Fruit Set, Growth and Development

Fruit set happens after pollination and fertilization, otherwise the flower or the fruit will drop. The flowering and fruit set efficiency could be measured by certain equations:

Flowering efficiency = \( \frac{\text{No. of flower buds}}{\text{No. of total buds}} \)

Initial Fruit set efficiency = \( \frac{\text{No. of fruits 6 weeks after anthesis}}{\text{No. of flowers}} \)

Final Fruit set efficiency = \( \frac{\text{No. of fruits before harvesting}}{\text{No. of flowers}} \)

Fruit Growth and Development

- This includes the following processes: cell division, cell expansion (enlargement) and intracellular space enlargement.
- The duration of cell division is different for different fruits. Stops at anthesis, after anthesis or never stop till maturation.
- Cell and intracellular space enlargement start after cell division.
- What induces cell division and cell enlargement? Seed tissues are rich in Gibberellins, auxins and cytokinins. These hormones produced by seed are likely inducers for fruit growth.

Growth curves

Each fruit follows one of these two ways:

1. Sigmoidal growth curve. Initial slow growth, followed by a rapid growth phase and then a second slow phase (apple, pear, walnut, pecan, strawberry, pineapple, orange, almond)
2. Double sigmoidal growth curve. Like in sigmoidal growth curve but the rapid growth phase interrupted with slow growth (olive, stone Fruits, fig, seeded grapes, raspberry, blueberry)

- In stone fruits and olive stage II of fruit development coincides with pit hardening

Flower and fruit drop

There are four periods:

1. Early flower drop, happens during anthesis.
   - Staminate flowers and flowers with aborted pistil
2. Late flower drop, happens mostly 2 weeks after anthesis.
   - Unfertilized perfect or pistilate flowers.
3. Mid-season fruit drop (June drop), happens 4-8 weeks after anthesis. Fruits drop due to abortion of the embryo and competition between fruits.

4. Preharvest fruit drop. Fruits drop due to abortion of the embryo and competition between fruits.

**Parthenocarpy**

Some species could be set and complete their growth and development without pollination and/or fertilization, and without seed development.

- Vegetative Parthenocarpy: Fruit set without pollination and fertilization. Examples, fig and some varieties of pear
- Stimulative Parthenocarpy: Fruit set without fertilization but with pollination. Examples, some varieties of grape

**Stenospermocarpy**

Fruit with aborted seed, fruit set with pollination and fertilization, and later the embryo will be aborted.

**What affects final fruit size?**

1. Crop load
2. Leaf area per fruit, L: F ratio.
3. Reserve carbohydrates & nitrogen
4. Number of seeds and their relative strength
5. Development prior to anthesis.
7. Pests and diseases

**Biennial Bearing or Alternate Bearing**

- It means that a light crop follows a heavy crop.
- It happens in most fruit trees.
- How it established? If certain orchard or area is subjected to some events, such as frost or disease, it will cause a sever reduction in crop in that year, flower initiation is excessive and the following year crop is so large that it limits flower initiation.
- Individual spurs or shoots exhibit a biennial tendency.
- How to reduce biennial bearing? By fruit thinning, it should be 3 - 4 weeks of full bloom.
- The old wood are more affected by biennial bearing.
Suggested questions

................................. is a complex range of phenolic compounds, which give the fruit a bitter or astringent taste.

................................. ................................. is fruit set with pollination but without fertilization.

Individual spurs or shoots exhibit a biennial tendency (T or F)
The June drop of fruit in the north hemisphere is the same as October drop in the south hemisphere. (T or F)

Which sentence is false
A. Individual spurs or shoots exhibit a biennial tendency
B. The old trees are less affected by biennial bearing
C. The new wood are less affected by biennial bearing
D. None of the above

Drop of unfertilized perfect flowers considered as
A. Early flower drop
B. Late flower drop
C. June drop
D. Preharvest fruit drop

The following fruits follow sigmoidal growth curve
Plum Olive
Pear Grape

Fruit set efficiency could be measured by
A. Number of flower buds/number of fruits
B. Number of flower bud/ total number of buds
C. Number of fruits/ number of flower bud
D. Total number of buds/ number of flower bud

Fruit growth and development includes the following processes
A. Cell differentiation and division
B. Cell differentiation and expansion
C. Cell division and expansion
D. All of the above

