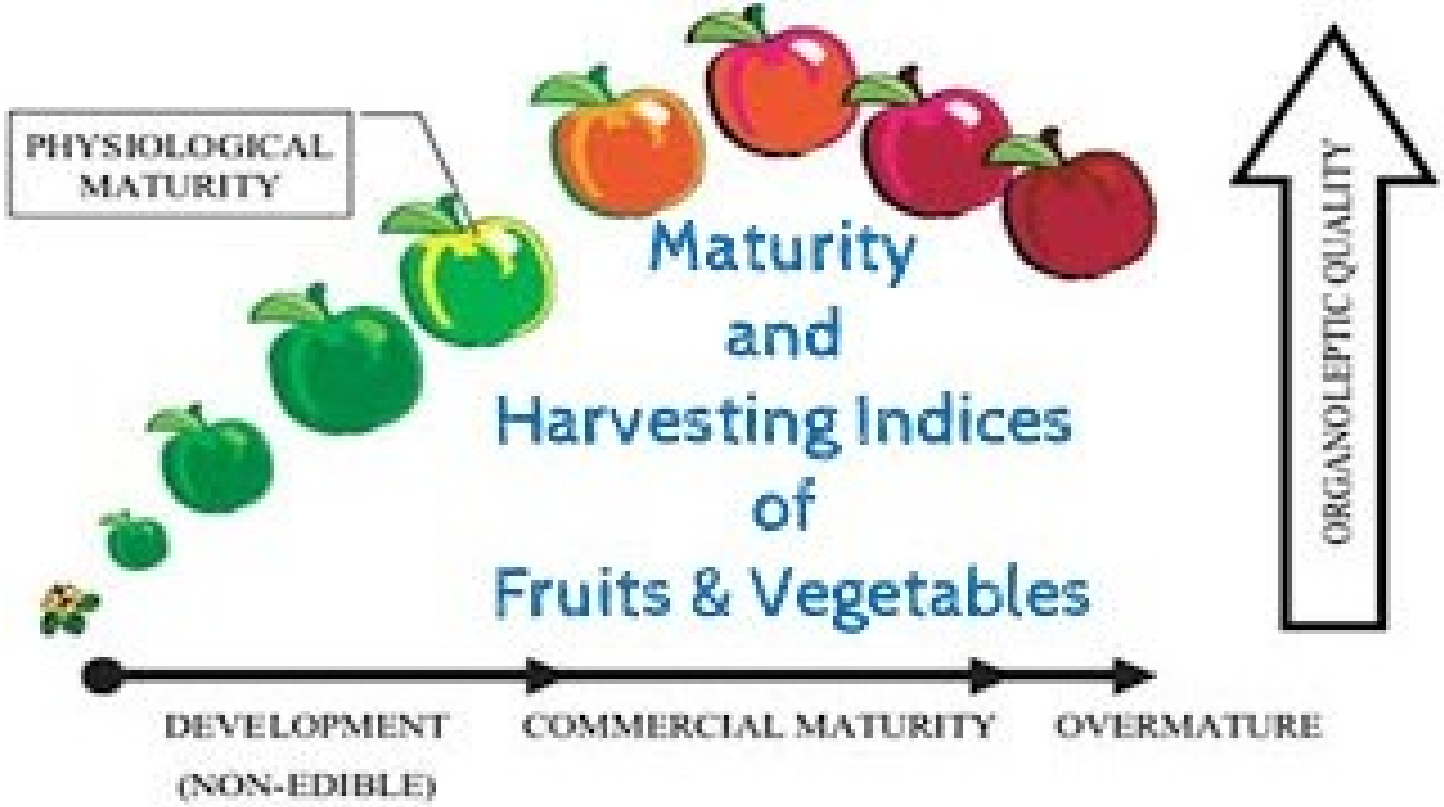
Maturity Indices in fruits and vegetables



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Maturity

- It is the stage of full development of tissues in fruits and vegetables after which ripening starts
- During the process of maturation the fruit receives a regular supply of nutrients from the plant
- When mature the abscission/ corky layer at the base of the stem stops this inflow.
- The fruit after wards depends on its own reserves

Maturity

- The stage of maturity at which the fruit is plucked influences the storage life and quality of fruits
- If harvested early: may lack flavor, and do not ripen properly
- If plucked late: may be fibrous or have very short shelf life

Maturity

Categories:

- Physiological maturity

- Horticultural maturity

Horticultural or Commercial maturity

- Stage of development when plant parts possess necessary characters preferred by consumers
- Depends upon intended use e.g. papaya, jackfruit

