



Interpreting Apple Maturity Reports to Optimize Harvest Decisions

Randy Beaudry
Michigan State University



Cranach the Elder ~1500 AD



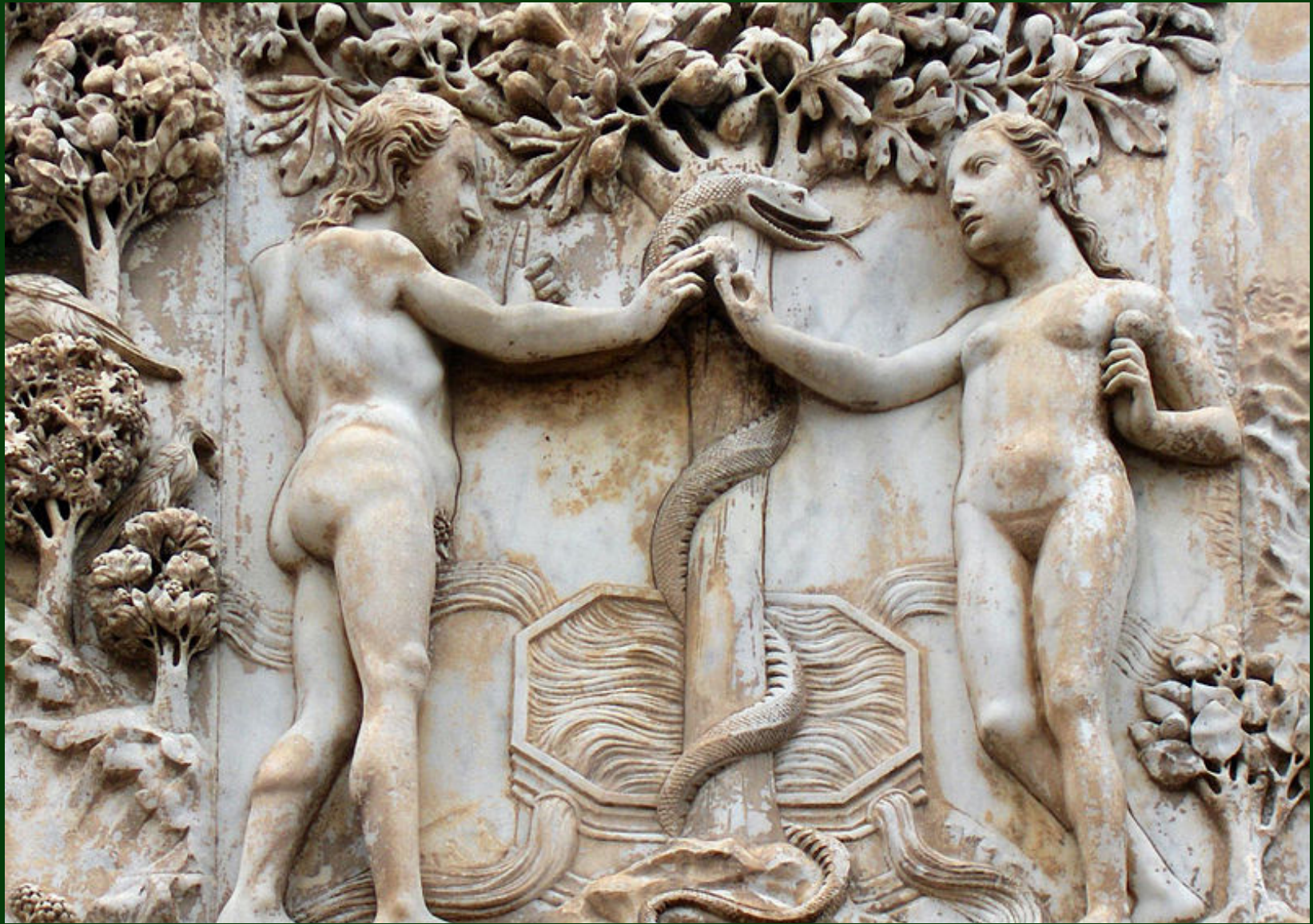
Apple



Cranach the Elder ~1500 AD



Michelangelo ~1500 AD



Lorenzo ~1250 AD



Lorenzo ~1250 AD

Fig



Mesopotamia ~2200 BC



Date palm



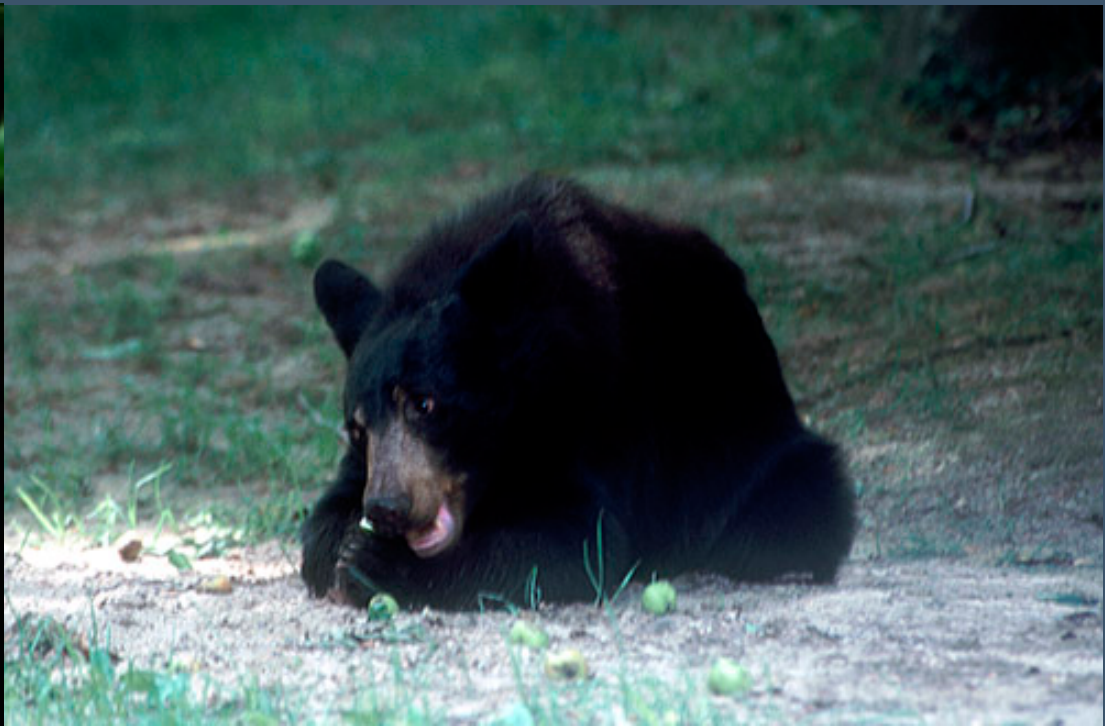
Mesopotamia ~2200 BC



“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)

