PRINCIPLES OF FRUIT & NUT TREE GROWTH, CROPPING & MANAGEMENT

Review of fundamentals

Ted DeJong
Department of Plant Sciences
UC DAVIS

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The overall objective of all cropping systems is to maximize resource capture and optimize resource use to achieve sustainable economic yields.

What resources are we mainly interested in?

light energy, carbon, oxygen, water and nutrients

What are the three most prominent chemical elements in dry plant parts

- Fruit?

- Wood?

Carbon	C
Hydrogen	H
Oxygen	O

Roughly in a ratio of 6:1:8

Where does all that CH_2O come from?

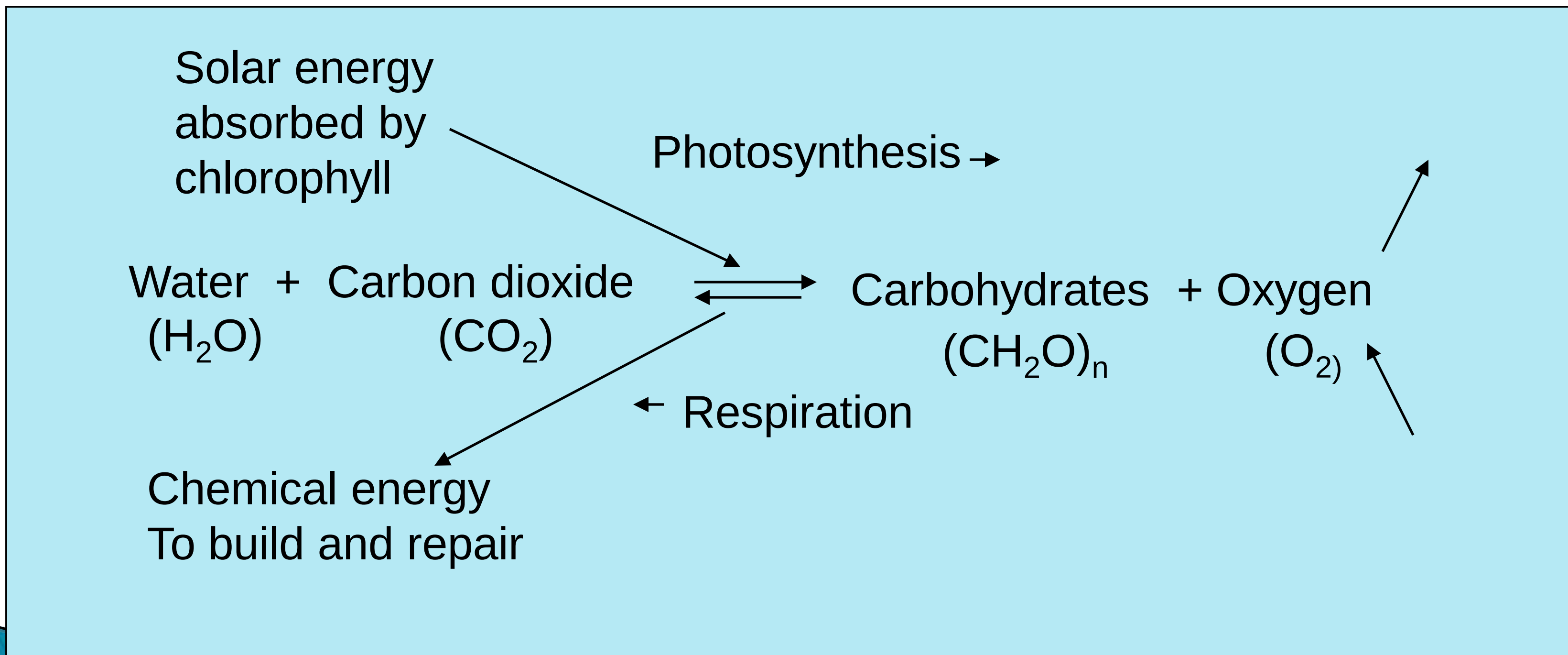
PHOTOSYNTHESIS

Photosynthesis is the process by which plants capture the energy in sunlight and convert it to a biologically usable form.

- The energy is stored in carbon bonds created during photosynthesis and liberated during respiration

