td>
</tr>
<tr>
<td>McIntosh</td>
<td>15-Sep</td>
<td>2-Sep</td>
<td>22-Sep</td>
<td>14-Sep</td>
<td>1-Sep</td>
</tr>
<tr>
<td>Honeycrisp</td>
<td>18-Sep</td>
<td>6-Sep</td>
<td>25-Sep</td>
<td>18-Sep</td>
<td>4-Sep</td>
</tr>
<tr>
<td>Empire</td>
<td>22-Sep</td>
<td>10-Sep</td>
<td>29-Sep</td>
<td>21-Sep</td>
<td>8-Sep</td>
</tr>
<tr>
<td>Jonathan</td>
<td>28-Sep</td>
<td>16-Sep</td>
<td>5-Oct</td>
<td>27-Sep</td>
<td>19-Sep</td>
</tr>
<tr>
<td>Jonagold</td>
<td>28-Sep</td>
<td>16-Sep</td>
<td>5-Oct</td>
<td>27-Sep</td>
<td>19-Sep</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>2-Oct</td>
<td>20-Sep</td>
<td>9-Oct</td>
<td>30-Sep</td>
<td>21-Sep</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>5-Oct</td>
<td>22-Sep</td>
<td>12-Oct</td>
<td>3-Oct</td>
<td>26-Sep</td>
</tr>
<tr>
<td>Goldrush</td>
<td>1-Nov</td>
<td>20-Oct</td>
<td>8-Nov</td>
<td>30-Oct</td>
<td>22-Oct</td>
</tr>
</tbody>
</table>

Phil Schwallier, Amy Irish-Brown, Denise Ruwersma Sept, 2010 Report
MSU Extension, Grand Rapids Area
More detailed reports from other district MSU Extension Fruit Educators will be posted on www.apples.msu.edu – under the Apple Maturity section.
Indices of Fruit Maturation

1. Ethylene generation (Climacteric crop)
2. Sugar Content
3. Flesh firmness
4. Starch content VS conversion to sugars
5. Color (ground/exterior)
6. Retention Force (sour cherry)
7. Fruit Weight and Size
Types of maturity indices

Physical properties: External and internal color; useful for many horticultural products

Measuring fruit surface color using a colorimeter

Color charts produced for many commodities
Starch content

McIntosh should be picked for CA storage as the average starch staining in flesh tissue changes from 60 and 40 percent; i.e., at starch-iodine index 5 and 6. Empire are usually at the best stage of fruit development for CA harvest when the average starch-iodine index for several blocks is 4.5 to 5.5. The harvest windows for CA Delicious and CA Island usually occur when the starch-iodine indexes are between 2.8 and 3.5.

Starch-iodine indexes for the harvest windows of other varieties have not yet been determined. If you do not have these four varieties to estimate the harvest windows for intercrops, the usefulness of the starch-iodine index is limited to comparisons of the current season with previous seasons.
SUPPLEMENT

GROUND COLOR FOR McINTOSH APPLES

1. 2.

3. 4.

5.

Inks prepared by the Icterechnical Corporation

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L. B. Simons, Director of Extension

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Measurement of soluble solids (°Brix)

Degrees Brix (symbol °Bx) is a measurement of the mass ratio of dissolved sucrose to water in a liquid. It is measured with a refractometer. A 25 °Bx solution is 25% (w/w).

refractometer

An optical instrument that is used to determine the refractive index of a substance. Can be used to determine the identity of an unknown substance based on its refractive index to assess the purity of a particular substance, or to determine the concentration of one substance dissolved in another.

Minimum maturity index: NZ kiwifruit 6.25 %
Passion fruit 14 - 18 %

Quality index: Cantaloupe (U.S. Fancy) 11 %
Cantaloupe (U.S. No. 1) 9 %
General Comments:
The weather has been more fall-like over the last week with daytime highs right around 70 and lows in the 50’s. This cooler weather pattern is helping with apple color development. Rainfall has been normal with 1.5 to 2.5 inches since September 1st. Normal rainfall amounts for the month of September usually are between 2 and 3 inches, so we’ve met that already for 2010 with half the month to go yet. Gala and Honeycrisp harvest is winding down. The redder strains of McIntosh have been stripped with other older strains to be harvested soon. In general, growers report they are picking out slightly less than estimated.