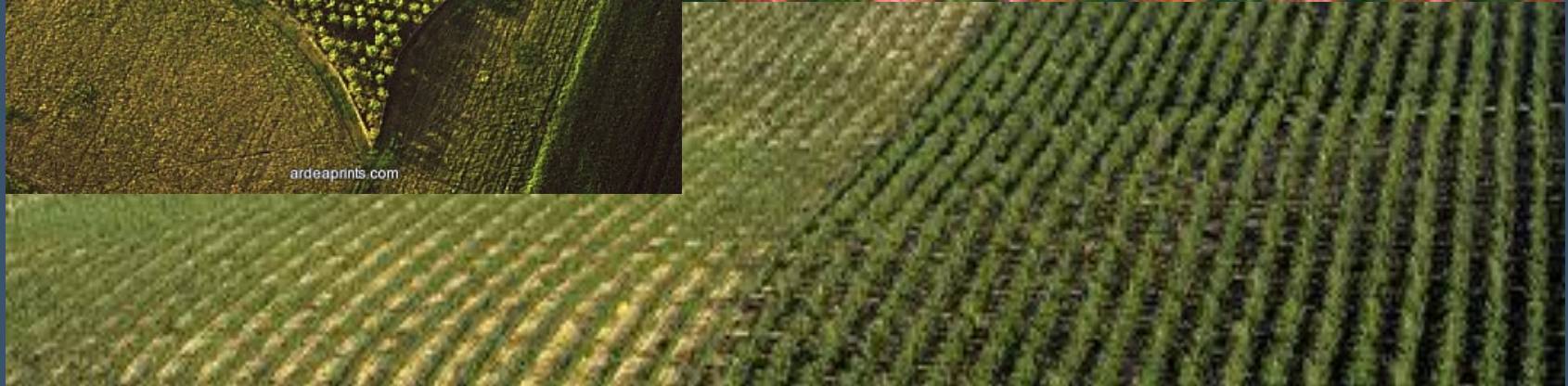
Bounty from Eden

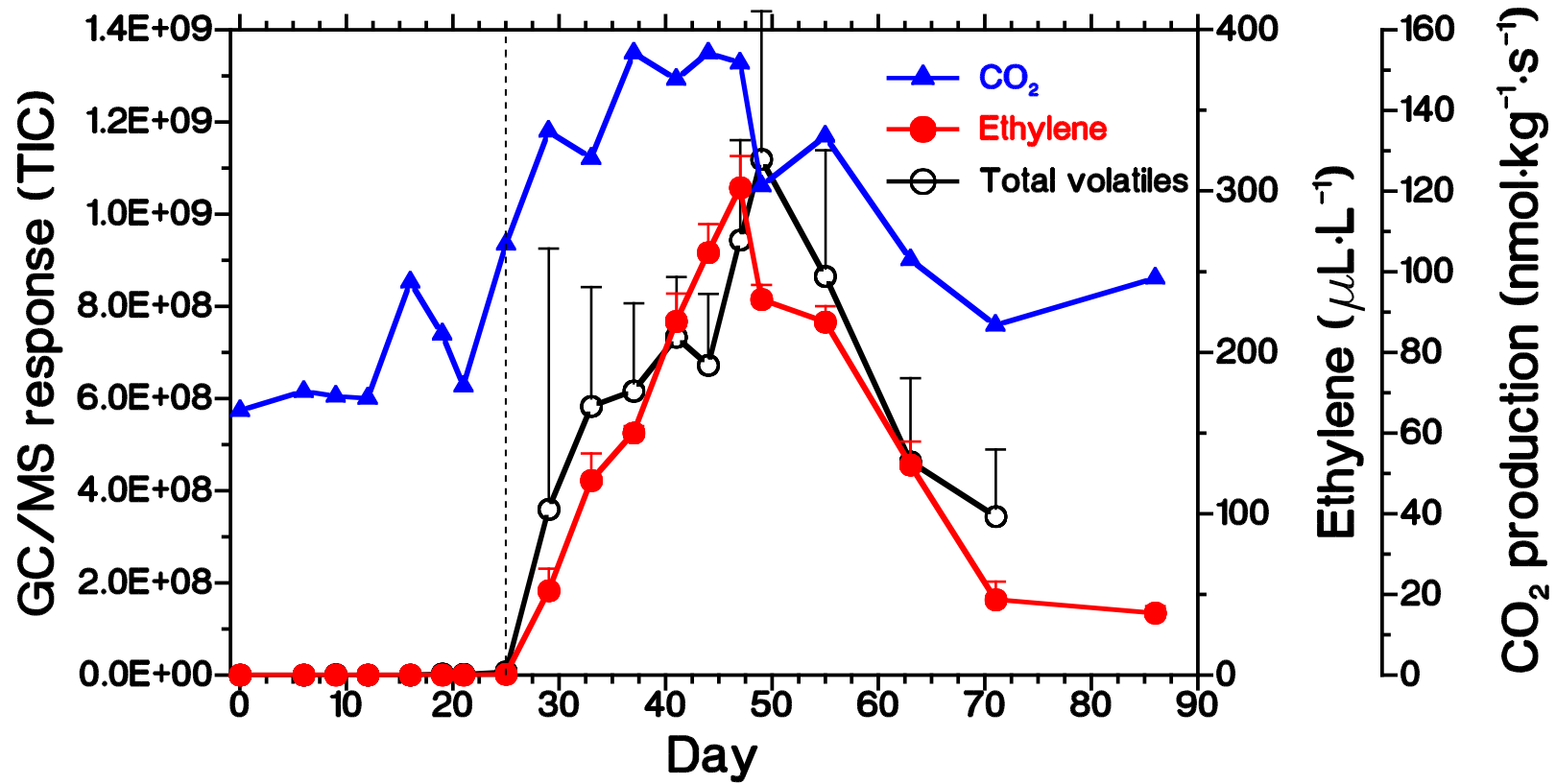




Be fruitful

...and multiply

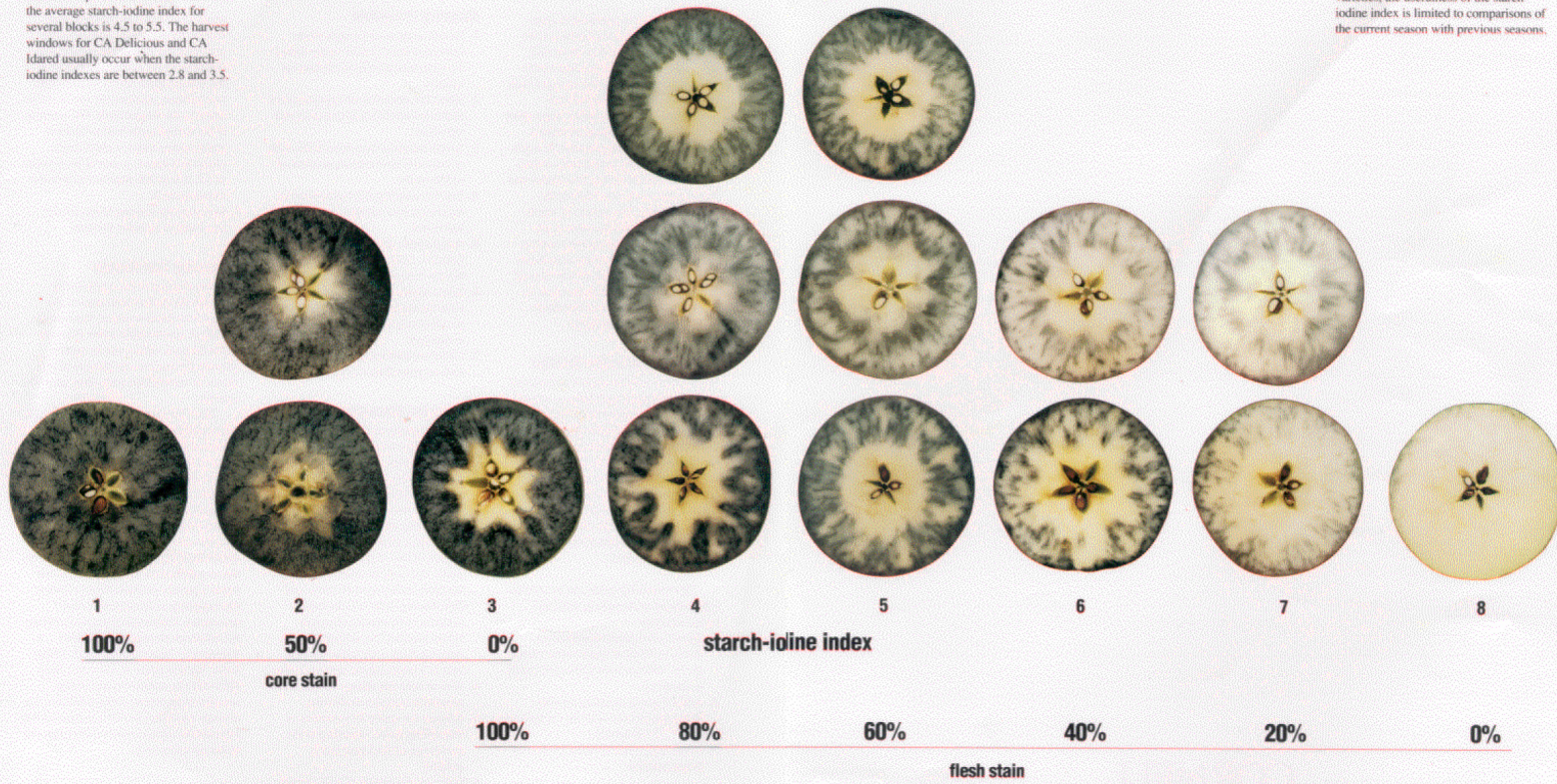




A program for maturation and ripening

McIntosh should be picked for CA storage 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 Idared 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 intervening varieties, the usefulness of the starch-iodine index is limited to comparisons of the current season with previous seasons.