The basic photosynthesis/respiration reactions

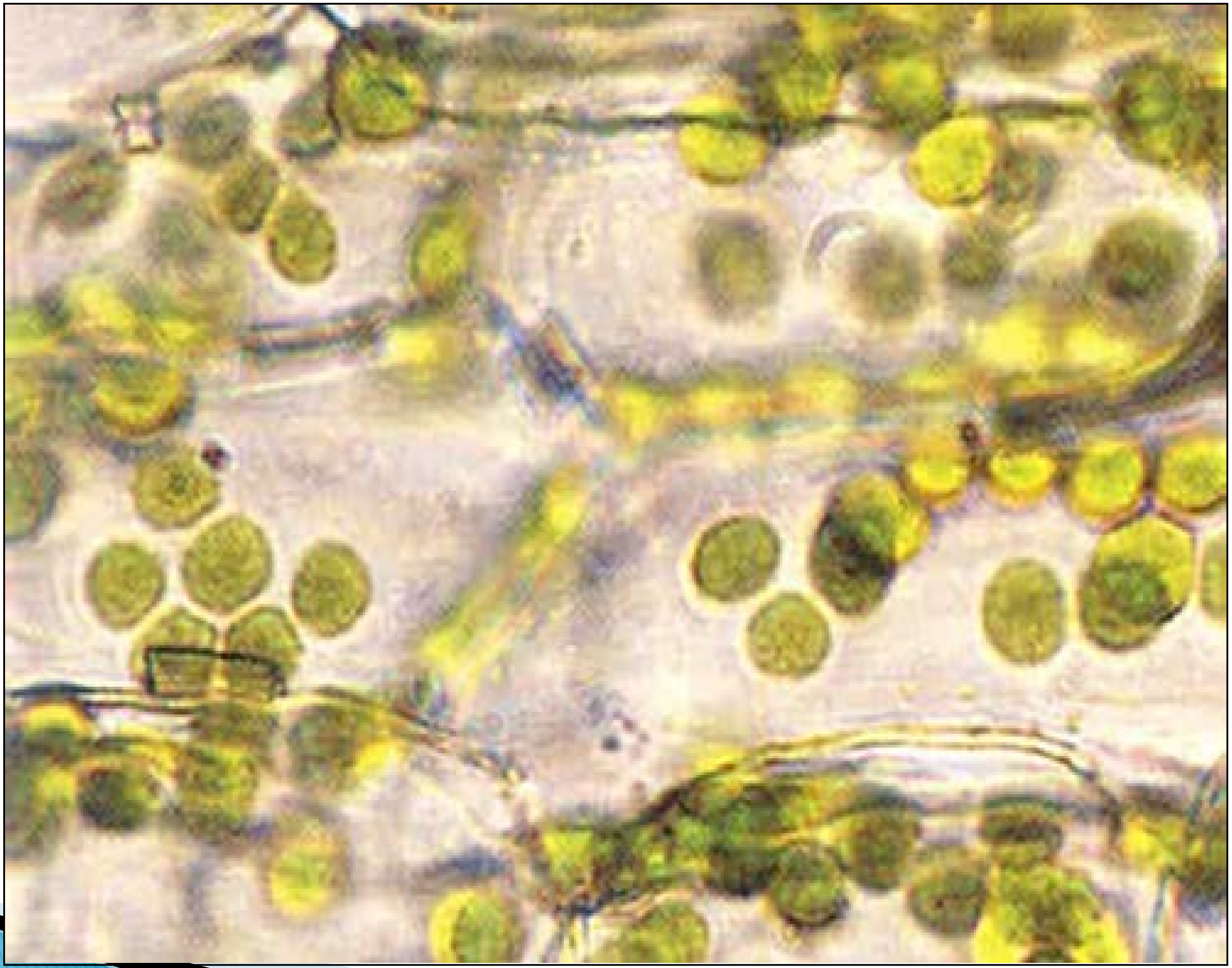
(the most important processes for supporting life on the planet)



- Plants, nature's original solar energy collectors.

- What are nature's natural solar energy cells?
- Chloroplasts.