Physiological maturity

- End of development stage
- Ability to ripen normally after harvest

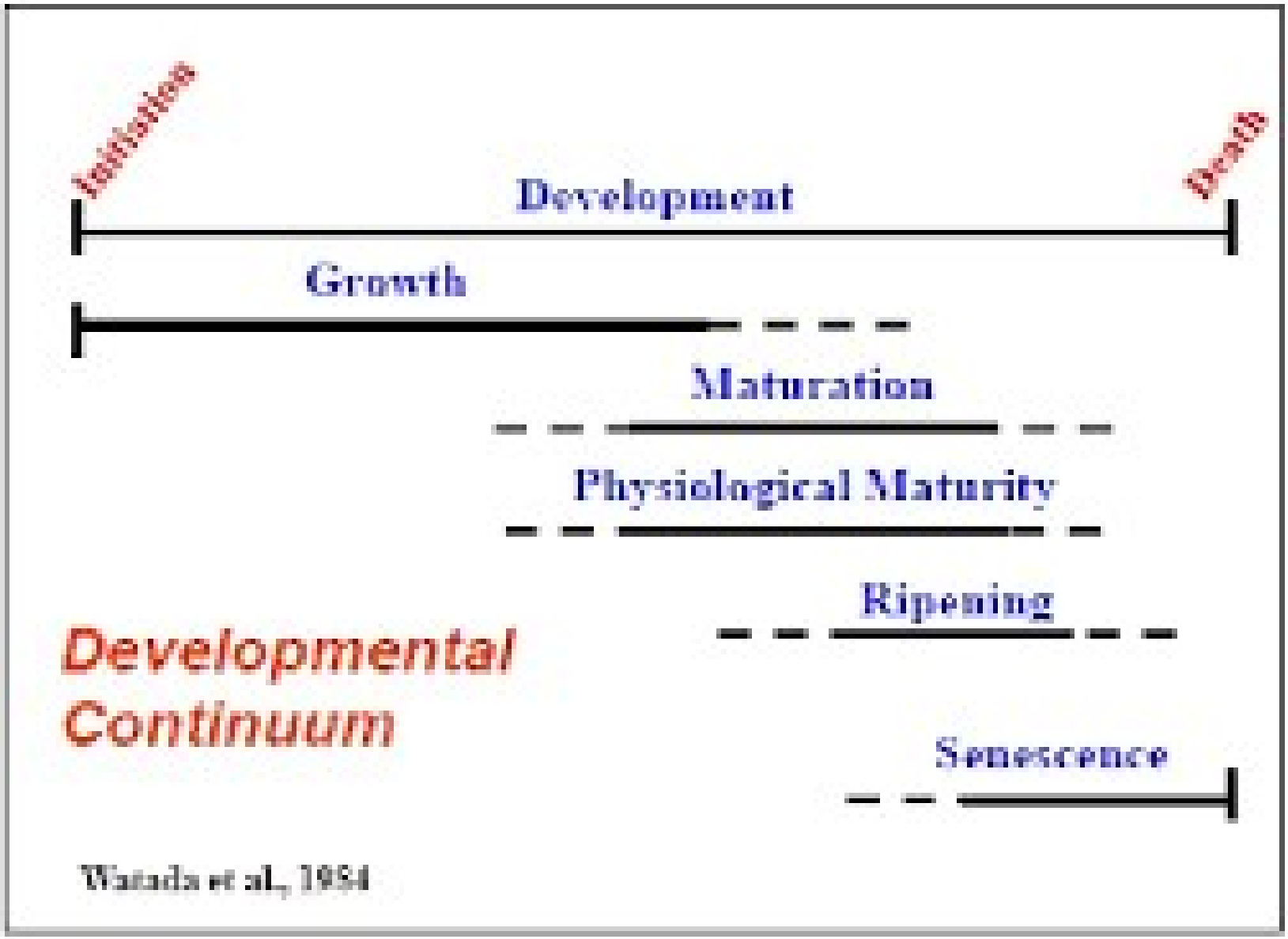
Maturity and shelf life

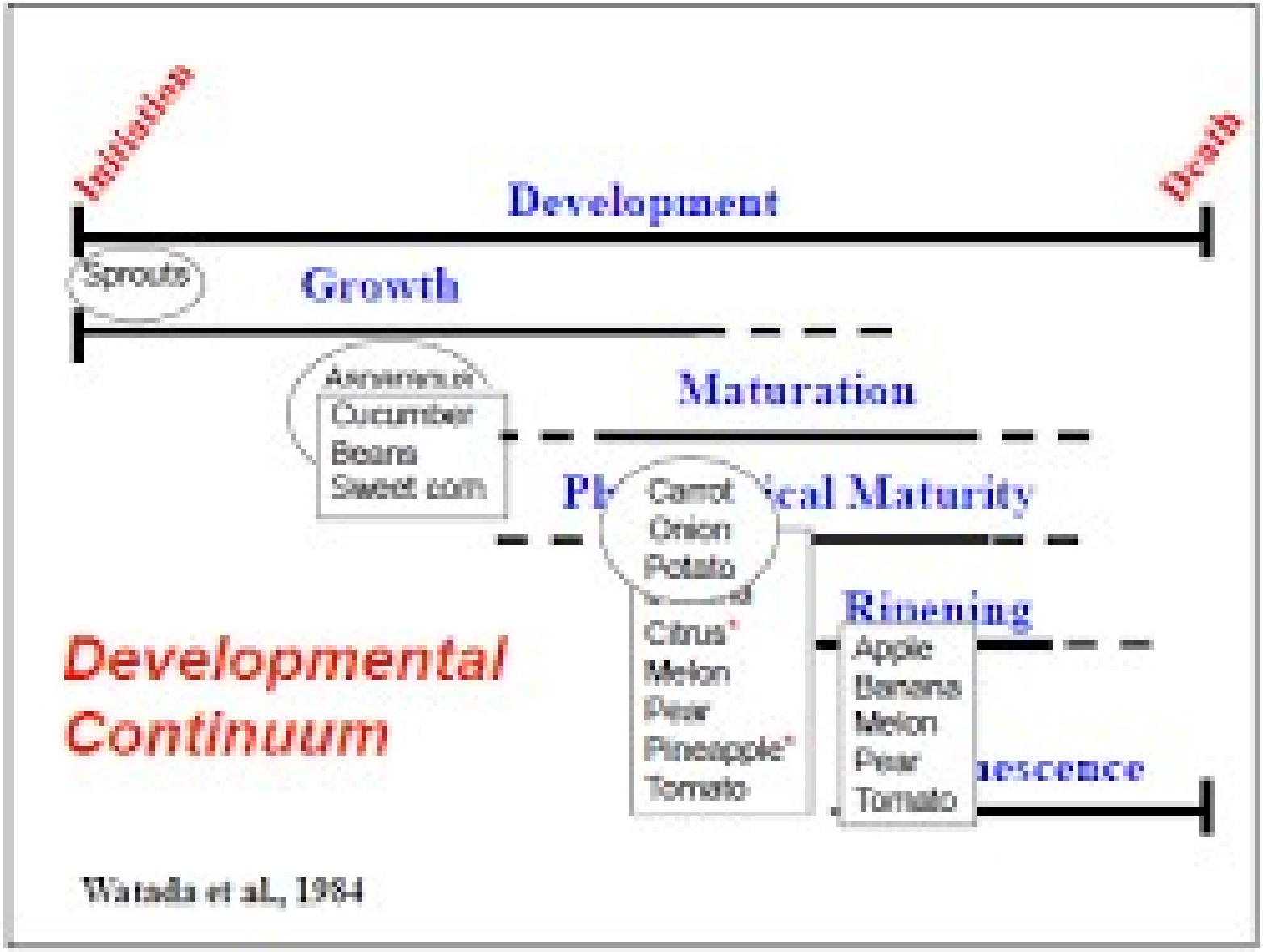
- Quality is maximized when harvested at more mature and ripe stage but shelf life increases when harvested at unripe stage

Lower maturity	Higher maturity
Never ripens	More decay
Shrivels	Better flavor
Poor flavor	Too soft
No repeat buys	Bruises easily
Long shelf life	Short shelf life

Maturity indices

- Maturity indices= harvest indices
- Sensory and nutritional quality
- Adequate shelf life
- Facilitate marketing standards
- Productivity


Initiation
Death
Development
Growth
Maturation
Physiological Maturity
Ripening
Senescence
Developmental Continuum
Watada et al., 1984