1
100%

2
50%
core stain

3
0%
100%

4
80%

5
60%

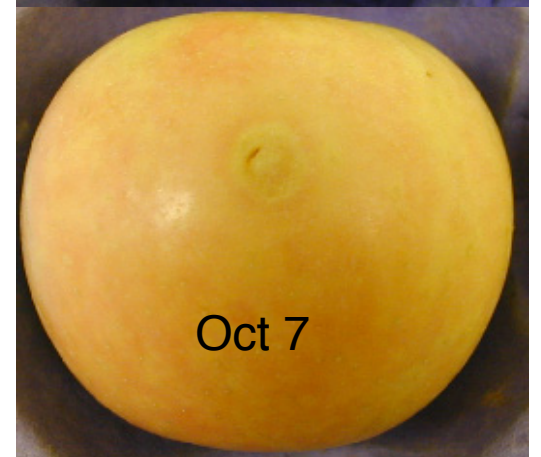
6
40%

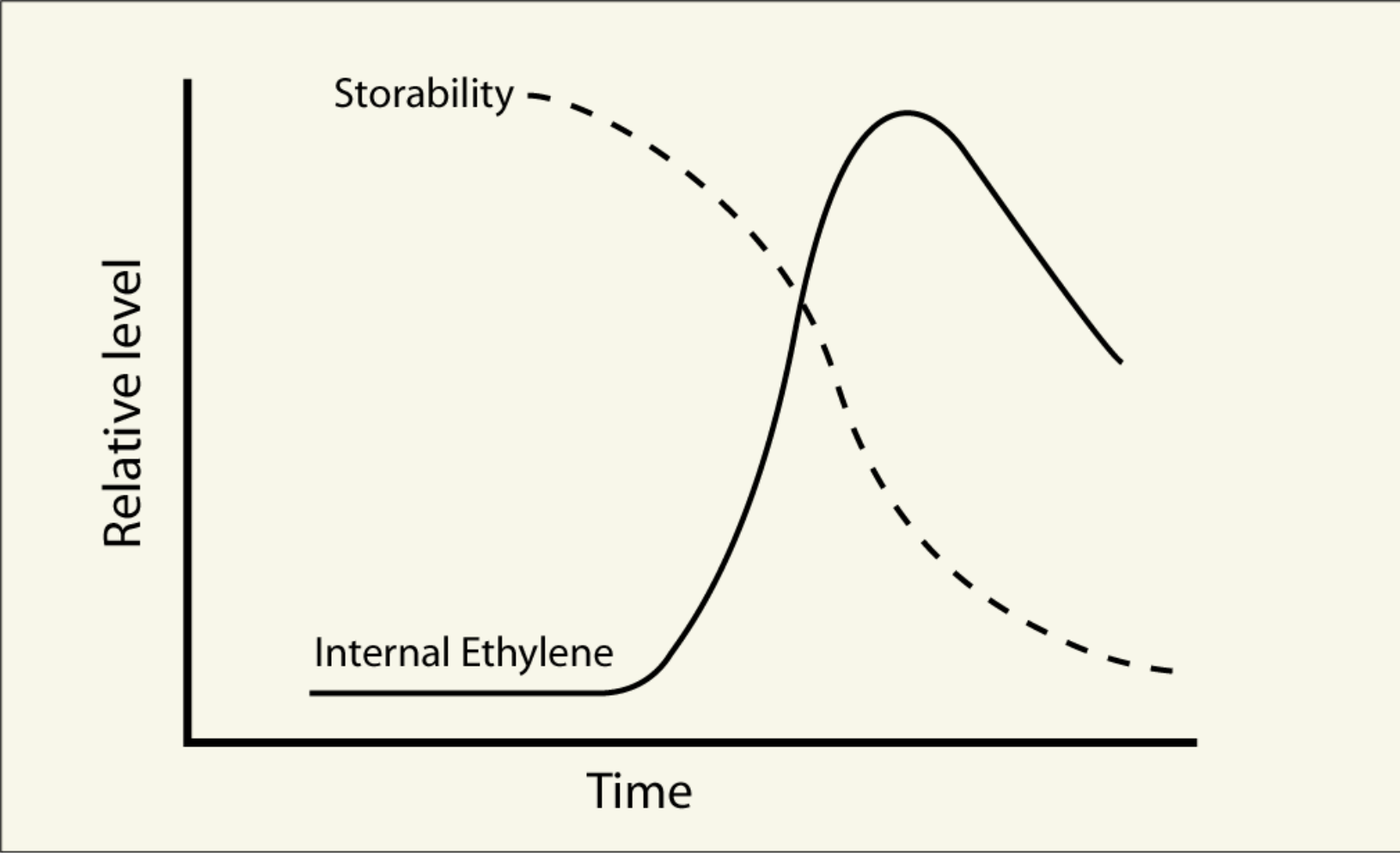
7
20%

8
0%

starch-iodine index

flesh stain



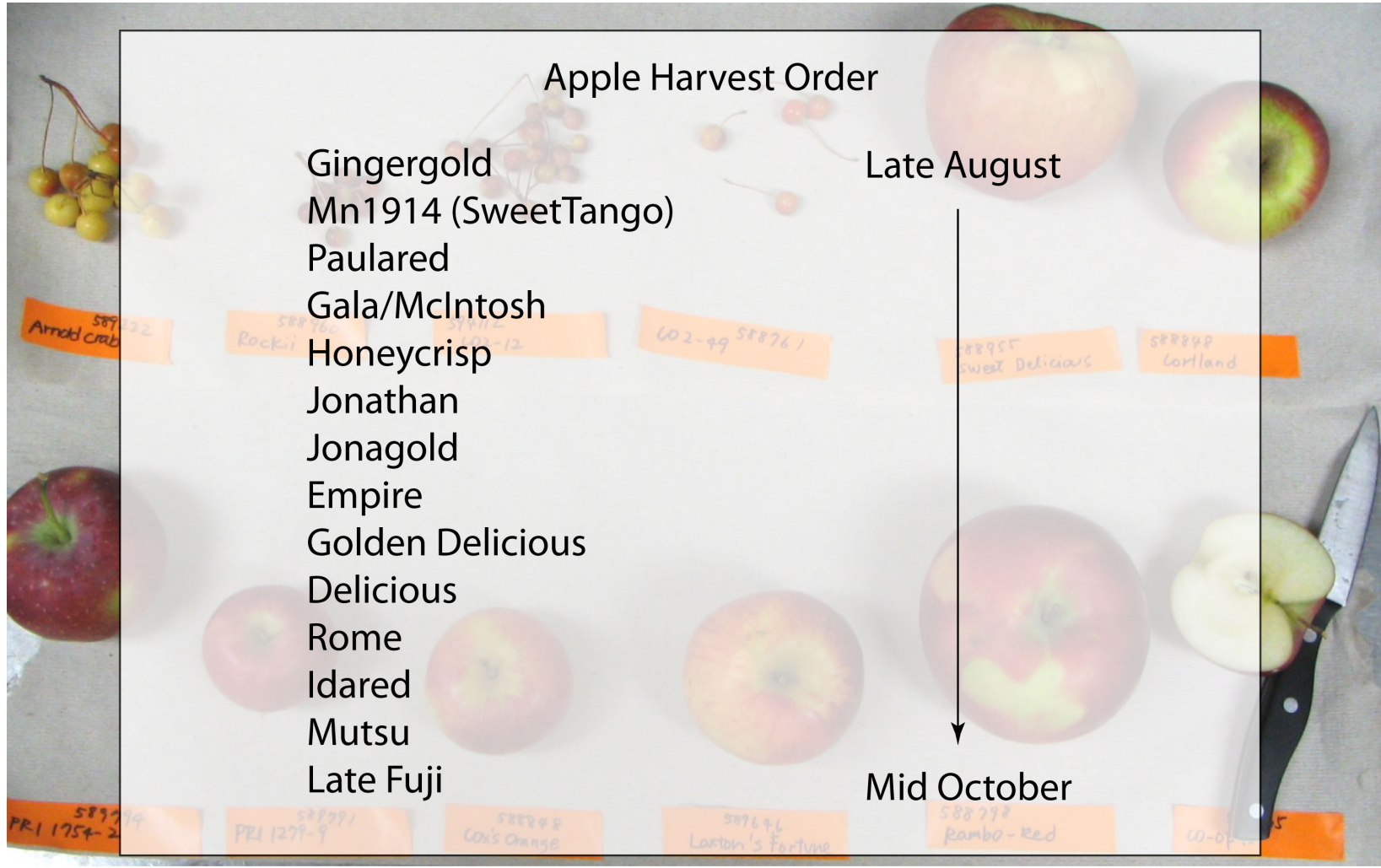


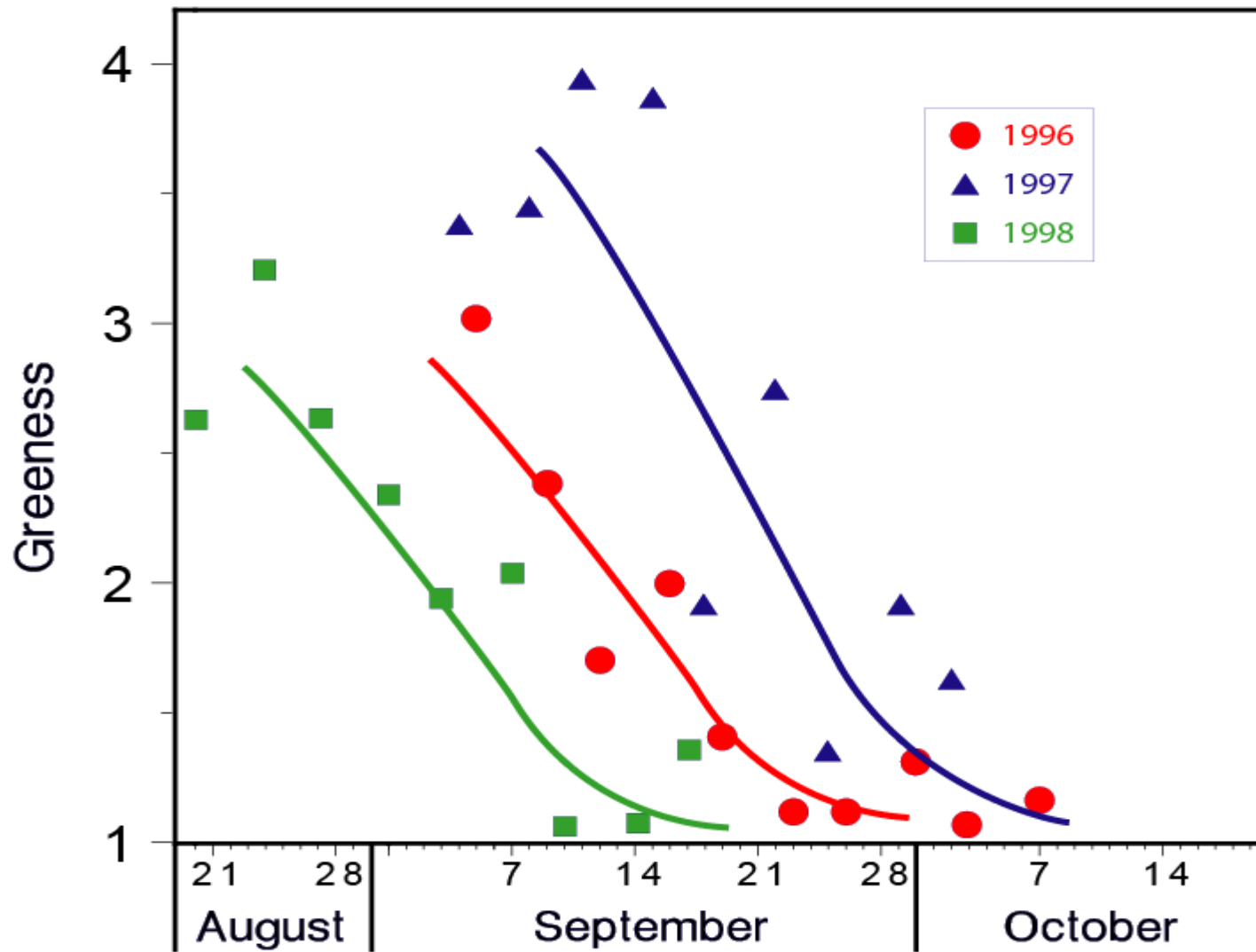
Apple Harvest Order

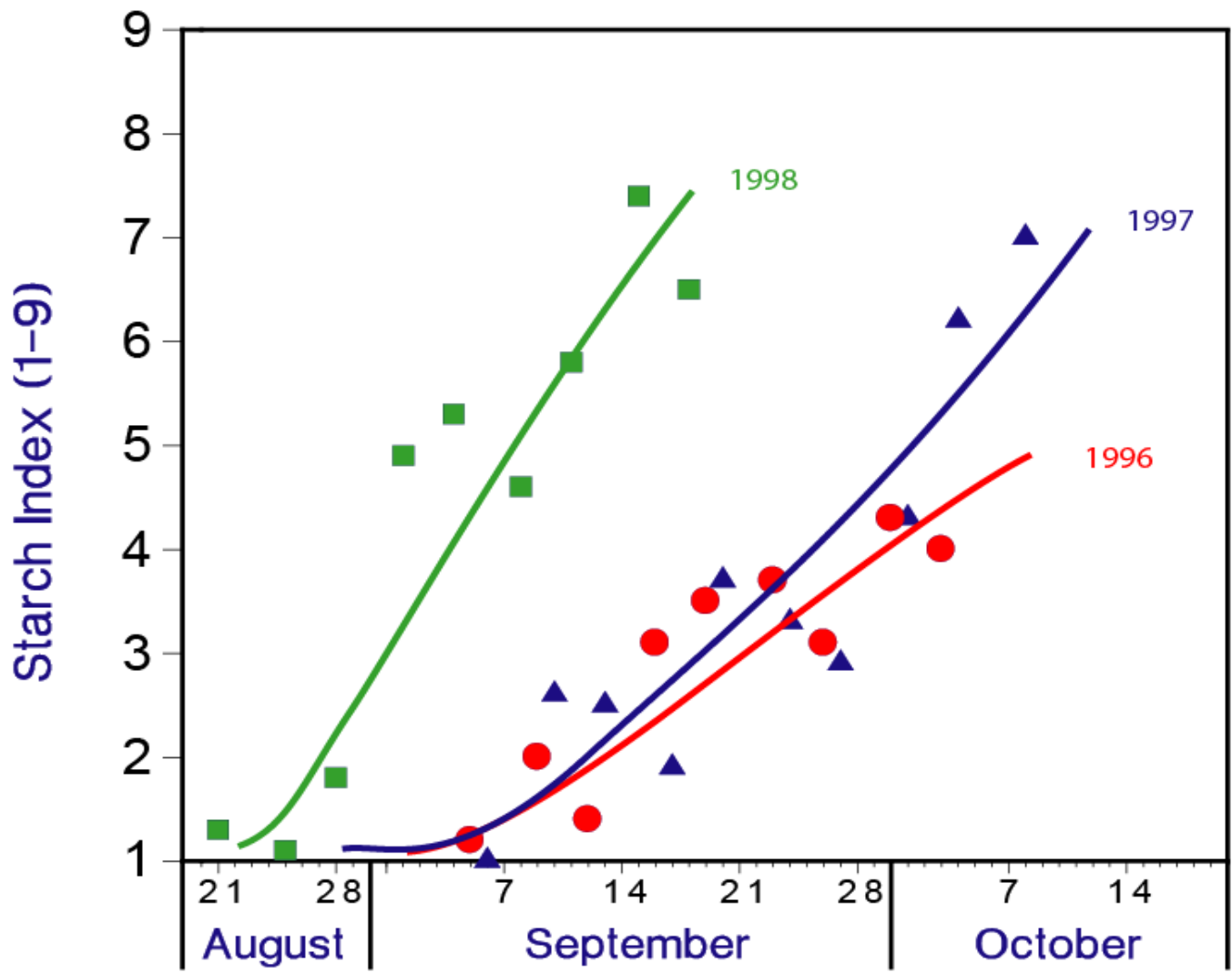
- Gingergold
- Mn1914 (SweetTango)
- Paulared
- Gala/McIntosh
- Honeycrisp
- Jonathan
- Jonagold
- Empire
- Golden Delicious
- Delicious
- Rome
- Idared
- Mutsu
- Late Fuji