Chloroplasts

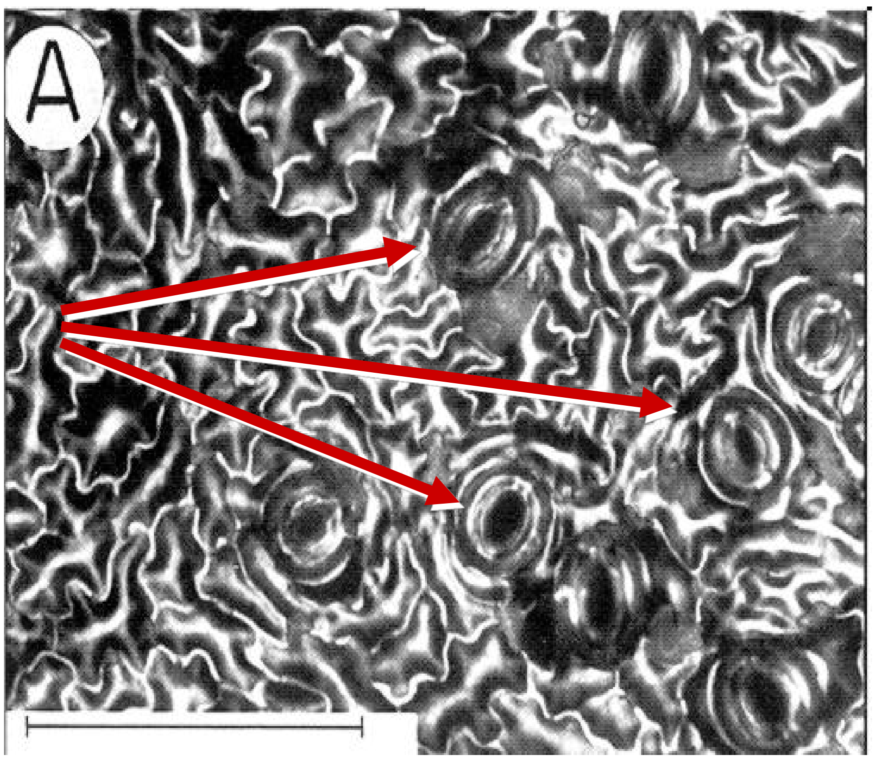


Chlorophyll

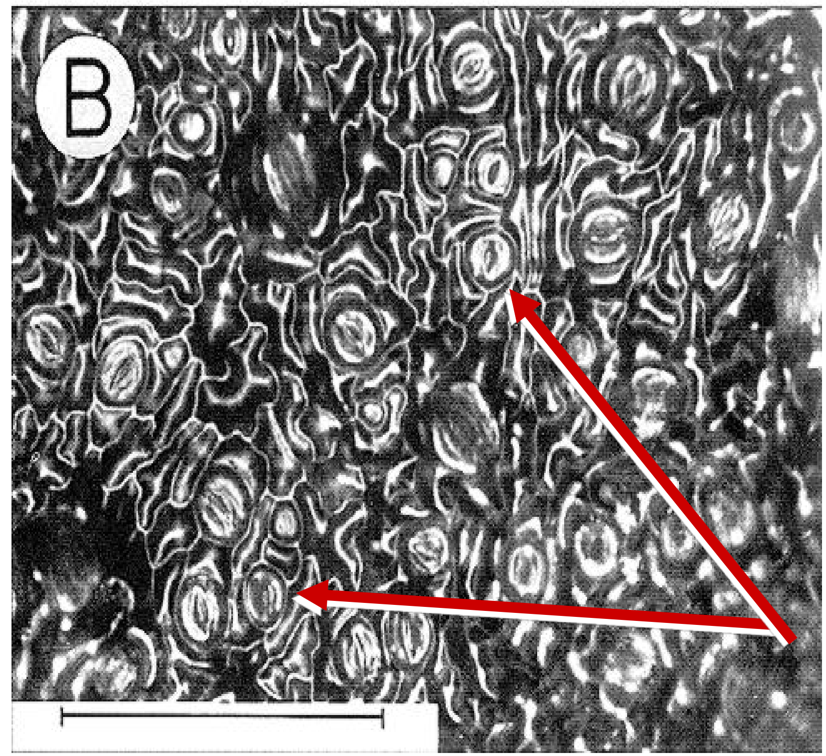
- Light energy is captured by the green pigment chlorophyll.
- Chlorophyll is found in all green tissues of plants.
- It is located in chloroplasts, specialized structures in the plant cells designed to be solar energy cells.

- The primary functions of leaves are to house and display the chloroplasts for solar energy collection.
- Problem: chloroplasts need an aqueous environment to function, air is dry and CO_2 from air is required for photosynthesis.
- Solution: leaves with waxy cuticle to prevent dehydration and air control vents called stomates.

Carbon dioxide in the leaf tissue is readily consumed by photosynthesis. CO_2 enters the leaf through pore that can be opened or closed.

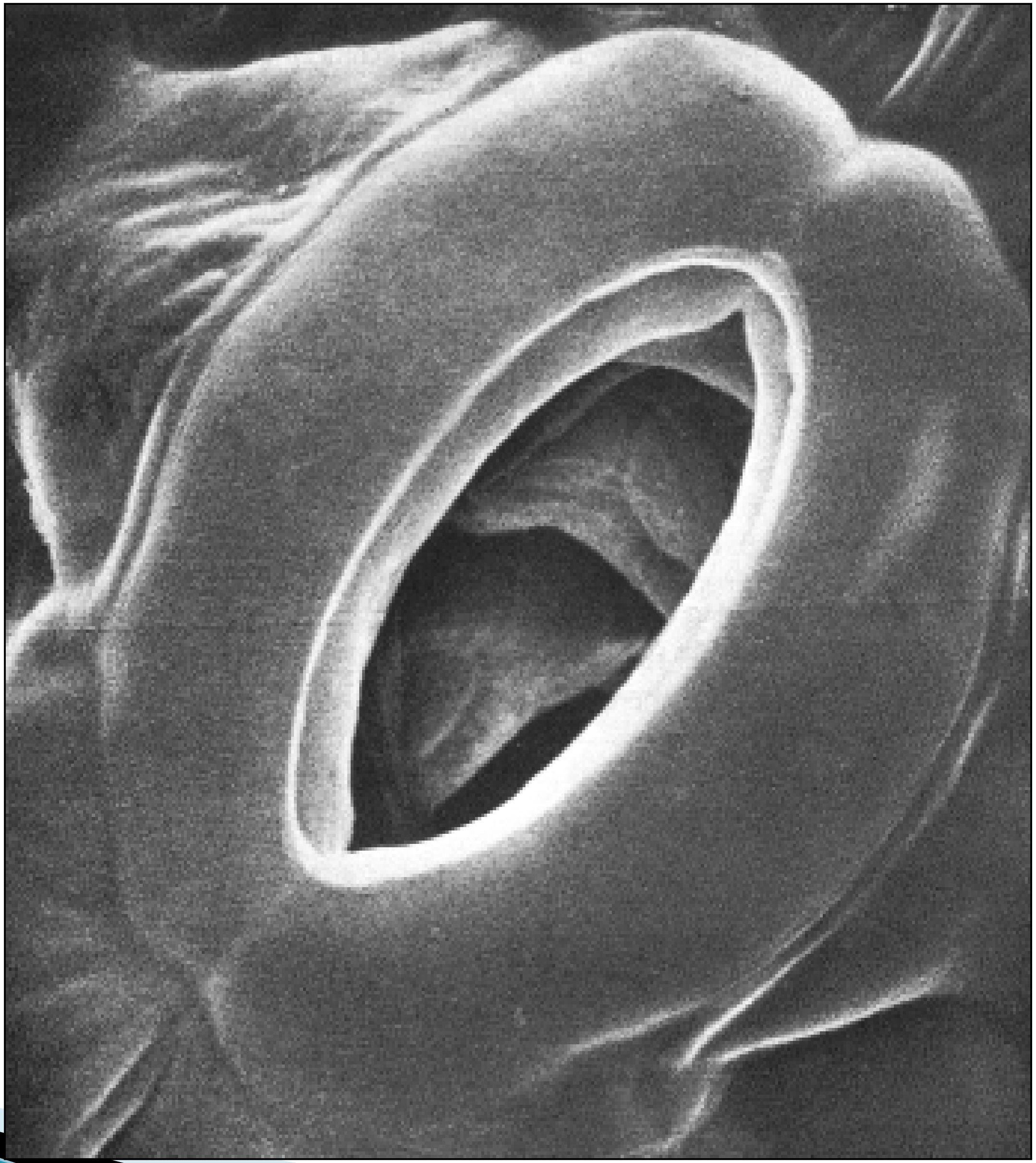


When the pores are open to admit CO_2, water escapes.