A grape fruit tree is 10 year old, after winter pruning 16 fruiting spurs are remained on the trellis, the average number of the flower buds per cane is 3. Each flower bud develops to shoot with 2 inflorescences in average, each inflorescence has 200 flowers. After fruit setting, 50 fruits remain on each inflorescence. The average weight of the fruit was 10g. According to this information answer questions 32-36

What is the yield of this tree
What are the initial and the final fruit set percentages
If you want 40 kg from each tree, how many inflorescences have you to remove
Fruit Maturation

Definitions:
Maturation: The processes by which fruit develop from immature to the mature state.
Maturity: The end point of maturation.
Physiological maturity: The attainment of the mature state just prior to the start of ripening.
Horticultural maturity: The stage at which growth or development is optimum for particular uses.

Types of horticultural maturity
- Harvested physiologically immature, green almond.
- Harvested firm matures but ripened later, pear, apple, plum, apricot, and peach.
- Harvested when ripe, berries, cherries, nuts.

Patterns of fruit ripening
1. Climacteric ripening pattern
   - Fruit ripening is accompanied by an increased rate of respiration and ethylene production
   - Apple, pear, apricots, peach, plums, banana, mango, kiwifruit
2. Non-Climacteric ripening pattern
   - Fruit ripening is accompanied by low rate of respiration and ethylene production
   - Cherry, fig, grape, citrus, pineapple, strawberry.

Chemical and physical changes
1. Sugars: Starch converts to sugar in some fruits like apple and banana or sugar is transported into the fruit during maturation like in grape and stone fruits.
2. Acids: Three most common are malic, citric and tartaric acid. The percentage usually less than 1 (<1%) except in lemon about 5%.
3. Flavor components: determined by many compounds; sugar, starch, acid and aromatic compounds like esters and alcohols.
5. Tannins: a complex range of phenolic compounds, which give the fruit a bitter or astringent taste.
6. Softening: during fruit enlargement there is increase in size of cells and thinning of cell wall. Most tissue softening is due to the breakdown of pectic acid and protopectins, and degrading of cellulose.
7. Respiration
8. Ethylene: it is the initiator of the ripening process in the fruits. With non-climacteric fruit, applied ethylene will stimulate some aspects of fruit ripening such as chlorophyll breakdown in citrus rind.
Factors affecting rate of maturation
1. Temperature: the most important factor promoting fruit maturation. Can be controlled by use of shelter, soil cultivation, choose of correct slope, or modification of training system.
2. Nutrition and Water: Frequent watering and high N tend to promote vegetative growth and delays fruit maturation, produce poorly colored fruit, and reduced storage life
3. Light: Shade reduces the temperature of the fruit and delays maturity and color development.
4. Pests and diseases: Advance fruit maturity through ethylene production.
5. Hormones and plant bioregulator:
6. Date of blossoming (Flowering)

Determining maturity
1. Ease of separation of fruit from the tree
2. Fruit color: Special color charts are used to make harvesting decisions.
3. Seed color: In apple, pear and strawberry seed change from white to brown.
4. Sugar or soluble solid: Peach, nectarines, apricot, citrus, kiwifruit, grape.
5. Starch: Apple and pear.
6. Acid levels: Maturity - decline in juice acidity.
7. Flesh firmness: Apple, pear, peach, apricot.
8. Fruit size and shape
9. Date or time after a reference date (days after bloom time)
Suggested questions

During fruit ripening most tissue softening is due to the breakdown of pectic acid and protopectins, and degrading of cell wall (T or F)

Climacteric fruit ripening is accompanied by an increased rate of respiration and ethylene production (T or F)

During maturation starch converts to sugar in some fruits like grape (T or F)

The following are the three most common acids in the fruits

A. Malic, citric and acetic acid
B. Malic, citric and tartaric acid
C. Malic, boric and tartaric acid
D. Folic, citric and tartaric acid

Which of the following fruits should be harvested when ripe

Peach  nuts
Apple  Pear

The following is climacteric fruit

Grape  Citrus
Peach  Cherry

……………………………………………………………………………………………………………………………………………………………… is the stage at which fruit growth or development is optimum for particular uses.

……………………………………………………………………………………………………………………………………………………………… is the attainment of the mature state just prior to the start of ripening.

Storing of climactric and non-climactric fruit in the same chamber is not advisable, why?

Discuss in details the chemical and physical changes during fruit maturation