Watada et al., 1984

Types of maturity indices

- **Visual indices**
  a) Shape
  b) Color

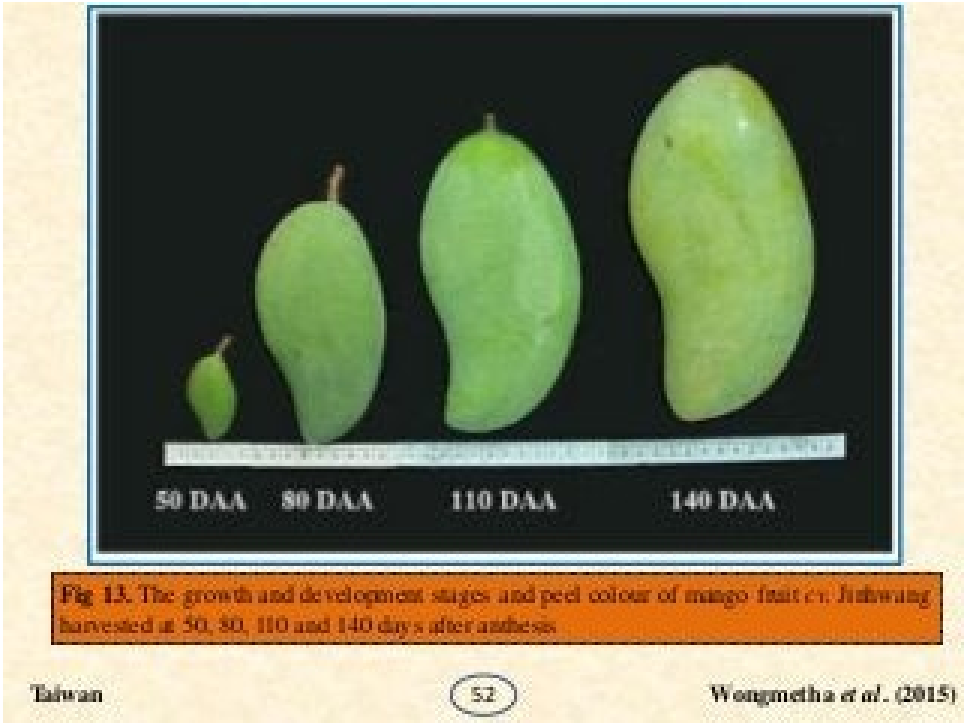
- **Physical indices**
  a) Firmness
  b) Accoustic sound test
  c) Specific gravity

Chemical indices
a) Total soluble solids
b) Titrable acidity

Calculated indices
a) Calender dates
b) Days after full bloom
c) Heat Units

Physiological Method
a) Respiration rate
b) Ethylene peak
c) Volatile production

Size and shape

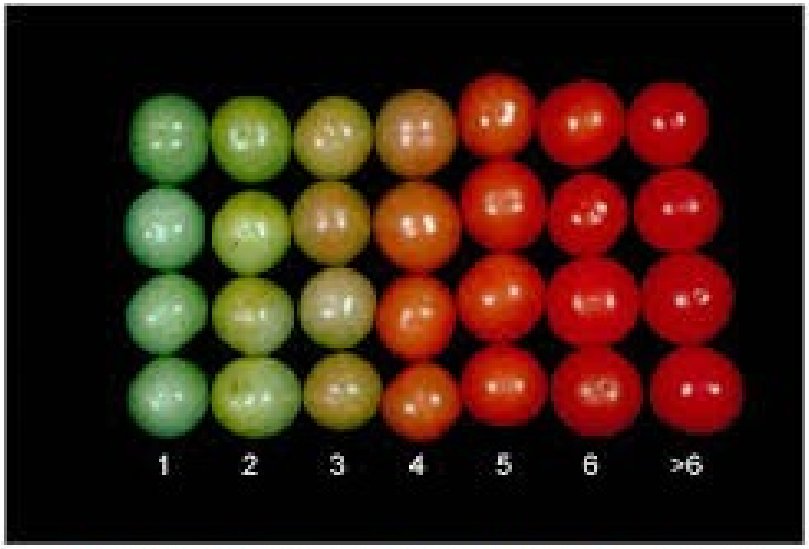


Fruit shape may be used to ascertain maturity:

Mango:
Fullness of cheeks adjacent to pedicel maybe used for ascertaining maturity