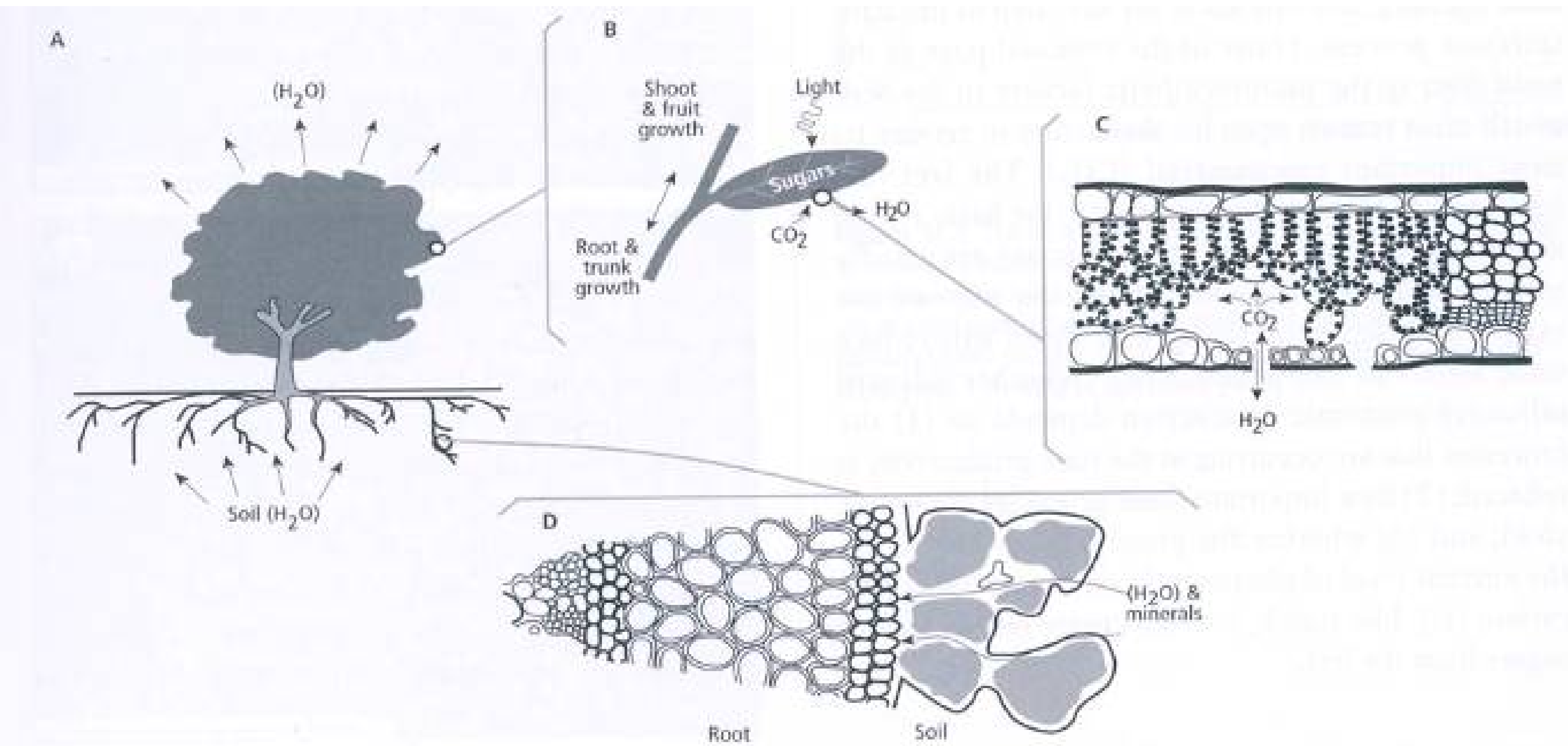


Under conditions of water stress, the pores close, shutting down photosynthesis.

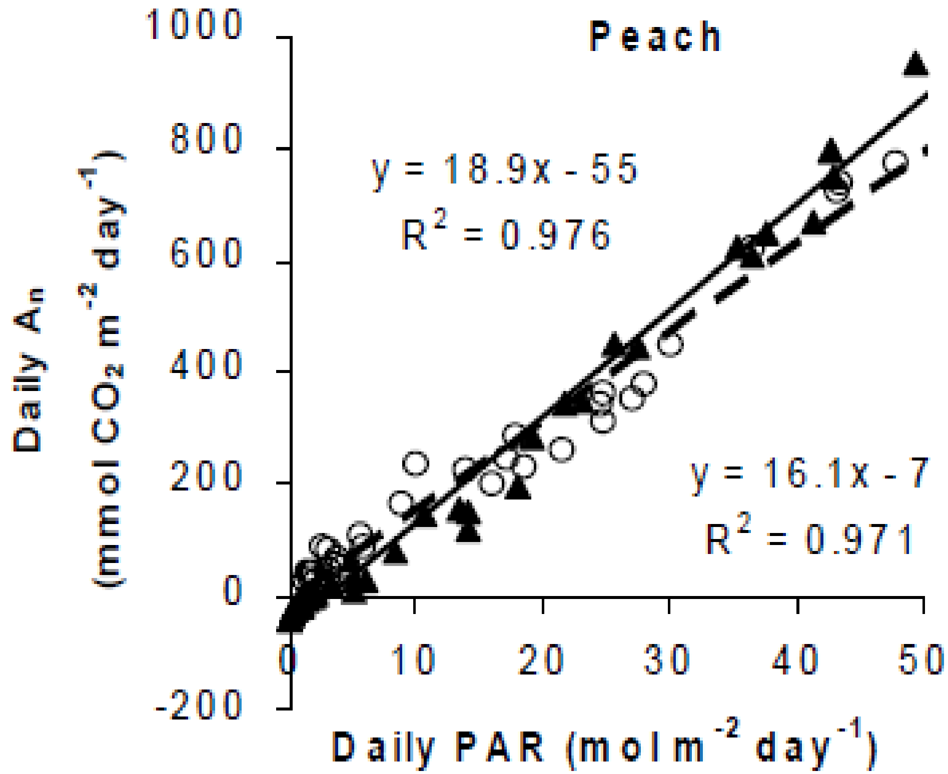
Stomate



Carrying out photosynthesis is always a compromise between taking up CO_2 and losing H_20.



