# Maturation and Maturity Indices

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**Postharvest Technology Short Course, June 2009**
**Chapter 6 Posthavest Technology Book**

## Quality:

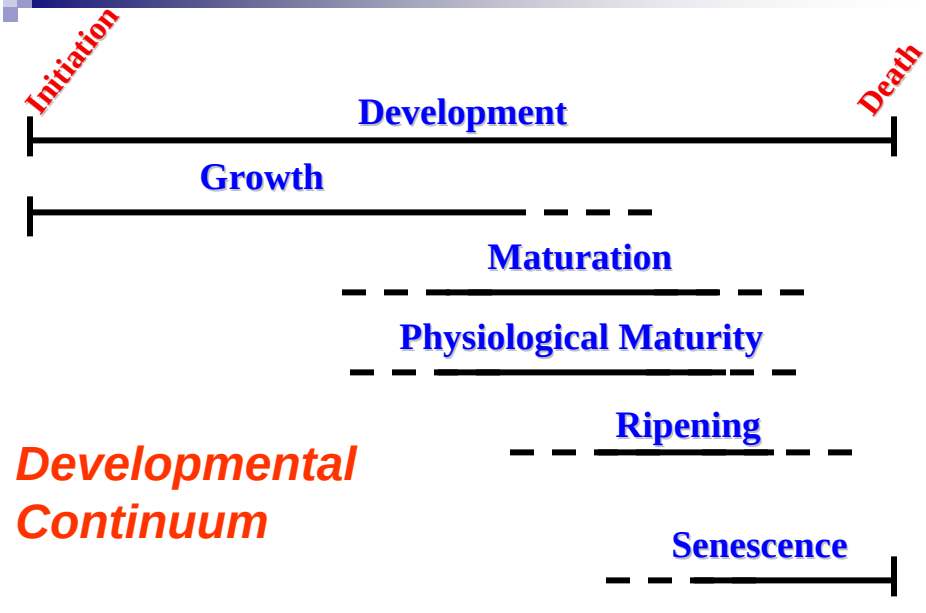
Attributes or characteristics that give a product value as a food

| Grower | Handler | Consumer |
|---|---|---|
| Good appearance | Good appearance | Good appearance |
| High yield | Shelf-life | Firmness |
| Resistant to diseases | Firmness | Flavor |
| Easy to harvest | | Nutritional value |
| Resists damage | | |

Harvesting at the correct maturity is key to satisfying quality expectations
**Maturity Indices = Harvest Indices**

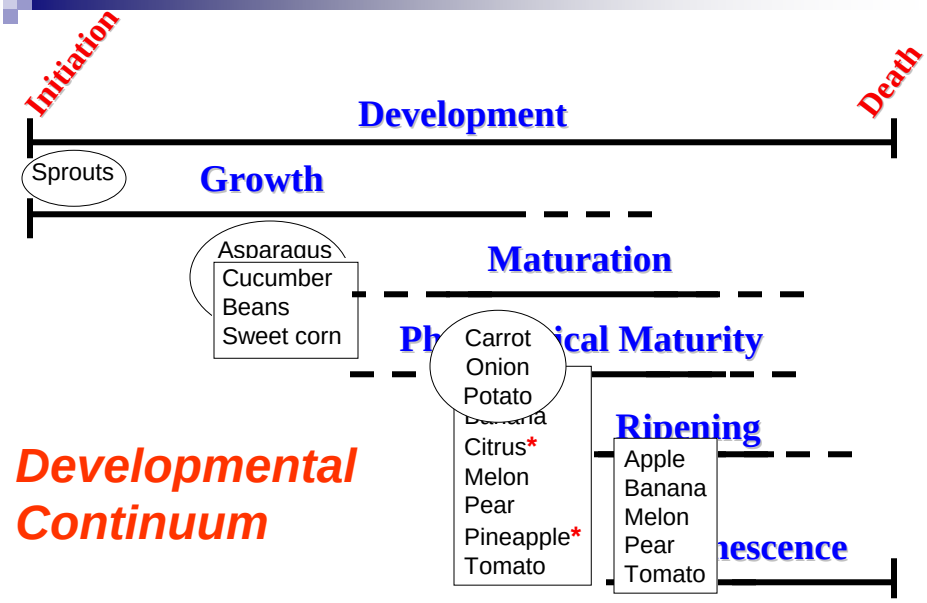
# Importance of Maturity Indices

**Sensory and Nutritional Quality**
**Use—Fresh market or Processed**
**Adequate shelf-life**
**Facilitate marketing—standards**
**Productivity**