Banana:
Angular shape becomes more round

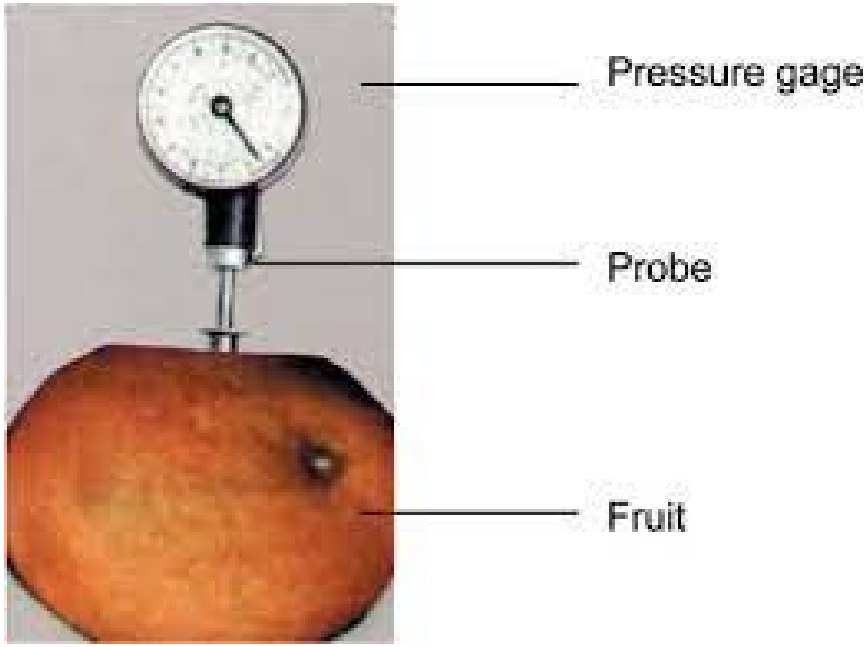
Colour



Maturity and Ripeness Stages of Cherry Tomatoes

Use of colorimeter

Firmness



Middle lamella dissolves as fruits mature; become soft

Fruits: apple pear, plum, guava, pear, kinnow etc.

Penetrometer helps measure the pressure required to force a plunger of a specified size inside the fruits tissue.
Such pressure is measured as pounds or kilograms force.

Accoustic/ Sound tests

When a fruit is tapped with finger knuckles at immature and ripened stages, it produces sounds of different quality

Ripe fruits give dull sound

E.g. Watermelon, Jackfruit

Specific Gravity

Ratio of the substance to the ratio of reference substance

As fruits mature their specific gravity increases

Useful for grading fruits according to maturity

If placed in tank full of water:
Fruits that sink: more mature
Fruits that float: less mature

$$\text{Specific gravity of fruits and vegetables} = \frac{\text{Weight of fruits and vegetables in air}}{\text{Weight of fruits and vegetables in water}}$$

Total Soluble Solids

Starch is broken down into sugars during ripening

Measurement of sugar content gives an idea of maturity

Measured by Brix refractometer

Measures the refractive index of fruit juice

Has a range: 0-32°B
28-62°B
56-90°B

Titrable Acidity

b) **Titratable acidity:**

- Titratable acidity (TA) can be determined by titrating a know volume of juice with 0.1N NaOH to end point
- The milliliters of NaOH needed are used to calculate the TA.
- The TA expressed as percent malic, citric or tartaric acid can be calculated as follows:

$$TA = \frac{\text{ml NaOH x N (NaOH) x acid meq. Factor* x 100}}{\text{Juice titrated}}$$