Under non-stress conditions, daily single leaf or canopy photosynthesis is a direct function of the light intercepted by a leaf or canopy during a day

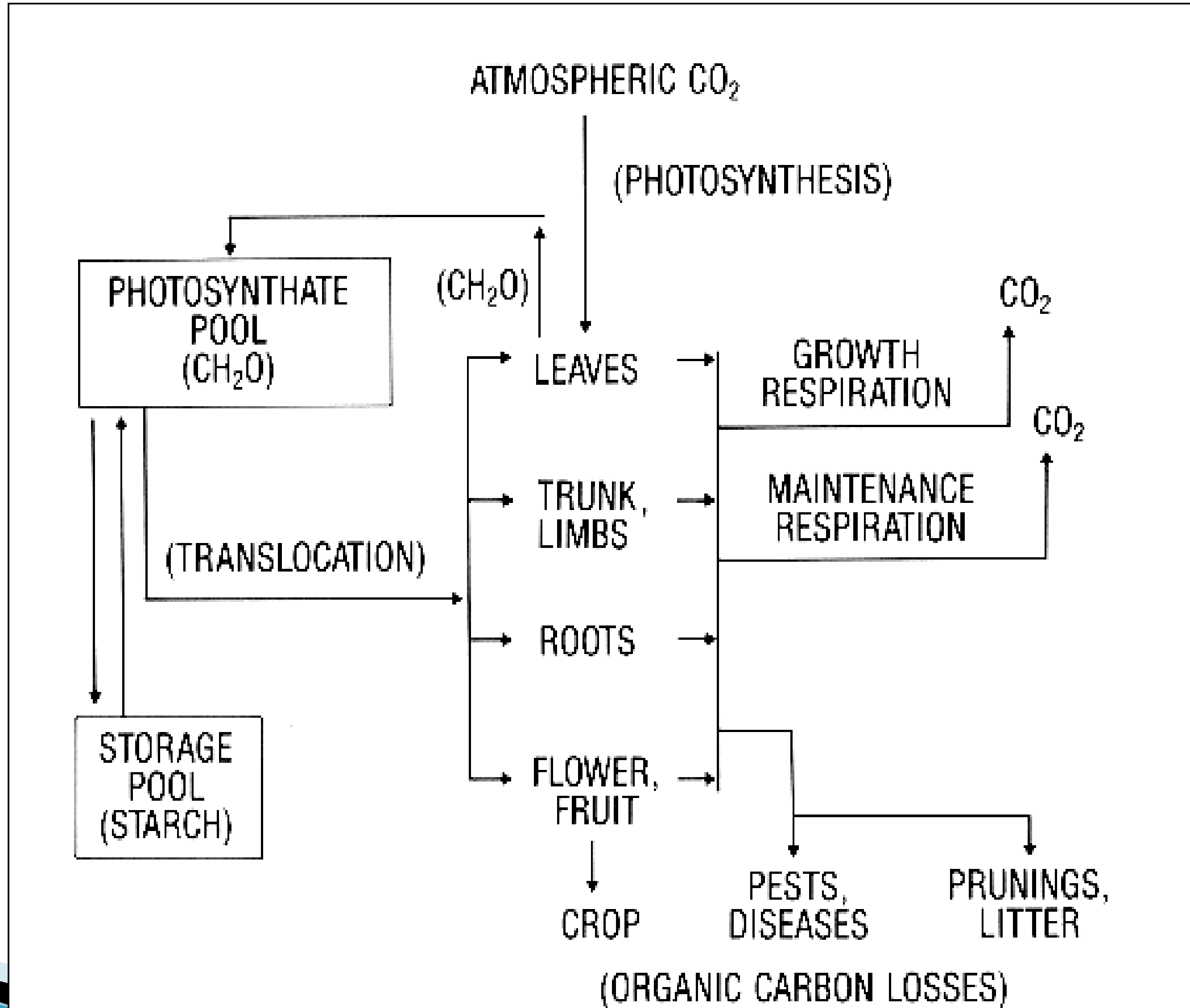


(ie. Trees have this figured out very well.)

Rosati, et al. 2002. Acta Hort. 584: 89-94

Carbon distribution within the tree

The translocated CHOs are mainly sucrose and glucose in most plants but rose family trees (pome and stone fruits) mainly transport sorbitol with some sucrose and glucose.



What determines how CHO's are allocated within the tree?

This is a question that has received much attention over the past 50 years and scientists still disagree about it.

However, I believe it is relatively simple.

Carbon distribution is mainly controlled by the development and growth patterns of individual organs and their ability to compete for CH_2O's

- A tree is a collection of semi-autonomous organs and each organ type has an organ- specific developmental pattern and growth potential.
- Organ growth is activated by endogenous and/or environmental signals.
- Once activated, environmental conditions and genetics determine conditional organ growth capacity.
- Realized organ growth for a given time interval is a consequence of organ growth capacity, resource availability and inter-organ competition for resources.
- Inter-organ competition for CHOs is a function of location relative to sources and sinks of CHOs, transport resistances, organ sink efficiency and organ microenvironment.