***Developmental Continuum***

**Watada et al., 1984**




Watada et al., 1984

## Terminology

### PHYSIOLOGICAL MATURITY

**The stage of development when a plant part will continue development even if detached; mature fruits**

### HORTICULTURAL MATURITY

**The stage of development when a plant part possesses the necessary characteristics for use by consumers**

## Physiological Maturity

**FRUITS**

- Immature
- Mature
- Ripening
- Ripe
- Overripe

## Horticultural Maturity

**VEGETABLES**

- Immature
- Mature
- Overmature

Maturity Indices
Bulb Onions

# Composition of Potato Tubers

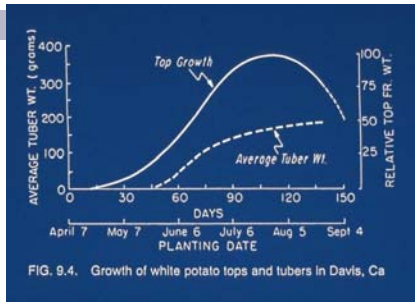


FIG. 9.4. Growth of white potato tops and tubers in Davis, Ca

| | Weight g | dry wt, % | Starch % | Sugar % |
|---|---|---|---|---|
| Flowering | 9 | 16 | 64 | 4.8 |
| Flowering ends | 11 | 17 | 66 | 5.2 |
| Leaves decline | 28 | 19 | 72 | 2.9 |
| 80% leaves dead | 33 | 21 | 73 | 0.8 |
| 100% leaves dead | 51 | 20 | 72 | 0.7 |

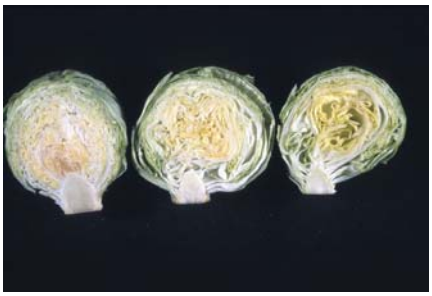
cv. Irish Cobbler; data from Burton, 1966

## Maturity Indices

- **Onions/Garlic**
  - Size
  - Drying and collapse of the “neck”
  - Drying of leaf scales
- **Potatoes**
  - Death of the plant
  - Size of tubers
  - Starch content; specific gravity
  - Periderm development

## Maturity Indices

- **Asparagus**
  - Size
  - Apex closed
- **Broccoli/Cauliflower**
  - Size
  - Florets closed
- **Carrot**
  - Size
- **Lettuce, head**
  - Size
  - Firmness, solidity
  - Flavor-sweetness, bitterness
- **Lettuce, Romaine**
  - Size
  - Number of leaves

**Checking Iceberg Lettuce Maturity**

June 2007

## Maturity Indices

- **Beans**
  - Size
  - Seed development
- **Summer Squash**
  **Cucumber**
  - Size
  - External color

**Immature fruit vegetables: very rapidly developing and changing**

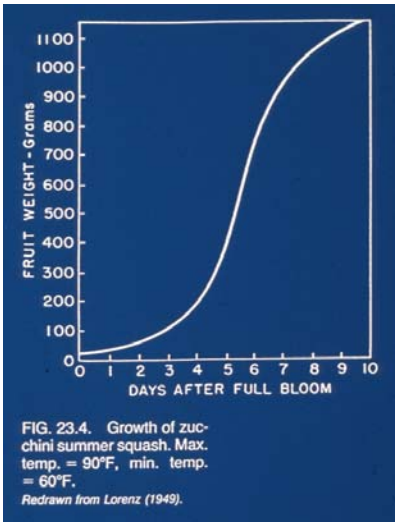



FIG. 23.4. Growth of zucchini summer squash. Max. temp. = 90°F, min. temp. = 60°F.
*Redrawn from Lorenz (1949).*