Summary of Grand Rapids apple maturity samples taken September 10 & 14, 2010:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ethylene (ppm)</th>
<th>Color % (range)</th>
<th>Firmness lbs pressure (range)</th>
<th>Starch (range)</th>
<th>Brix (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gala</td>
<td>1.85</td>
<td>86% (80-95)</td>
<td>14.5 (13-17.6)</td>
<td>6 (5-7)</td>
<td>14.1 (13.5-15.5)</td>
</tr>
<tr>
<td>Honeycrisp</td>
<td>29.1</td>
<td>70% (30-90)</td>
<td>15.6 (11.3-18.4)</td>
<td>5.75 (3-8)</td>
<td>14.5 (13.5-16)</td>
</tr>
<tr>
<td>Red Mac Strains</td>
<td>74.4</td>
<td>96.8 (95-99)</td>
<td>14.1 (11.8-16.6)</td>
<td>4.4 (4-6)</td>
<td>13.2 (12-14)</td>
</tr>
<tr>
<td>Ruby Jon</td>
<td>4.93</td>
<td>97.2 (95-100)</td>
<td>14.2 (12-16.5)</td>
<td>4 (4-4)</td>
<td>13.8 (13-14.5)</td>
</tr>
<tr>
<td>Jonagold</td>
<td>---</td>
<td>77% (65-84)</td>
<td>17.1 (15.9-18)</td>
<td>3.6 (2-6)</td>
<td>13.8 (12-15)</td>
</tr>
<tr>
<td>Empire</td>
<td>1.87</td>
<td>80.5 (65-95)</td>
<td>16.7 (14-18.8)</td>
<td>3.3 (3-5)</td>
<td>12.2 (10.5-14)</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>0.03</td>
<td>2% (0-10)</td>
<td>15.9 (14.3-17.6)</td>
<td>4.1 (3-6)</td>
<td>11.2 (11-12)</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>6.9</td>
<td>89.5% (70-99)</td>
<td>15.5 (11-17)</td>
<td>2.05 (1-4)</td>
<td>11.4 (10.5-13)</td>
</tr>
<tr>
<td>Ida Red</td>
<td>0.158</td>
<td>56% (30-80)</td>
<td>16.7 (13.9-18.6)</td>
<td>2 (2-2)</td>
<td>11.4 (12-12)</td>
</tr>
</tbody>
</table>

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Fruit Ripening:
“I was a herdsman and a piercer of sycomore fruit” - Amos 7:14

Ficus sycomorus
Ripening Definition:

“The composite of the processes that occur from the latter stages of growth and development through the early stages of senescence and that results in characteristic esthetic and/or food quality, as evidenced by changes in composition, color, texture, or other sensory attributes.”

(Watada et al., 1984)
Fruit Ripening

- History of the climacteric
  - F. Blackman (1909) observed that Cherry laurel and Tropæoleum leaves during senescence and “starvation” undergo a respiratory minimum followed by an increase to a peak value and subsequent decline.
  - F. Kidd and C. West (1922) described “the rate of respiration of mature apples after gathering increased until it reached a maximum, then fell off”
Fruit Ripening

• History of the climacteric
  – F. Kidd and C. West (1924) described “the onset of the second, or senescence phase of the life is characterised by a relatively sudden alteration in the level of respiratory activity...This striking phenomenon, which appears to mark the transition from growth to senescence, is here termed “the climacteric”
They determined that, relative to the minimum, the climacteric rise was only moderately diminished by a drop in temperature from 22 to °8 C, even though the time from preclimactic minimum to maximum was about increased 10-fold.
CLIMACTERIC FRUIT