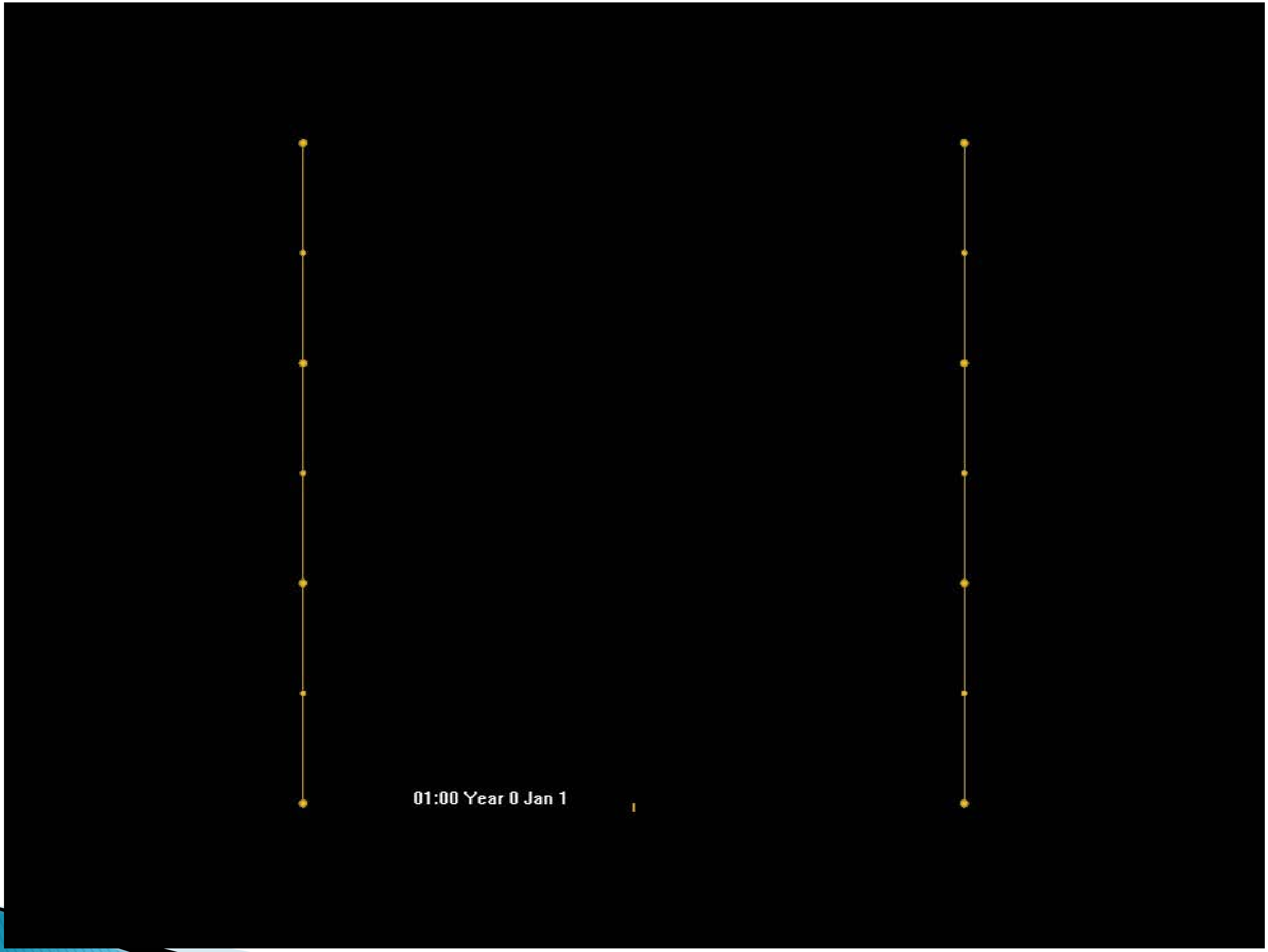
One of the most practical examples of this concept is this type of tree.

Important points

- ***Organ development and growth*** dictate tree growth and production (not *vice versa*)
- ***Organ development*** is ***not*** same as ***organ growth***
- ***Organ development*** dictates ***organ growth potential*** but full growth potential does not have to be fulfilled for development to continue.
- ***Organ growth*** depends on ***development*** but ***organ development*** does ***not*** depend on ***organ growth*** beyond a minimum threshold.

What does this carbon distribution look like through time as the plant grows?

- Results from a new, 3-dimensional computer graphics based simulation model called L-PEACH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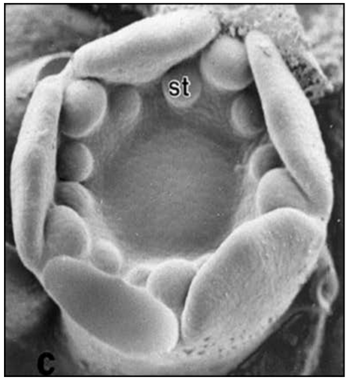
Flower anatomy and pollination in tree crops

Ted DeJong




Lecture outline

1. Flower anatomy

- Structures within a flower
- Perfect flowers, imperfect flowers, monoecy, and dioecy

2. Flower and fruit development

- Vegetative and floral tissue
- Floral bud development and fruit quality problems