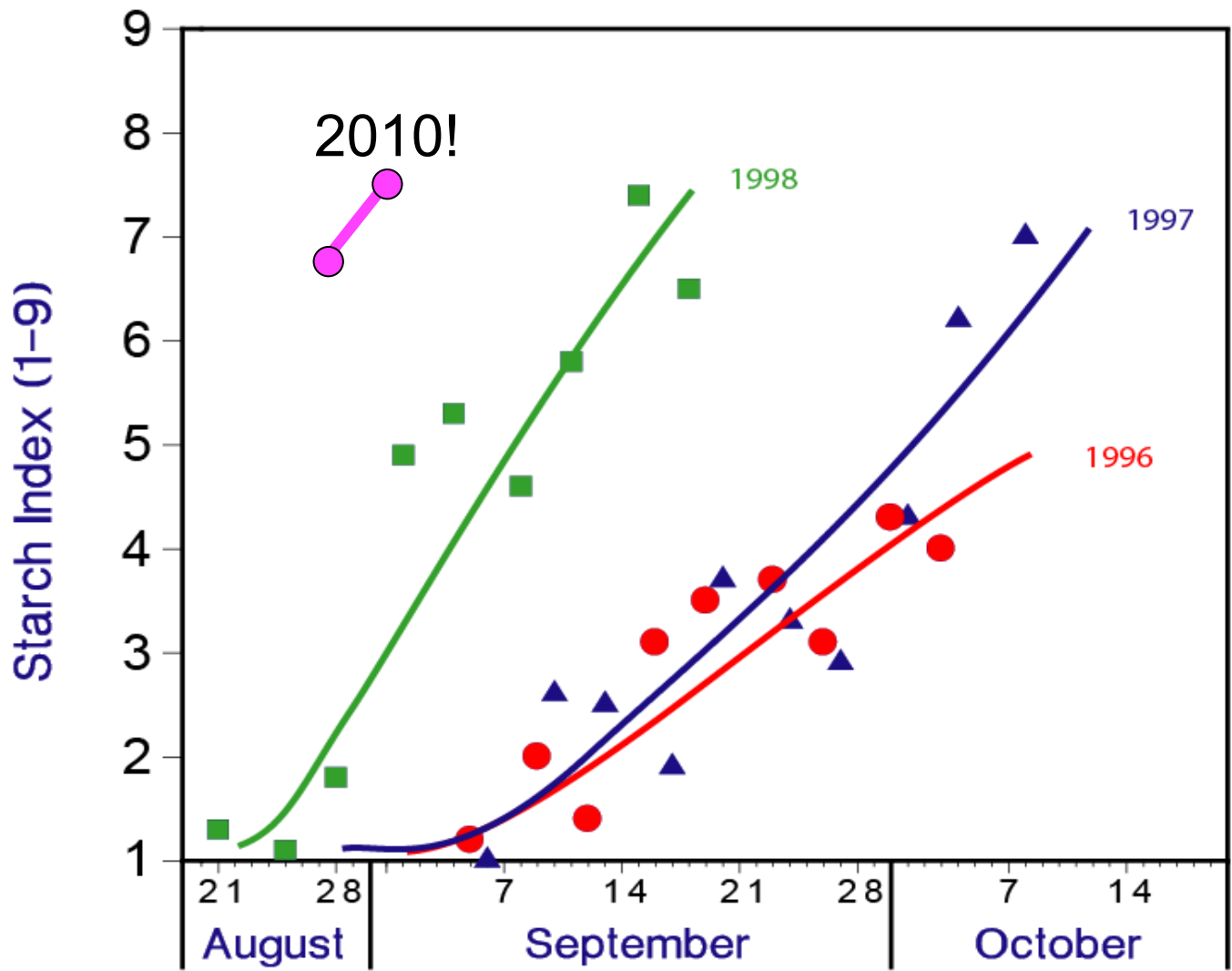
Late August

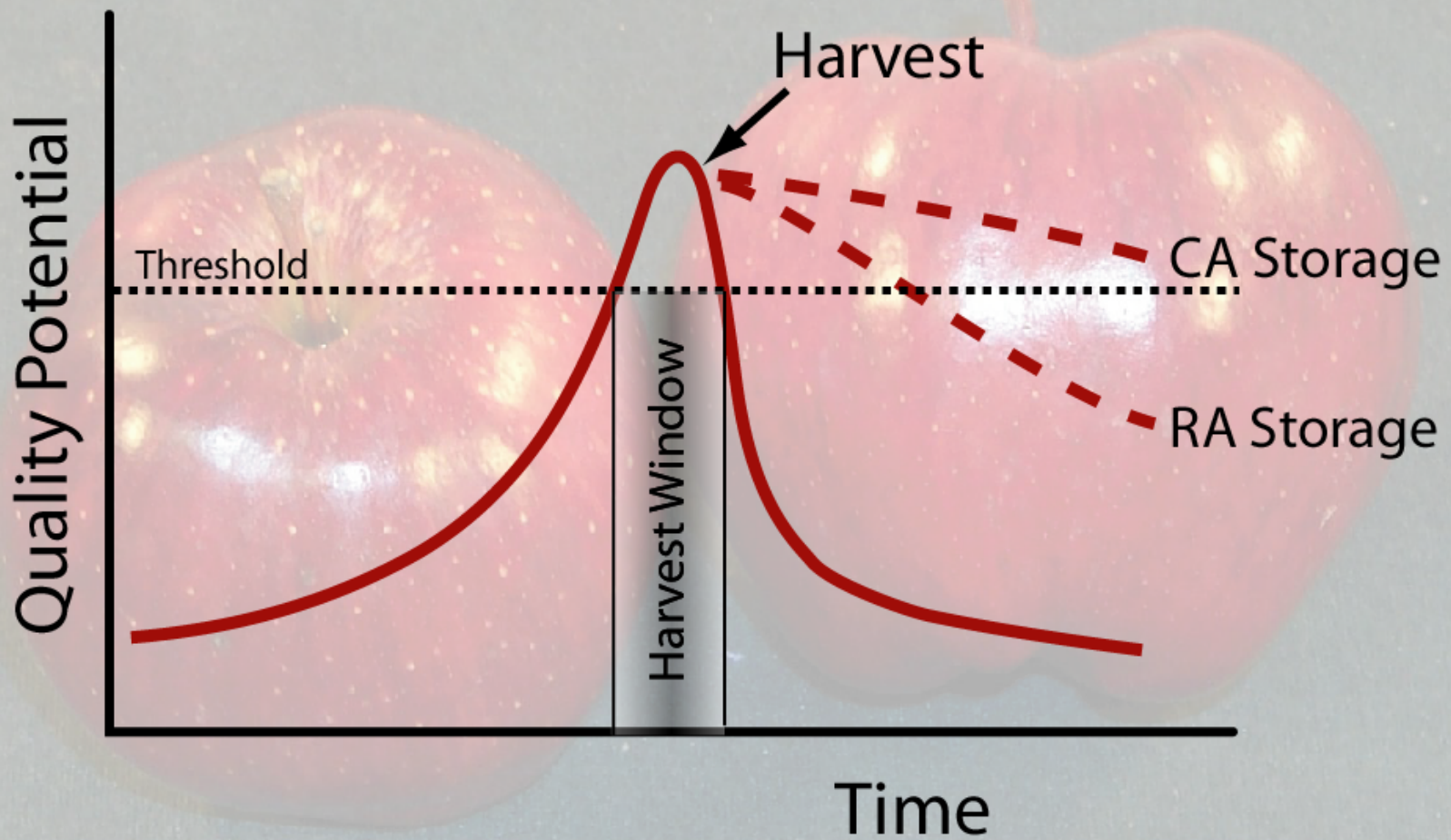
Mid October



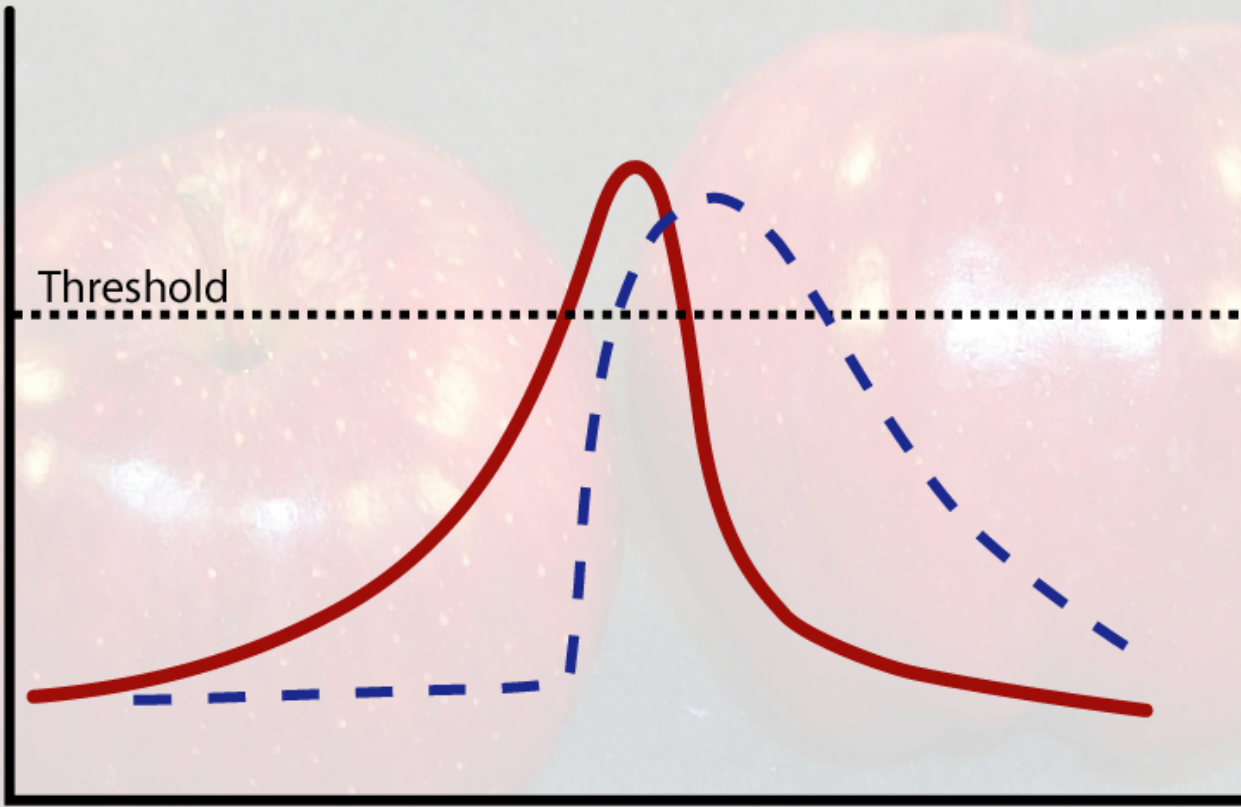








Quality Potential



Threshold

Time

Ethylene Production

Predicting Apple Maturity

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

Variety	Normal date	2010	2009	2008	2007
Paulared	24-Aug	24-Aug	31-Aug	24-Aug	14-Aug
Gingergold	26-Aug	26-Aug	2-Sep	26-Aug	14-Aug
Gala	10-Sep	29-Aug	17-Sep	11-Sep	28-Aug
McIntosh	15-Sep	2-Sep	22-Sep	14-Sep	1-Sep
Honeycrisp	18-Sep	6-Sep	25-Sep	18-Sep	4-Sep
Empire	22-Sep	10-Sep	29-Sep	21-Sep	8-Sep
Jonathan	28-Sep	16-Sep	5-Oct	27-Sep	19-Sep
Jonagold	28-Sep	16-Sep	5-Oct	27-Sep	19-Sep
Golden Delicious	2-Oct	20-Sep	9-Oct	30-Sep	21-Sep
Red Delicious	5-Oct	22-Sep	12-Oct	3-Oct	26-Sep
Idared	10-Oct	28-Sep	17-Oct	9-Oct	2-Oct
Rome	15-Oct	3-Oct	22-Oct	14-Oct	7-Oct
Fuji	25-Oct	13-Oct	1-Nov	25-Oct	18-Oct
Braeburn	25-Oct	13-Oct	1-Nov	25-Oct	18-Oct
Goldrush	1-Nov	20-Oct	8-Nov	30-Oct	22-Oct

Phil Schwallier, Amy Irish-Brown, Denise Ruwersma Sept , 2010 Report

MSU Extension, Grand Rapids Area

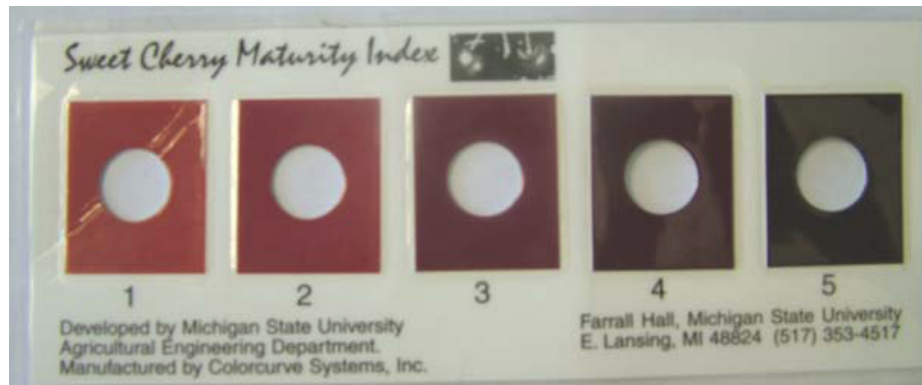
More detailed reports from other district MSU Extension Fruit Educators will be posted on www.apples.msu.edu – under the Apple Maturity section.

Indices of Fruit Maturation

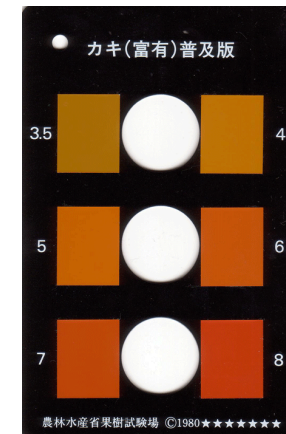
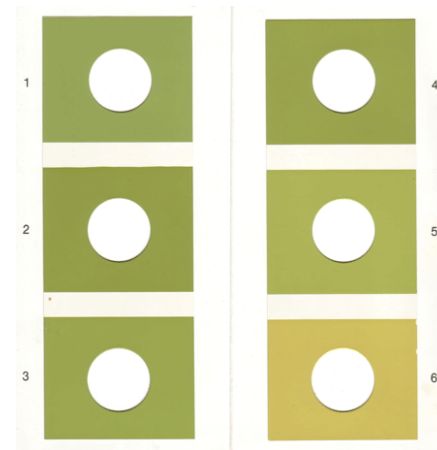
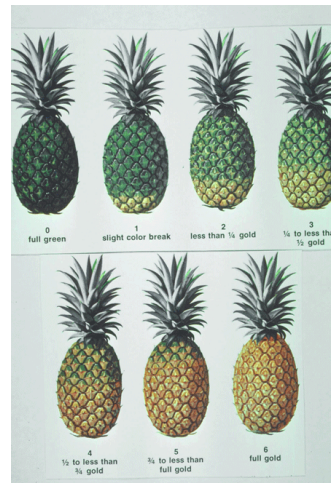
1. Ethylene generation (Climacteric crop)
2. Sugar Content
3. Flesh firmness
4. Starch content VS conversion to sugars
5. Color (ground/exterior)
6. Retention Force (sour cherry)
7. Fruit Weight and Size

Types of maturity indices

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



Measuring fruit surface color using a colorimeter

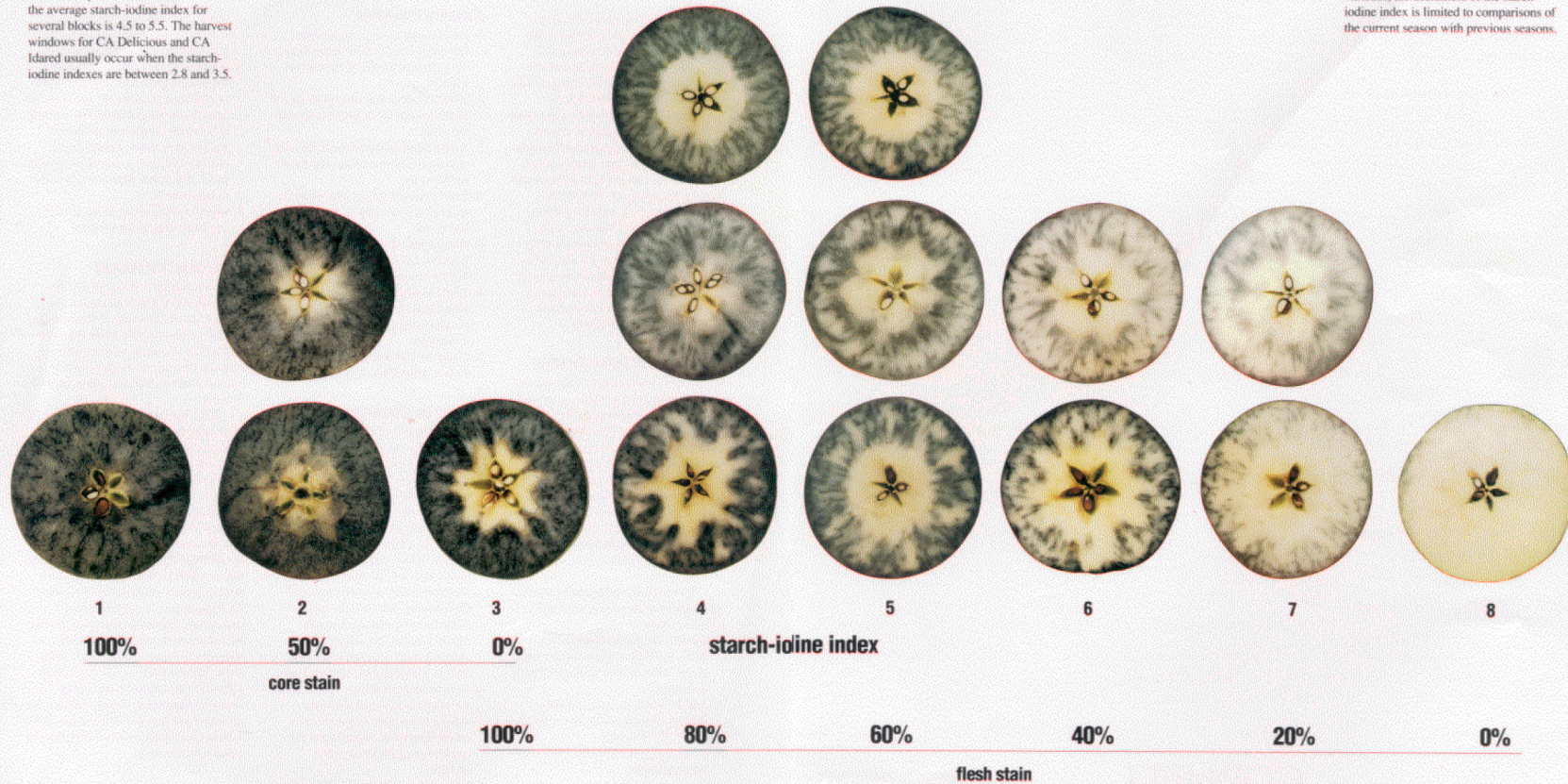


Color charts produced for many commodities

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 Idared usually occur when the starch-iodine indexes are between 2.8 and 3.5.

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Background
color

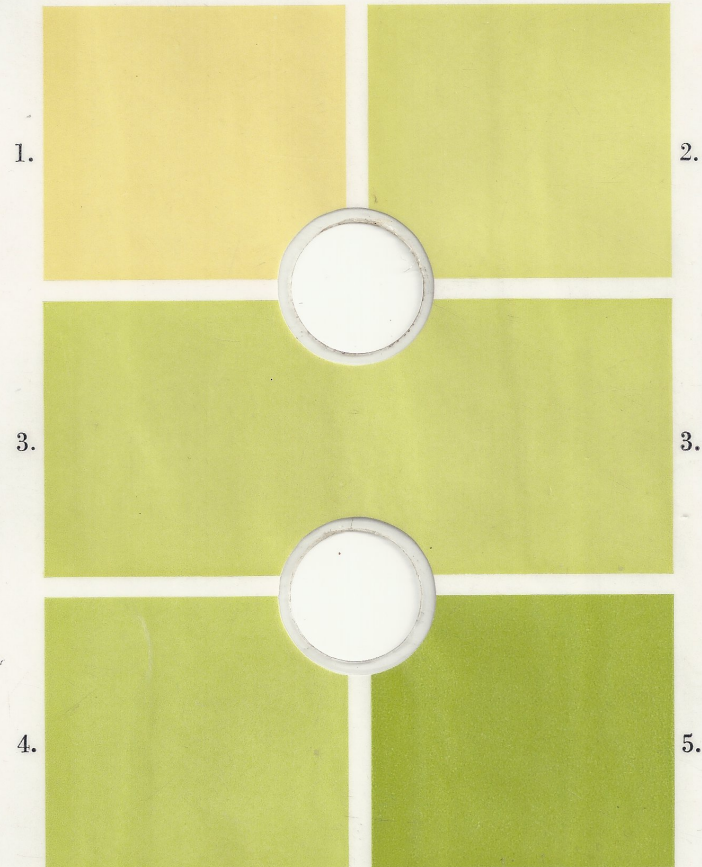
Bulletin 750

July, 1948

Davey

SUPPLEMENT

GROUND COLOR FOR McINTOSH APPLES



Inks prepared by the Interchemical Corporation

Cornell Extension Bulletin

Published by the New York State College of Agriculture
at Cornell University, Ithaca, New York

L. R. Simons, Director of Extension

Published and distributed in furtherance of the purposes provided
for in the Acts of Congress of May 8 and June 30, 1914

Measurement of soluble solids (°Brix)



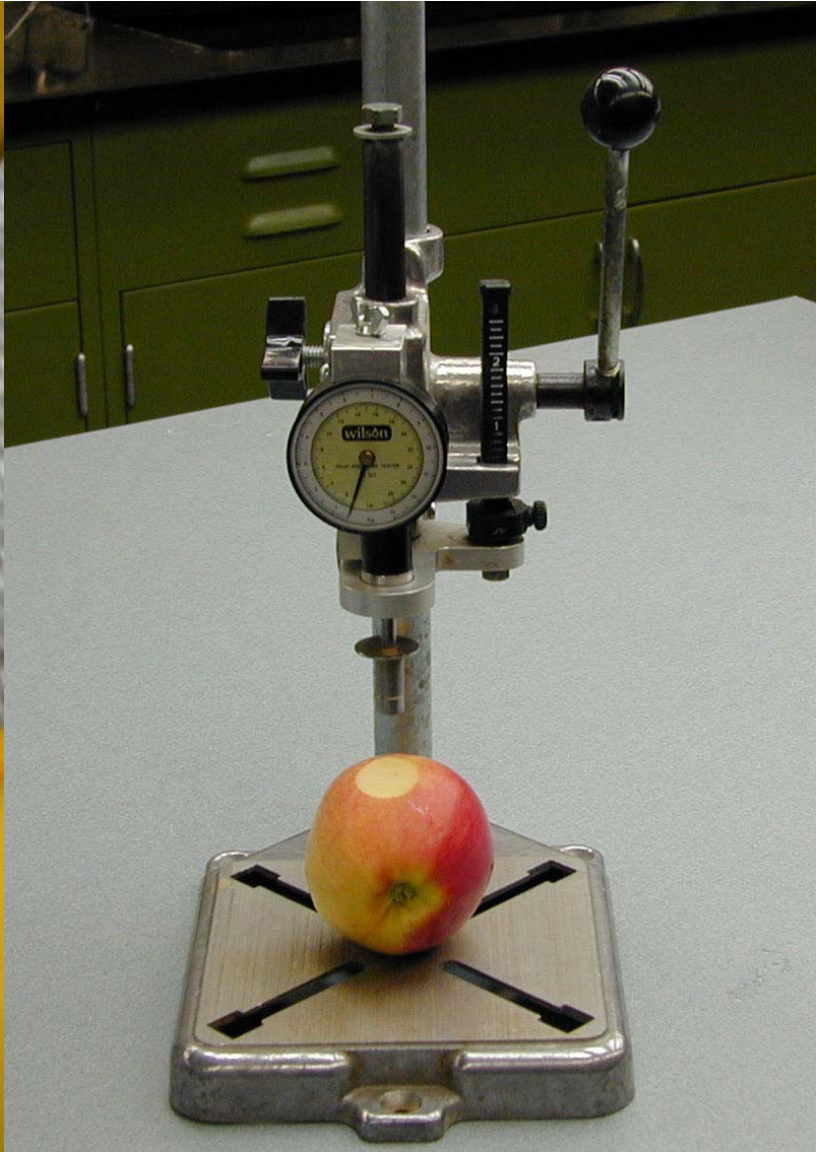
An optical instrument that is used to determine the refractive index of a substance. Can be used to determine the identity of an unknown substance based on its refractive index to assess the purity of a particular substance, or to determine the concentration of one substance dissolved in another.

refractometer

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).