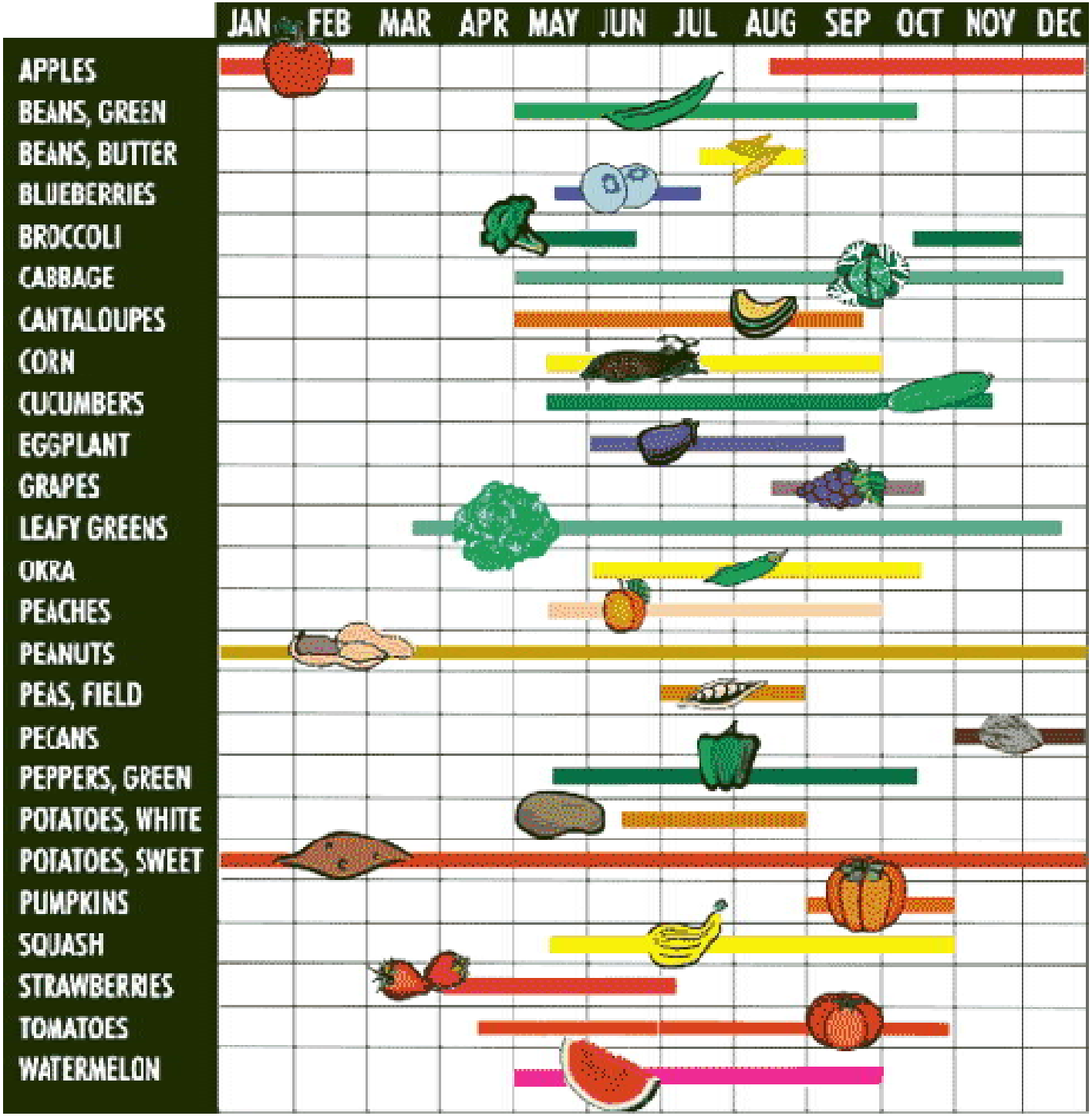
Acid	Acid meq. factor	Commodities
Citric	0.0064	Berries, citrus fruits, pineapple
Malic	0.0067	Apple, pear, peach, tomato
Tartaric	0.0075	Grape

iv) Calculated indices:

a) Calendar Date/Days after full bloom :

- Useful guide to harvest, where seasonal variation in climate is small

- This method works well when the blooming period is short period


JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
APPLES
BEANS, GREEN
BEANS, BUTTER
BLUEBERRIES
BROCCOLI
CABBAGE
CANTALOUPES
CORN
CUCUMBERS
EGGPLANT
GRAPES
LEAFY GREENS
OKRA
PEACHES
PEANUTS
PEAS, FIELD
PECANS
PEPPERS, GREEN
POTATOES, WHITE
POTATOES, SWEET
PUMPKINS
SQUASH
STRAWBERRIES
TOMATOES
WATERMELON

Days after full bloom

It is reliable but varies from year to year and location to location

In such cases, the optimum date of harvest can be predicted by doing night temperature correction for 15 days following full bloom. For every 10 F variation from an average night temperature, a correction of 1 day is made in the standard figure from full bloom.

Mango: 110-125 days (Var. alphanso and Pairi)
Banana: 99-107 days (Dwarf Cavendish)

Heat Units

All plants have a tolerable growth temperature range
Higher is the temperature in this range, faster is ripening or earlier harvest
Principle: If everything remains same, the time a fruit takes to fully develop is dependent on the surroung temperature

Expressed in degree-hours or degree-days

Degree-hour: is the accumulated heat unit equivalent to the exposure of the crop to one degree above the reference temperature for one hour.

Degree-day: : is the accumulated heat unit equivalent to the exposure of the crop to one degree above the reference temperature for one day.