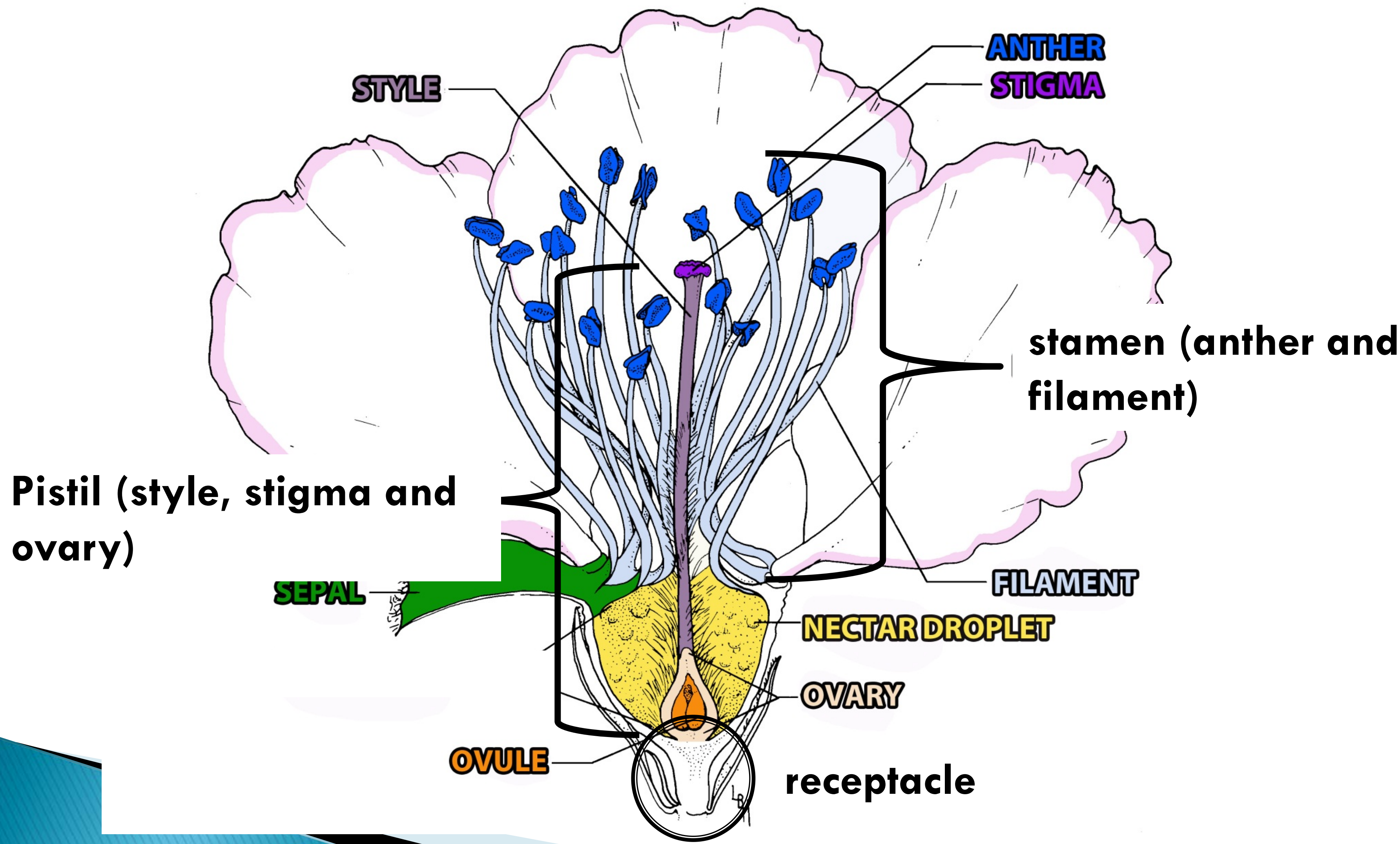
3. Pollination

- Pollination and common modes of pollen transport
- What happens after pollination?
- Effective Pollination Period (EPP)
- Fruit and nut quality issues related to pollination
- Mechanisms that limit self-pollination

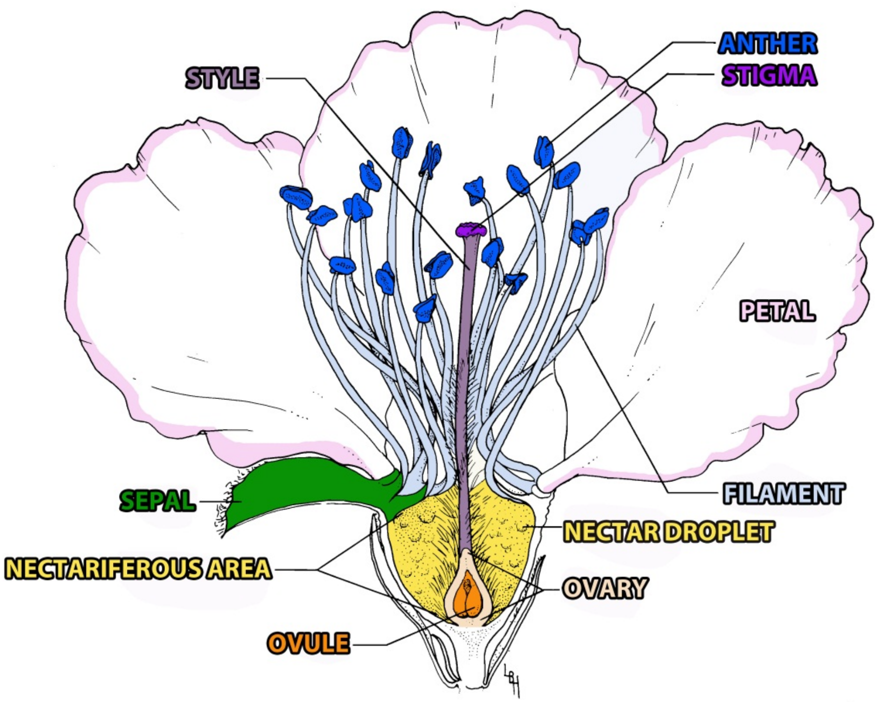
4. Link between flower and fruit anatomy