**Harvest Maturity**

# Maturity Indices

- **Peppers**
  - Size
  - Color
  - Firmness
  - Seed development
- **Tomato**
  - External and Internal color
  - Development of locules (jelly)
  - Firmness
  - Size
  - Development of cuticle

## Maturity & Ripening Stages

European Color Chart Tomatoes

1  **GREEN** The tomato surface is completely g shade of green may vary from light to dark.

2  **BREAKERS** There is a definite break of col bruised fruit tannish-yellow, pink or red or 1 tomato surface.

3  **TURNING** Tannish-yellow, pink or red color shows on over 10% but not more than 30% of the tomato surface.

4  **PINK** Pink or red color shows on over 30% but not more than 90% of the tomato surface.

5  **LIGHT RED** Pinkish-red or red color shows on over 60% but red color covers not more than 90% of the tomato surface

6  **RED** Red means that more than 90% of the tomato surface, in aggregate, is red

http://www.tomato.org/
http://www.floridatomatoes.org/

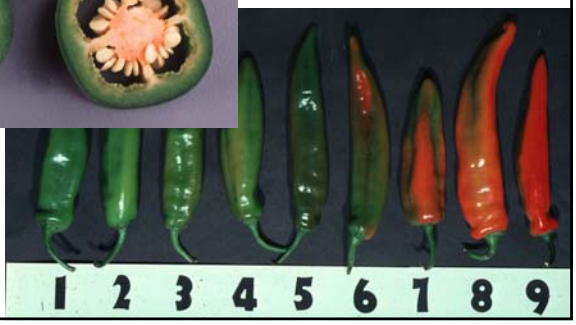
Mature-green and Breaker Stages

Checkerboarding

## Ripe Grape Tomato

| Initial Maturity Stage | Weight per fruit, g | Soluble solids, % | Titratable acidity, % | Red color, hue | Firmness, N force |
|---|---|---|---|---|---|
| 3 | 4.9 | 5.9 | 0.59 | 35.8 | 11.5 |
| 4 | 5.7 | 6.7 | 0.68 | 36.3 | 13.6 |
| 5 | 5.9 | 7.5 | 0.67 | 37.7 | 13.7 |
| | ** | ** | ** | ns | ** |

Average 7 cvs, Cantwell, Test#2 2003




**Harvest/maturity Indices**
**Peppers & chiles**

## Maturity Indices

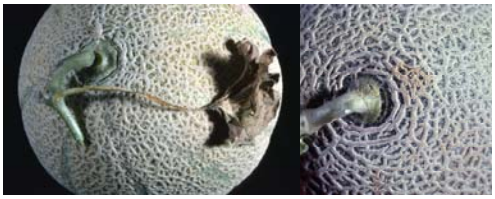
- **Nonclimacteric fruits**
  **(or fruits with no starch reserves)**
  - Pineapple
  - Strawberry
  - Citrus
  - Cherry
  - Cactus pear
  - Melons

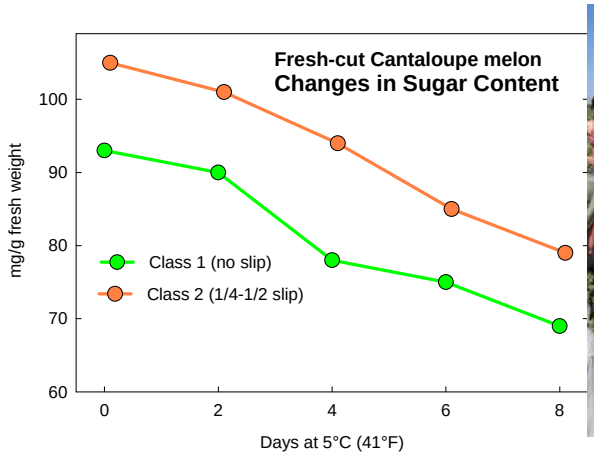
- **Climacteric fruits**
  **(or fruits with starch reserves)**
  - Apples
  - Pears
  - Mango
  - Banana