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

Quality index: Cantaloupe (U.S. Fancy) 11 %
Cantaloupe (U.S. No. 1) 9 %











MSU Fruit Team Apple Maturity Report 2010

Grand Rapids Area Report Number 4

September 15, 2010

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.

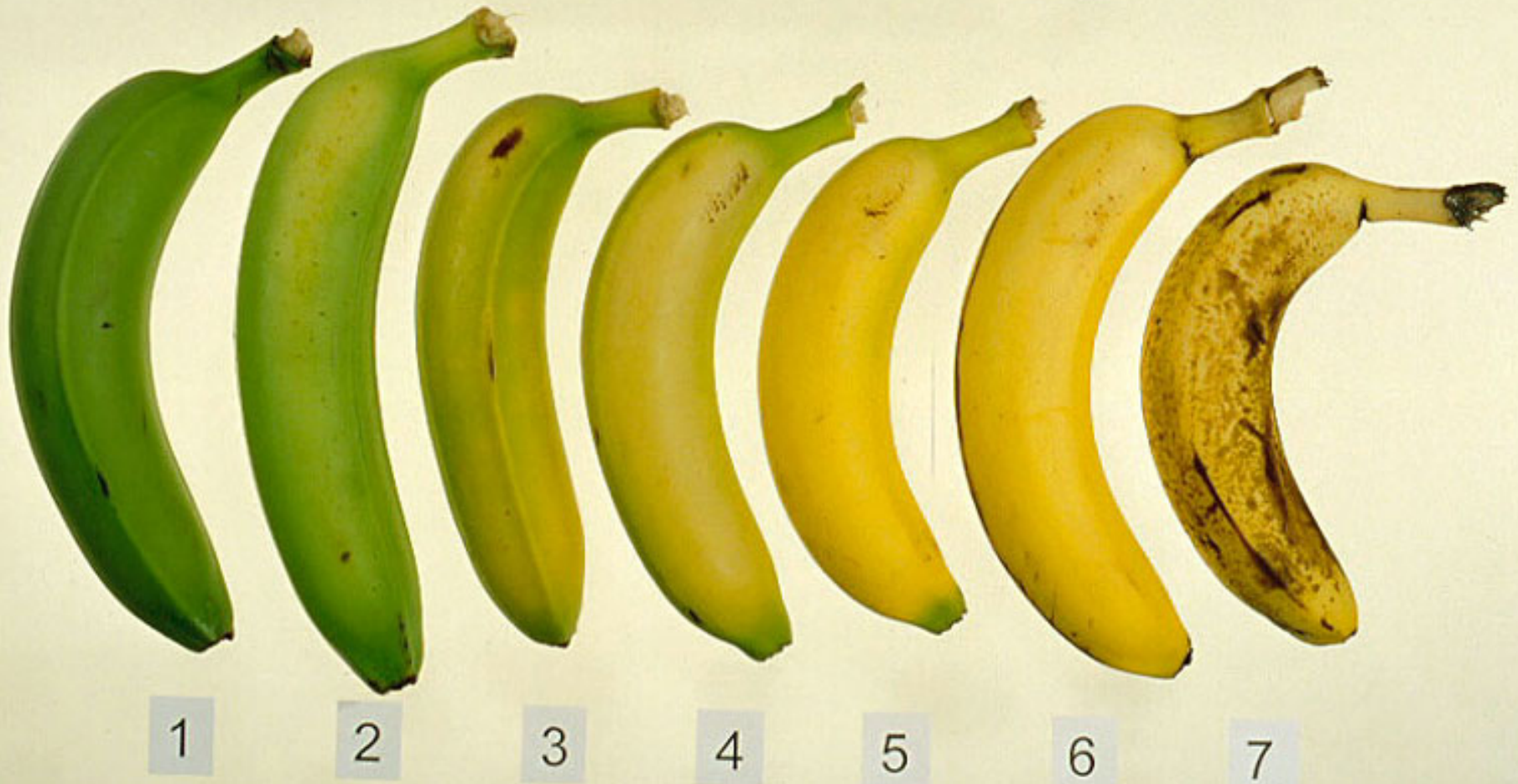
Summary of Grand Rapids apple maturity samples taken September 10 & 14, 2010:

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

Phil Schwallier, Amy Irish-Brown, Denise Ruwersma
MSU Extension, Grand Rapids Area

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Fruit Ripening:



“I was a herdsman and a piercer of
sycamore 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

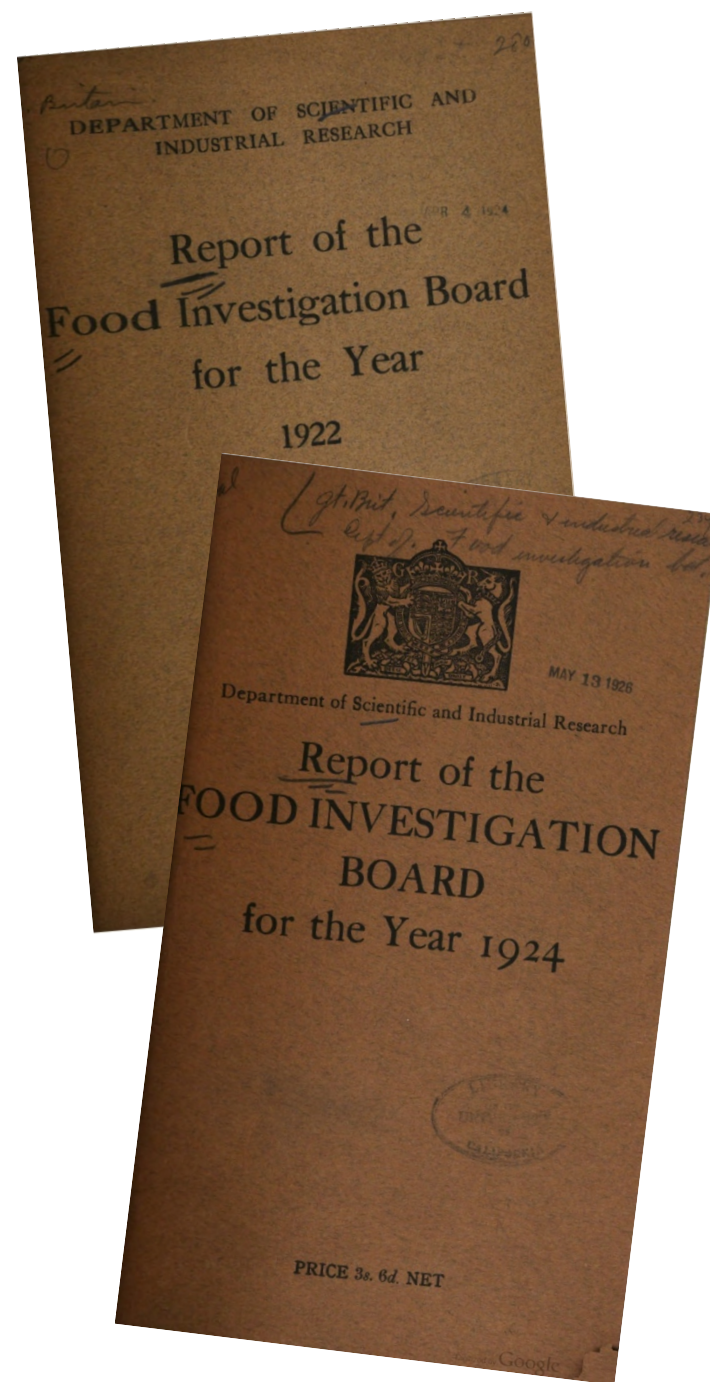


PLATE 1.—LOW TEMPERATURE RESEARCH STATION, CAMBRIDGE.

- History of the climacteric
 - F. Blackman (1909) observed that Cherry laurel and *Tropæolum* 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

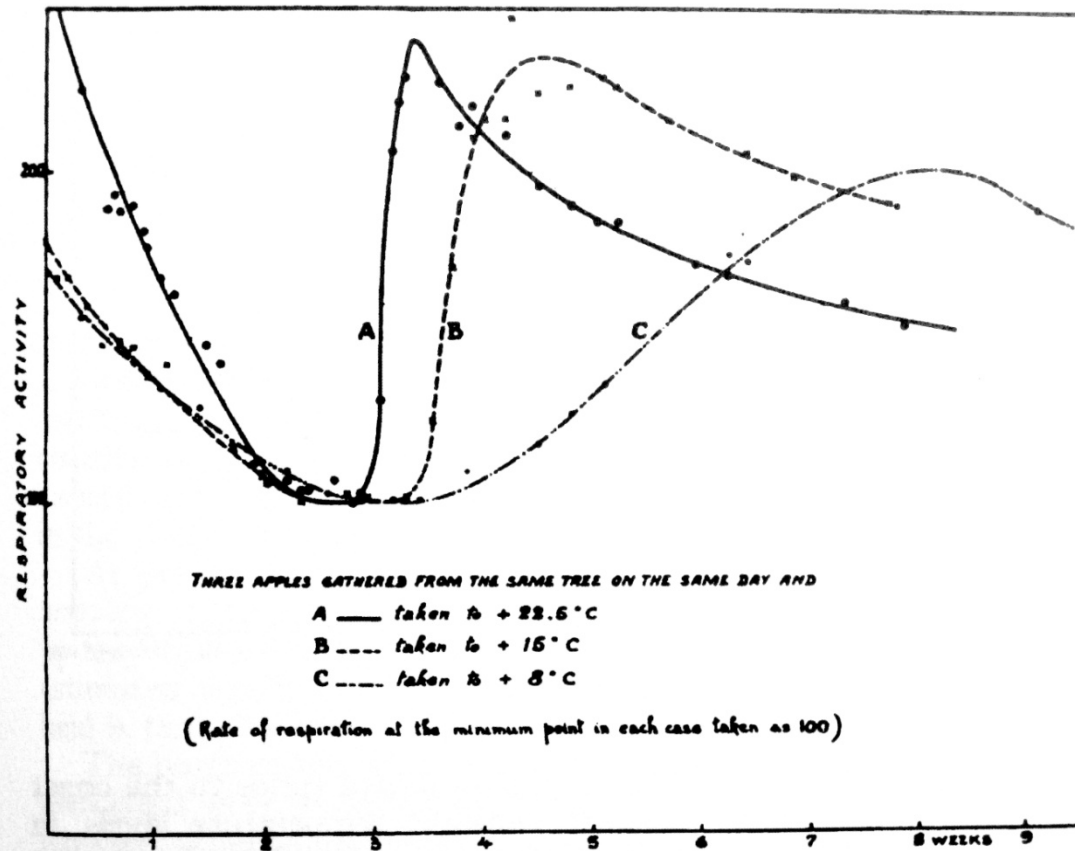
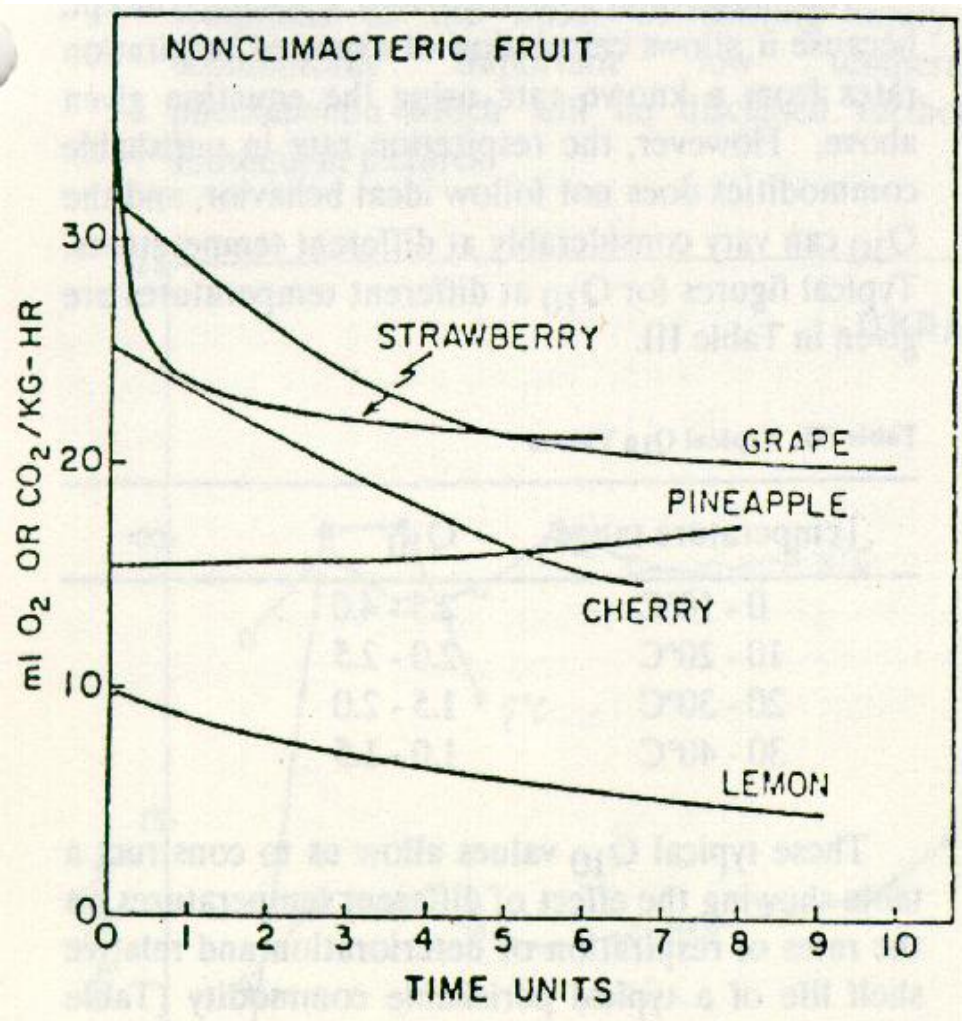
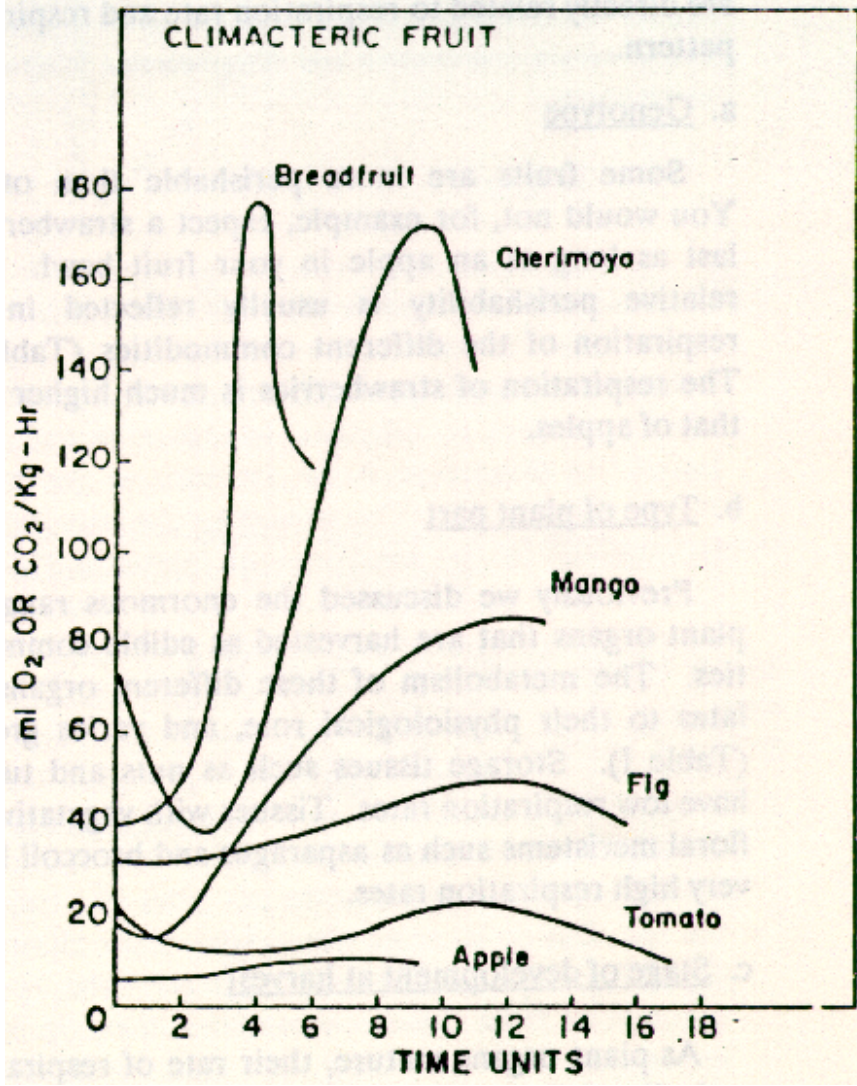