TABLE 6.1. Accumulated Heat Units for Harvest Maturity.

Commodity	Base Temp. (°F)	Mean Heat Units (deg-day)	From	To
Peas	40	1200–1700	Planting	Opt. maturity
Corn	50	2000–2200	Planting	Opt. maturity
Asparagus	40	440–620	Planting	1st cut
Snap bean	50	1150	Planting	10% seed
Tomato	55	1350	Blossom	Ripe
Lettuce	40	1400–1700	Planting	Harvest
Apples	40	4400–5000	Blossom	Harvest ripe
Cherry	55	950	Blossom	Ripe

General formula:

Mean heat units= (Actual temperature-Reference temperature) x time

Example

Base temperature=40°F
Day temperature-60° F
Each hour constitutes= 60-40= 20 degree hours

Average temperature in a day=55°F
Equivalent = 15 degree days

1200 degree days required for peas from planting to maturity

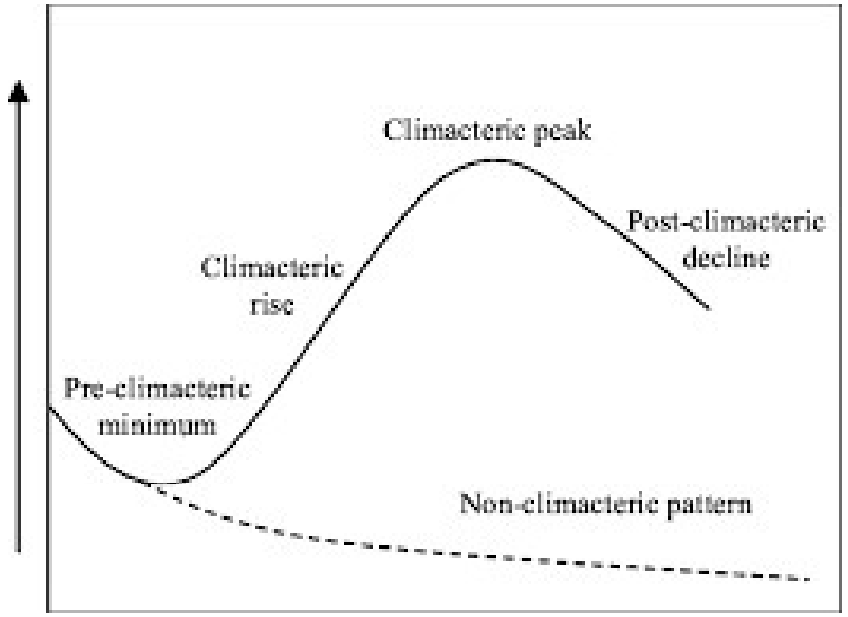
So, 1200/ (55-40)= 80 days from planting to harvest