# Cantaloupe Maturity/Ripeness

- Fruit begins to separate from stem
  - Abscission zone; “slip”
  - External color between net
  - Net well developed with wax
  - Subtending leaf dries up
  - Internal color, firmness, soluble solids

**The “slip” is a very useful attribute & applicable to old & new cantaloupe varieties**






López and Cantwell, 1995

**Honeydew and other melons are more difficult to harvest at the proper stage of ripeness**

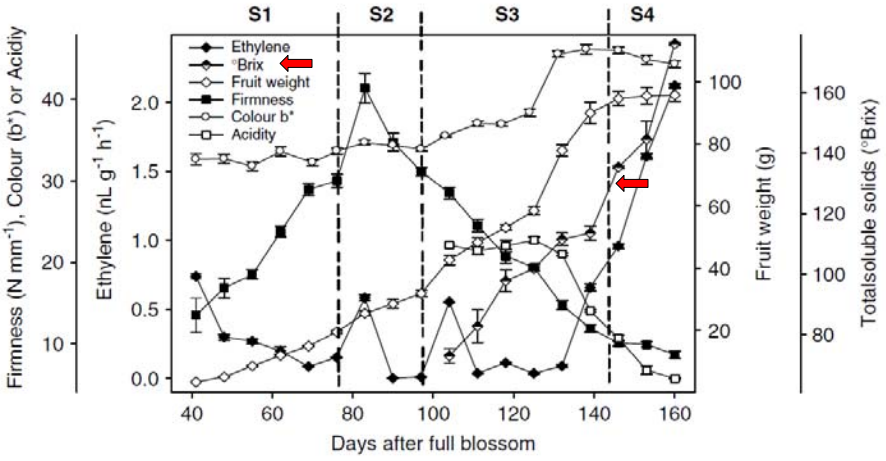
## Composition of Ripe Strawberry

**Harvested at different stages.**
**Held at 70°F (21°C) to complete color change.**

| Maturity | % SS | % Acid | Ratio |
|---|---|---|---|
| 25% color | 4.28 | 0.80 | 5.35 |
| 50% color | 4.56 | 0.79 | 5.77 |
| 75% color | 4.98 | 0.68 | 7.32 |
| 100% color | 5.48 | 0.59 | 9.28 |

## Pineapple Stored at 7°C (44°F)


| Maturity | % Soluble solids | | | |
|---|---|---|---|---|
| days | 0 | 7 | 14 | 21 |
| Shipping green | 6.9 | 8.4 | 8.5 | 8.5 |
| ¼ color | 13.6 | 13.6 | 13.7 | 12.2 |
| ½ color | 13.6 | 14.0 | 13.8 | 12.7 |
| Full color | 15.4 | 15.0 | 14.2 | 12.6 |




Evolution of some physical, chemical and physiological parameters during fruit development and ripening on the tree of 'Golden Globe' Plum.

Diaz-Mula et al., 2008. J. Sci. Food Agric 88:2499-2507

Relationship between sugar/acid ratio and sensory panelist's Response to the question about **Willingness to Buy** navel oranges

| | | Number of responses | |
|---|---|---|---|
| Sampling week | % samples below sugar/acid Ratio of 8* | YES | NO |
| Nov 14-18 | 39 | 42 | 58 |
| Nov 28-Dec 2 | 27 | 53 | 47 |
| Dec 12-16 | 13 | 63 | 37 |

***from California A grade standard**

Source: Ivans and Feree, 1987

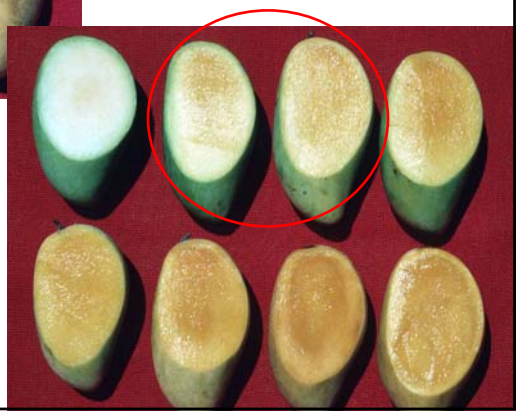
California orange on plane returning from Indonesia PH workshop Nov 19, 2007