FIG. 15

Kidd and West, 1924



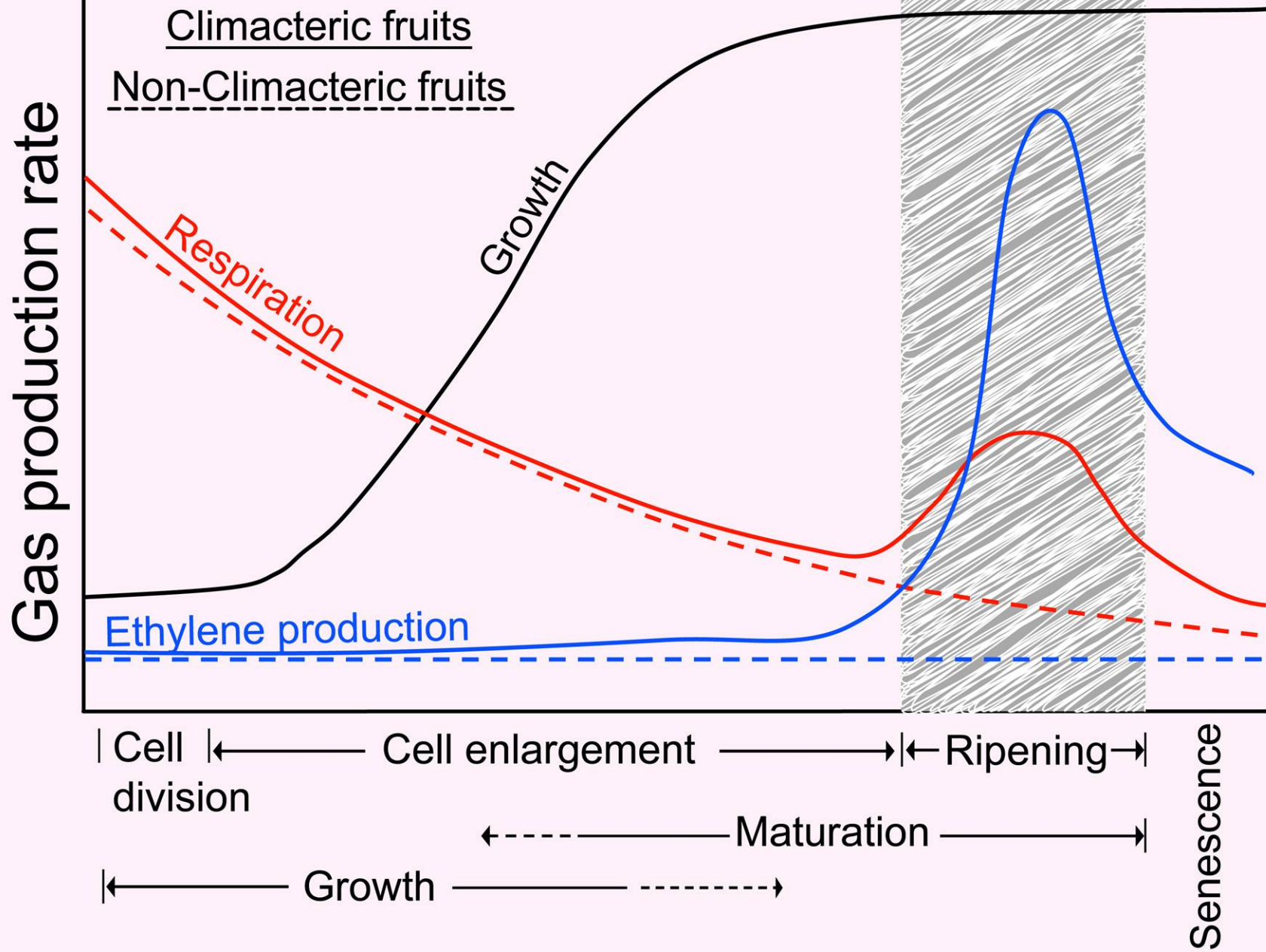
Climacteric

- Apple
- Apricot
- Avocado
- Banana
- Blueberry
- Breadfruit
- Carambola
- Cherimoya
- Feijoa
- Fig
- Guava
- Jackfruit
- Kiwifruit
- Mango
- Muskmelon
- Papaya
- Passion Fruit
- Peach
- Pear
- Persimmon
- Plum
- Quince
- Rambutan
- Sapodilla
- Sapote
- Soursop
- Tomato

Nonclimacteric

- Cacao
- Cherry
- Cucumber
- Grape
- Grapefruit
- Lemon
- Lime
- Longan
- Loquat
- Lychee
- Olive
- Orange
- Pepper
- Pineapple
- Pomegranate
- Strawberry
- Tamarillo
- Watermelon

Note: Most vegetables and flowers are nonclimacteric; broccoli and carnation are climacteric