Breadfruit
Cherimoya
Mango
Fig
Apple
Tomato

ml O₂ OR CO₂/Kg-Hr

0 2 4 6 8 10 12 14 16 18
TIME UNITS

NONCLIMACTERIC FRUIT

STRAWBERRY
GRAPE
PINEAPPLE
CHERRY
LEMON

ml O₂ OR CO₂/Kg-HR

0 1 2 3 4 5 6 7 8 9 10
TIME UNITS
<table>
<thead>
<tr>
<th>Climacteric</th>
<th>Nonclimacteric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Cacao</td>
</tr>
<tr>
<td>Apricot</td>
<td>Cherry</td>
</tr>
<tr>
<td>Avocado</td>
<td>Cucumber</td>
</tr>
<tr>
<td>Banana</td>
<td>Grape</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Grapefruit</td>
</tr>
<tr>
<td>Breadfruit</td>
<td>Lemon</td>
</tr>
<tr>
<td>Carambola</td>
<td>Lime</td>
</tr>
<tr>
<td>Cherimoya</td>
<td>Longan</td>
</tr>
<tr>
<td>Feijoa</td>
<td>Loquat</td>
</tr>
<tr>
<td>Fig</td>
<td>Lychee</td>
</tr>
<tr>
<td>Guava</td>
<td>Olive</td>
</tr>
<tr>
<td>Jackfruit</td>
<td></td>
</tr>
<tr>
<td>Kiwifruit</td>
<td></td>
</tr>
<tr>
<td>Mango</td>
<td></td>
</tr>
<tr>
<td>Muskmelon</td>
<td>Cacao</td>
</tr>
<tr>
<td>Papaya</td>
<td>Cherry</td>
</tr>
<tr>
<td>Passion Fruit</td>
<td>Cucumber</td>
</tr>
<tr>
<td>Peach</td>
<td>Grape</td>
</tr>
<tr>
<td>Pear</td>
<td>Grapefruit</td>
</tr>
<tr>
<td>Persimmon</td>
<td>Lemon</td>
</tr>
<tr>
<td>Plum</td>
<td>Lime</td>
</tr>
<tr>
<td>Quince</td>
<td>Longan</td>
</tr>
<tr>
<td>Rambutan</td>
<td>Loquat</td>
</tr>
<tr>
<td>Sapodilla</td>
<td>Lychee</td>
</tr>
<tr>
<td>Sapote</td>
<td>Olive</td>
</tr>
<tr>
<td>Soursop</td>
<td></td>
</tr>
<tr>
<td>Tomato</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Most vegetables and flowers are nonclimacteric; broccoli and carnation are climacteric.
Competitive inhibitor of ethylene biosynthesis
Inhibits endogenous ethylene production
Does not affect sensitivity to exogenous ethylene
Applied approximately 3 to 4 weeks before harvest
Alter rate of maturation

Quality Potential

Threshold

Time

Ethylene Production

+ Retain
Alter rate of maturation

Quality Potential

Threshold

Time

Ethylene Production

+ ReTain
Jonagold
ReTain

5 locations, 3 years
+- ReTain
+- CA storage
Jonagold

Averaged over 5 locations in 1996 -

Little effect on color

Minor inhibition of starch conversion

Marked effect on ethylene production
Jonagold
Averaged over 5 locations in 1996

More firm fruit for later harvests

Delay in increase in moderately firm fruit to later harvests

No difference in soft fruit
NAA in Combination
With ReTain – and other materials
ReTain + NAA on McIntosh

Figure 5. Effect of AVG (Retain) sprayed alone or in combination with NAA (Fruitone N) at various timings before harvest on pre-harvest fruit drop of mature McIntosh/M.26 trees at Chazy, New York in 2008. (Vertical bars are LSD’s, P≤0.05, n=5).

Robinson et al., NY Fruit Quarterly, 2008
ReTain, NAA on Internal Ethylene - Honeycrisp
Thanks !