Heat Units

- Planning
- Planting
- Harvesting
- Factory programs

Corn, peas and tomato for processing

Respiration Rate

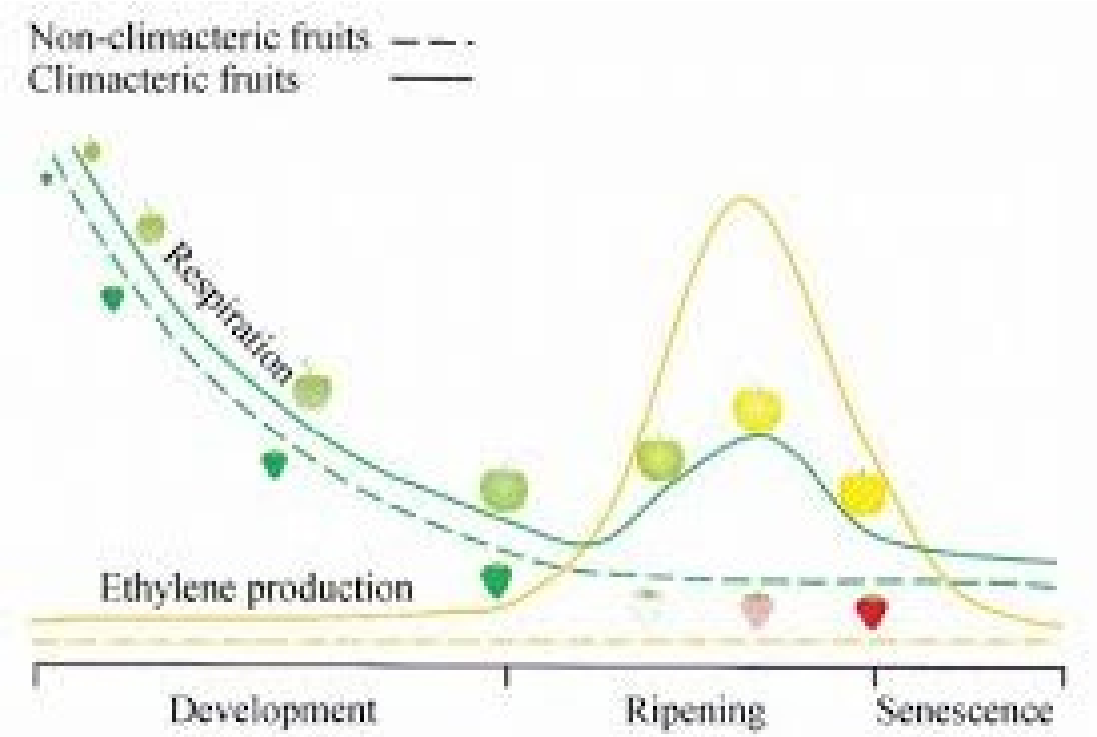


Climacteric pattern of respiration

Particularly useful in climacteric fruits as there is a sharp increase in respiration rate; helpful in pin pointing the most appropriate time of harvest

Determination of respiration peak can help in determining the maturity of the product.

Ethylene peak



Climacteric fruits have ethylene peak

Helpful in determining the maturity stage for harvesting

Volatile production

Apple: Ethyl-2 -methyl butyrate

Banana: Eugenol

Grapefruit: Nootaketone

Lemon: Citral

Orange: Valencene

Maturity indices

- Sign or indications of the readiness for harvest
- Basis for determining harvest date

- **Two types of maturity indices**

i) **Subjective:**

- Qualitative
- Use the senses (color, size, shape, sound, firmness, juice content etc.)

ii) **Objective:**

- Quantitative
- Are measurable indices (TSS, TA, Starch content, oil content, firmness, dry matter, Days after full bloom, heat degree day, respiration and ethylene production, production of volatiles etc.)

Features of maturity indices

Maturity indices should be

- 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

Advantages of estimation of maturity

- To maintain the quality of the product
- To enhance the freshness, appearance and elegance of the produce
- Improvement in the storage life of produce
- Management of ripening and senescence (hasten/ delay harvesting)
- Extended utilization of the produce
- For long distance transportation of produce
- To maximize returns

- Limitations of maturity indices
  - Soil conditions, nutrition, irrigation
  - Season , climate
  - Position on the plant
  - Pruning and other cultural practices and management practices
  - varieties

Some maturity measures of fruits are given in the table below:

Fruits	Maturity indices
Citrus, Papaya, Pineapple, Grapes , Mango, Strawberry	Peel colour
Mango, Apple	Pulp colour
Citrus, Apple, Pear	Size
Banana, Pineapple, Litchi, Mango	Shape
Banana	Drying of plant parts
Melon, Mango	Surface characteristics
Musk melon, Grape, Mango (Tapka stage)	Ease of separation from plants
Watermelon	Tapping
Jackfruit	Aroma
Mango, Pineapple, Guava	Specific gravity
Melons, Apple, Pear	Firmness
Melon, Grapes	Sugars
Grapes, Sweet orange, Papaya	TSS
Citrus, Mango, Pineapple	Acidity
Apple, Pear, Banana	Starch index
Citrus	Juice content
Mango, Grape, Apple, Pear	Heat units
Melons, Pineapple	Days from anthesis

Some maturity measures of vegetables are given in the table below:

Vegetable	Maturity indices
Tomato	Seeds slipping when fruit is cut, or green colour turning pink
Egg plant, Bitter gourd, Slicing cucumber	Desirable size reached but still tender
Water melon	Dull hollow sound when thumped
Musk melon	Easily separated from vine with a slight twist leaving clean cavity (full slip stage)
Snake gourd	Desirable size reached and thumbnail can still penetrate flesh readily
Cowpea, Snap bean, Sweet pea, Winged bean	Well filled pods that snap readily
Lima bean and Pigeon pea	Well filled pods that are beginning to lose their greenness
Okra	Desirable size reached and the tips of which can be snapped readily
Cauliflower	Curd compact
Broccoli	Bud cluster compact
Radish and Carrot	Large enough and crispy
Potato, Onion and Garlic	Tops beginning to dry and topple clown
Yams, Bean and Ginger	Large enough