Climacteric fruits

Non-Climacteric fruits

Gas production rate

Growth

Respiration

Ethylene production

Cell division

Cell enlargement

Ripening

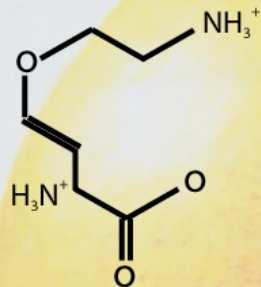
Senescence

Maturation

Growth

ReTain

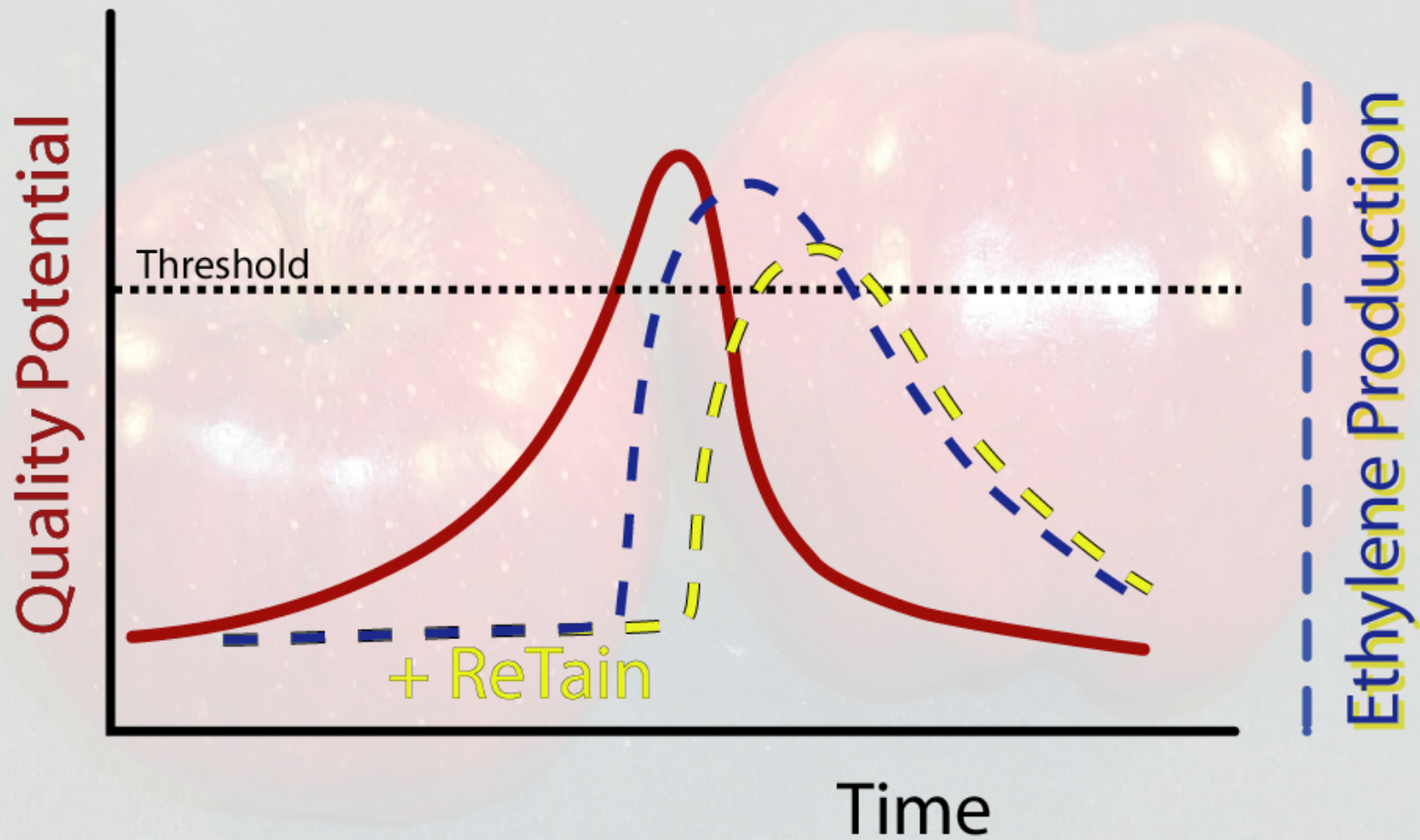
MODE OF ACTION



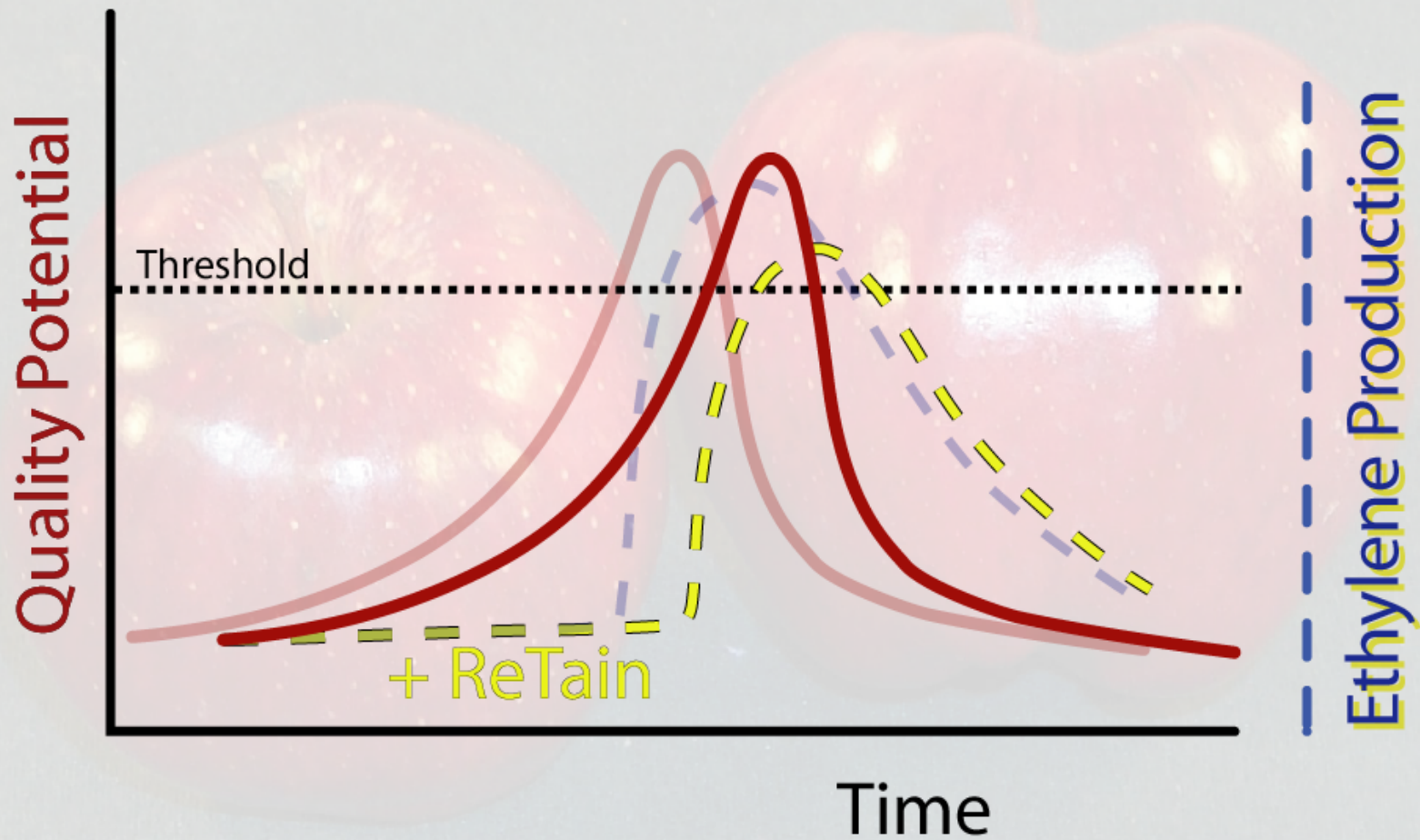
Competitive inhibitor of ethylene biosynthesis
Inhibits endogenous ethylene production
Does not affect sensitivity to exogenous ethylene
Applied approximately 3 to 4 weeks before harvest

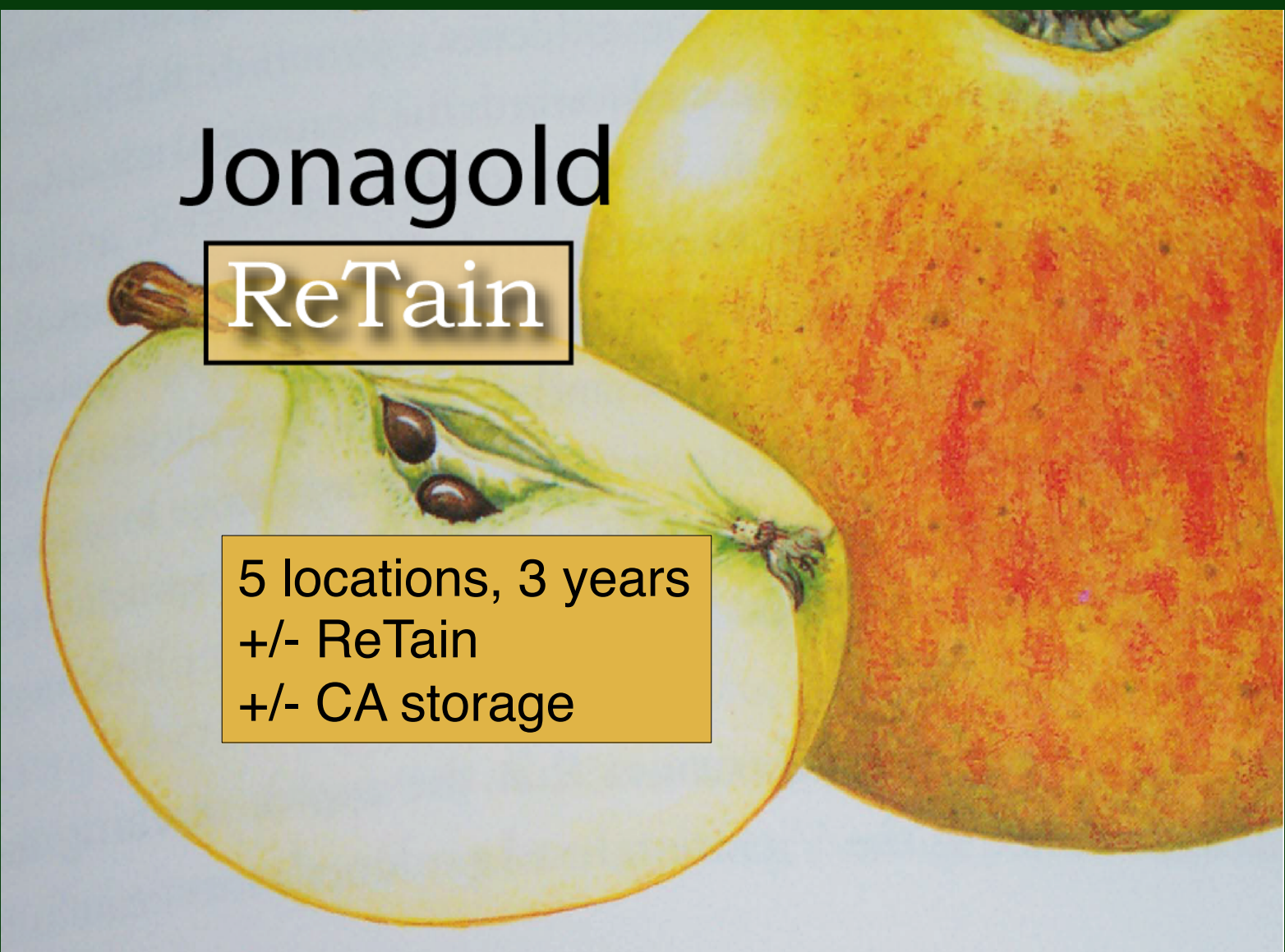


Alter rate of maturation



Alter rate of maturation



An illustration of a Jonagold apple, showing a whole fruit on the right and a sliced half on the left. The whole fruit has a yellow and red mottled skin. The sliced half shows a pale yellow-green flesh and two dark brown seeds. The text 'Jonagold' is written in black above the sliced half, and 'ReTain' is written in white inside a yellow box over the sliced half. A yellow box with black text is also positioned below the sliced half.