Mangosteen and eating Quality—maturity issues

| Color Index | Color of Fruit |
|---|---|
| 1 | Pale yellow green |
| 2 | Blotchy pink |
| 3 | Pinkish red |
| 4 | Maroon Red |
| 5 | Dark maroon violet |
| 6 | Violet black |

## Maturity Indices

- **Nonclimacteric fruits or fruits with no starch reserves**
  - Pineapple
  - Strawberry
  - Cherry
  - Cactus pear
  - Melons
- **Climacteric fruits or fruits with starch reserves**
  - Apples
  - Pears
  - Mango
  - Banana



**Mango maturity indices**

Fullness of shoulders

Internal and external color

Lenticels and hairs on pit

Starch content; specific gravity

# Indicators of Harvest Maturity

## APPLES

- Days from full bloom
- Time/temp (heat units) from anthesis
- Days from harvest to onset of ethylene production
- Ground color
- Soluble solids content (SSC)
- Flesh firmness and SSC
- Starch disappearance pattern
- Internal ethylene concentration
- Changes in firmness or starch content

**Streif Index considers starch, sugar, firmness**

Golden Delicious at Retail Market: How is the maturity in this box?

## It is necessary to use several maturity Indices

## Maturity Indices
## Requirements for establishing

- Simple, easy to carry out
- Objective vs subjective indicators
- Related to quality
- Related to storage life
- Represents a progressive change with maturity
- Permits prediction of maturity from year to year
- Inexpensive

## Use of Maturity Indices Limitations

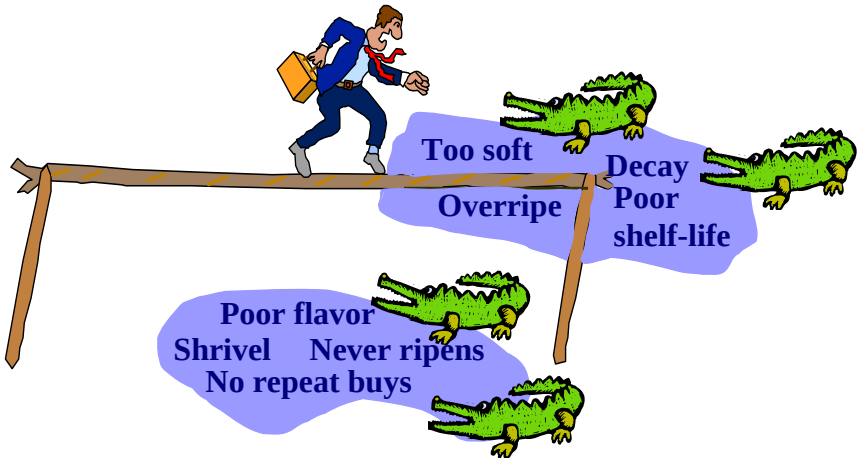
- Soil conditions, nutrition, irrigation
- Season, climate
- Position on the plant
- Pruning, other cultural practices
- Varieties

## Predicting Maturity

- **Days from planting to harvest**
- **Progressive changes in size, composition**
- **Difficult to do; need new tools and methods**
  - **Nondestructive firmness measurement,** fruits
  - **Chlorophyll fluorescence,** broccoli; green tissues
  - **NIR spectroscopy,** sugar concentration in melon
  - **MR imaging** constituents, internal defects

## Harvest Maturity for Fruits: A balancing Act

Too often we err on the side of shelf-life at the expense of good eating quality




## Maturity and Fruit Quality

- Know the consequences of harvesting at different stages of maturity/ripeness on final eating quality.
- Make sure workers involved in harvest, selection are well trained to ID correct maturity/ripeness.