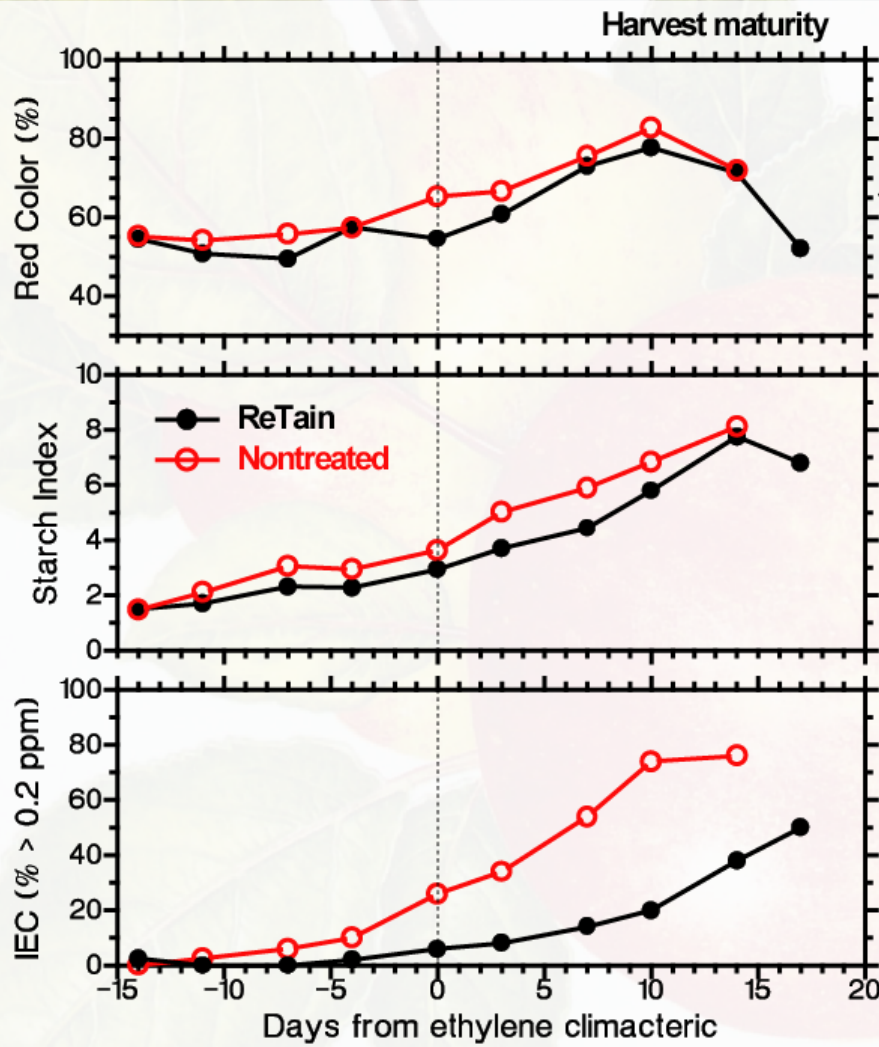
Jonagold

ReTain

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

Jonagold

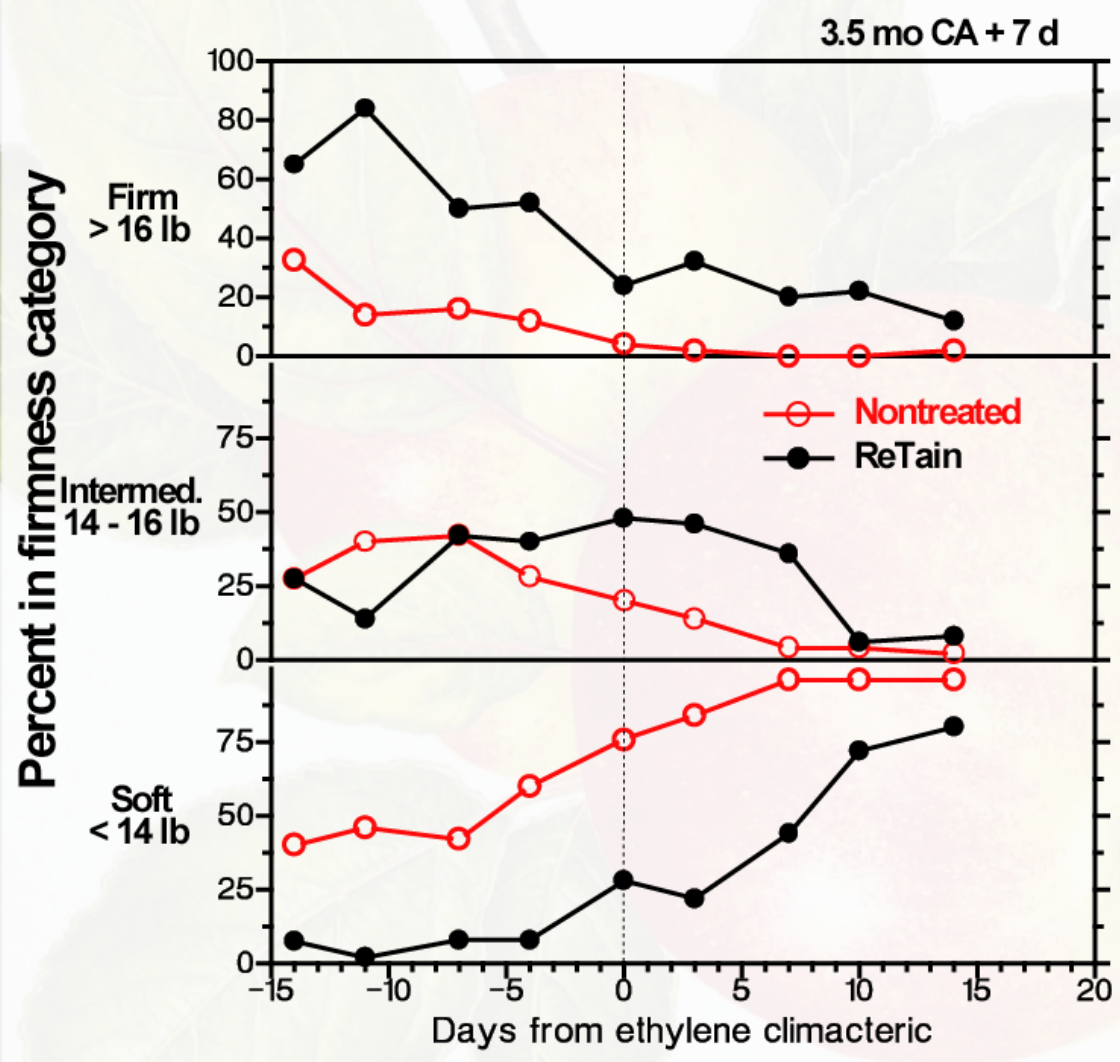
Averaged over 5 locations in 1996 -



Little effect on color

Minor inhibition of starch conversion

Marked effect on ethylene production



Jonagold

Averaged over 5 locations in 1996

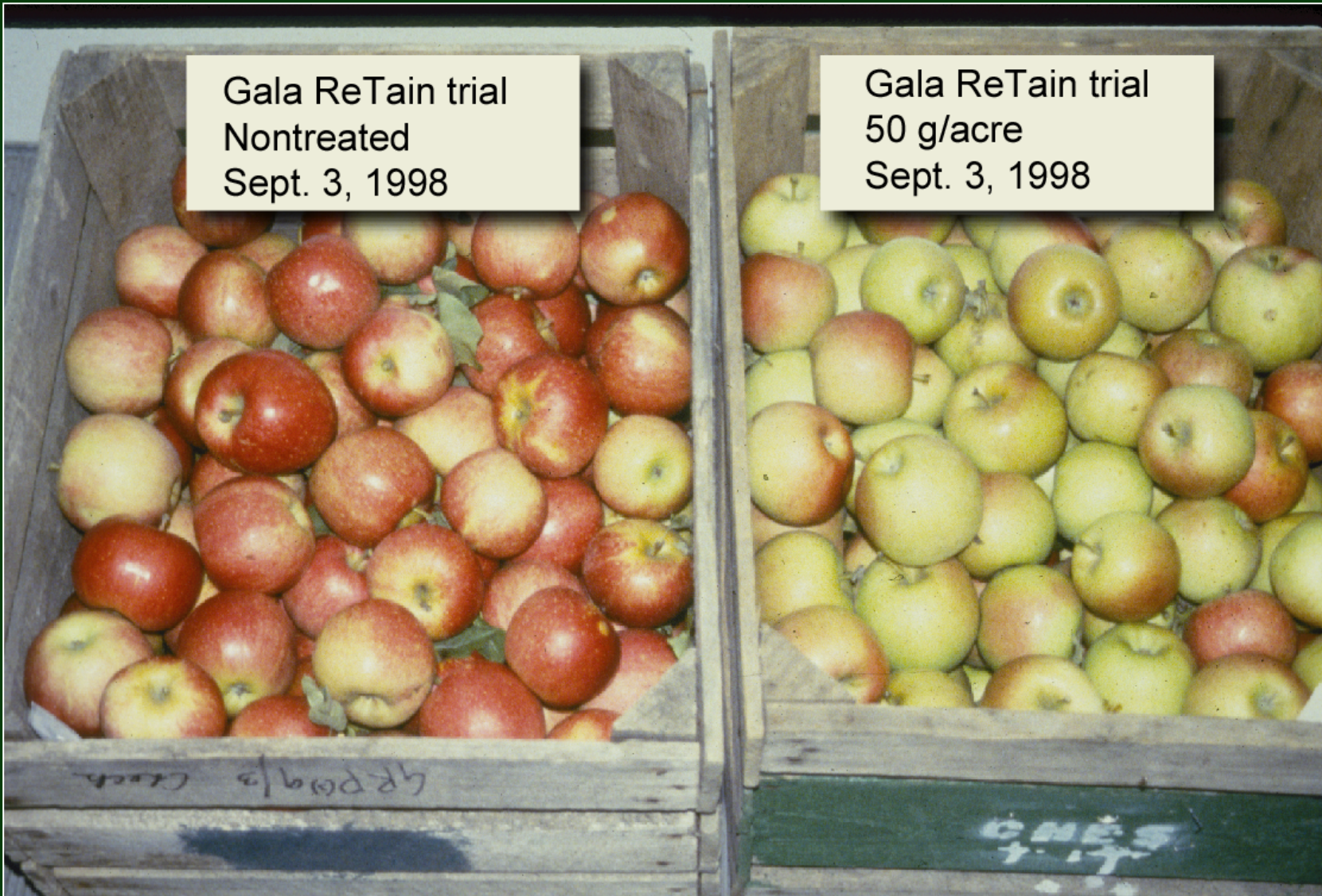
More firm fruit for later harvests

Delay in increase in moderately firm fruit to later harvests

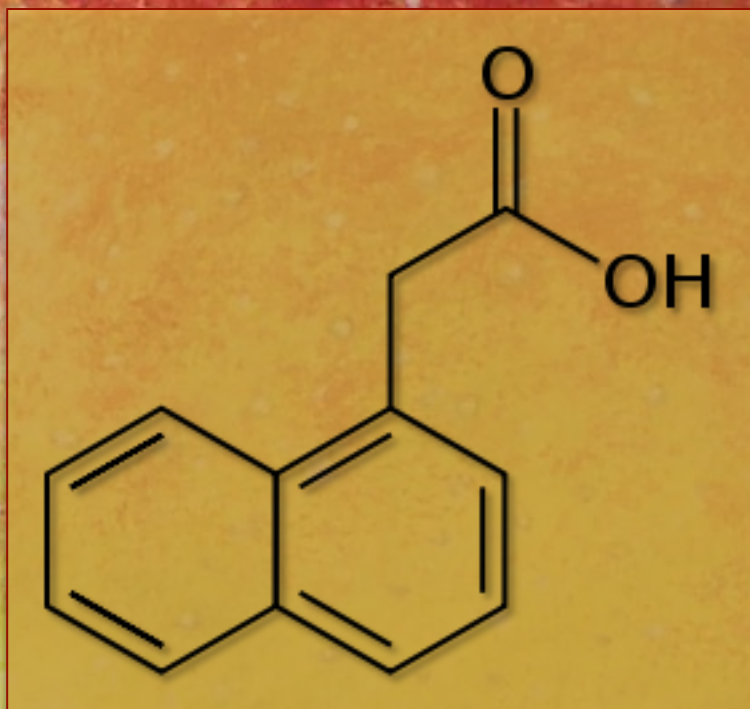
No difference in soft fruit

Gala ReTain trial
Nontreated
Sept. 3, 1998

Gala ReTain trial
50 g/acre
Sept. 3, 1998



NAA in Combination
With ReTain – and other materials



ReTain + NAA on McIntosh

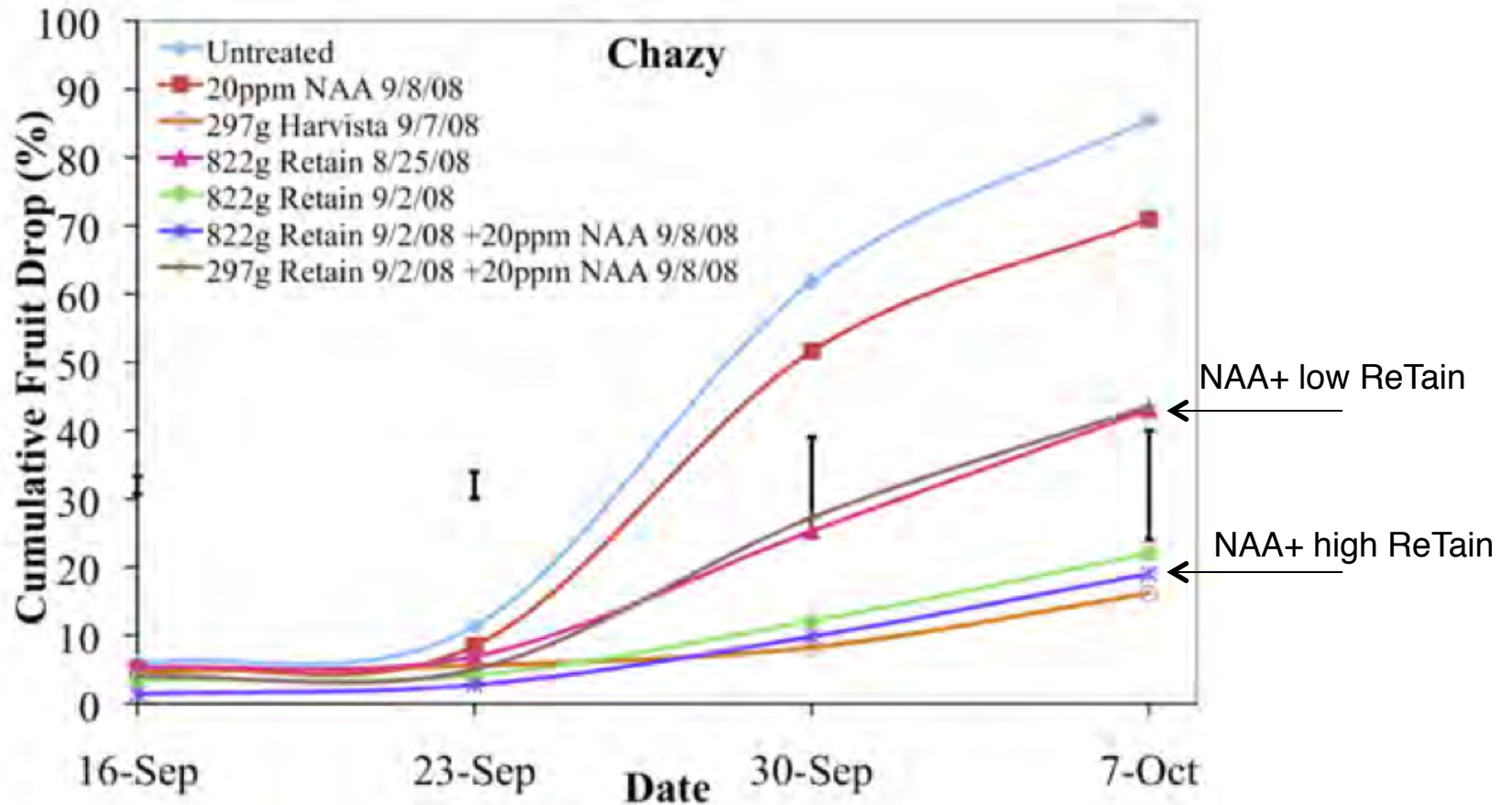
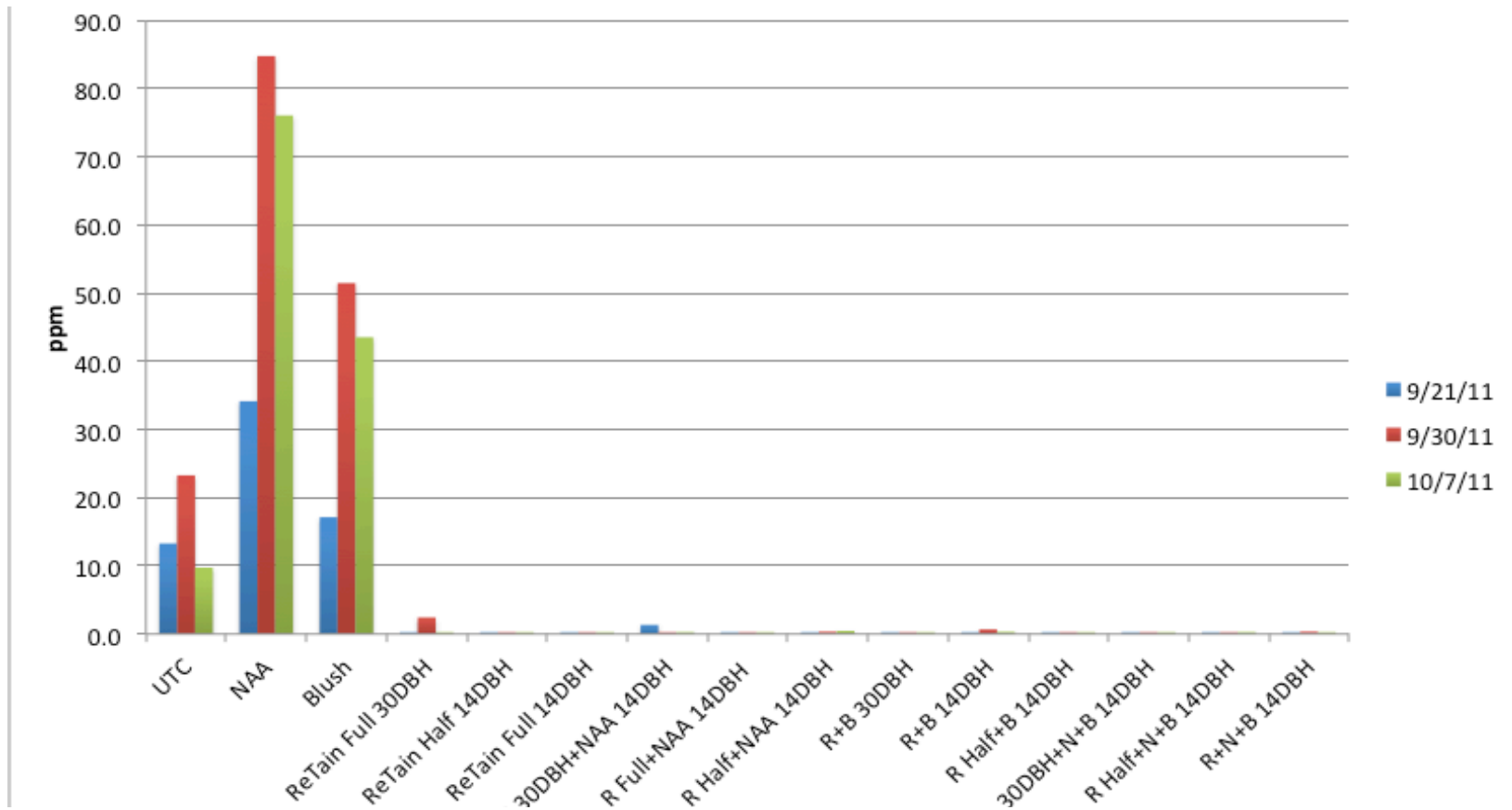


Figure 5. Effect of AVG (Retain) sprayed alone or in combination with NAA (Fruitone N) at various timings before harvest on pre-harvest fruit drop of mature McIntosh/M.26 trees at Chazy, New York in 2008. (Vertical bars are LSD's, $P \leq 0.05$, $n=5$).

ReTain, NAA on Internal Ethylene - Honeycrisp



Thanks !