- Three primary flower “types”
- Fruit anatomy

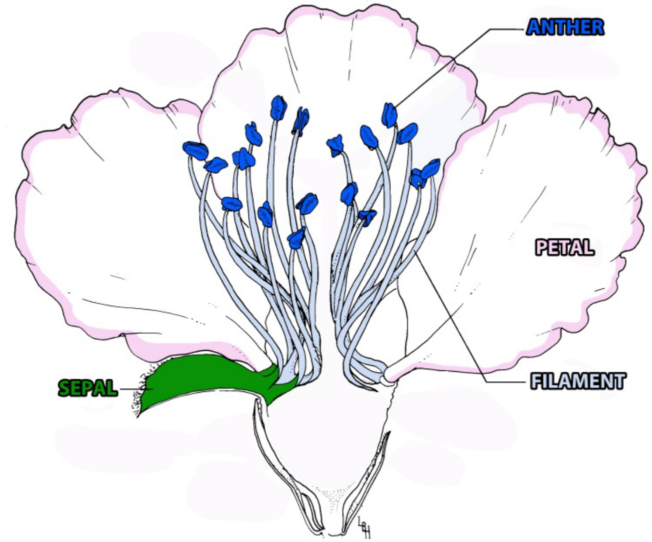
Flower anatomy



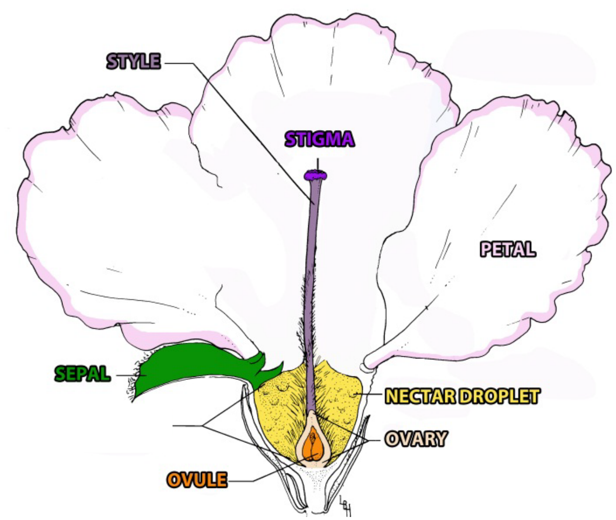
Perfect and imperfect flowers



“Perfect” flower



Male flower

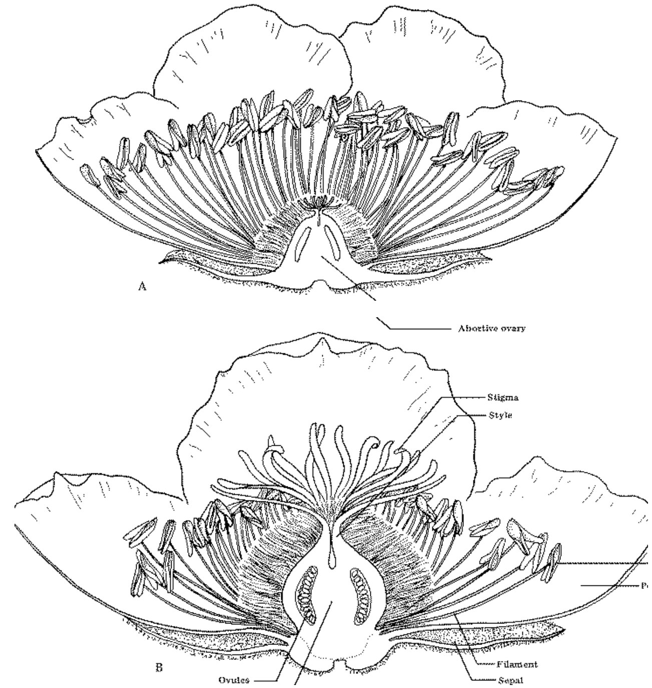


Female flower

Examples of imperfect flowers in tree crops

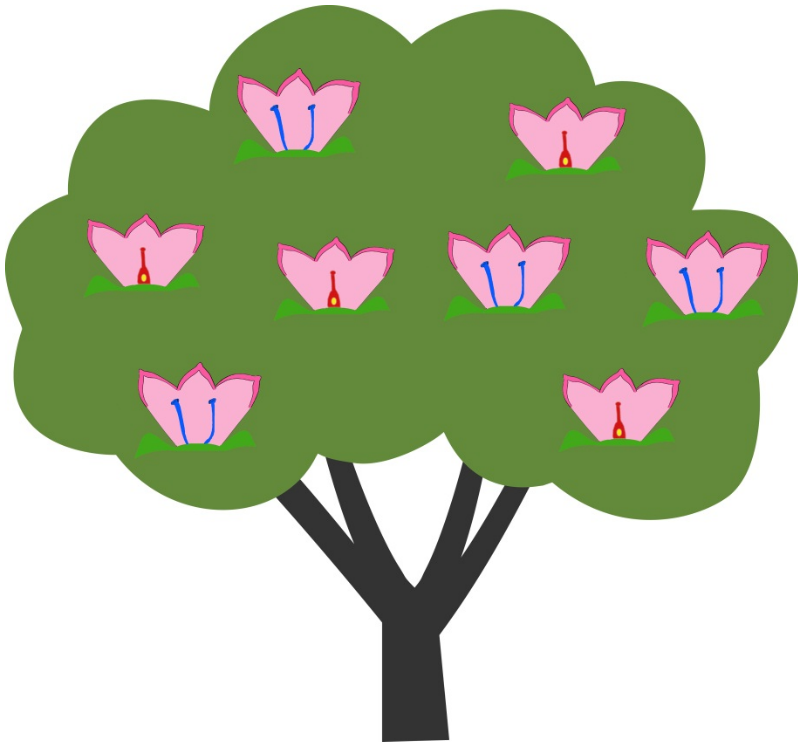
Walnut

Pistachio



Kiwifruit

Monoecious vs. dioecious species



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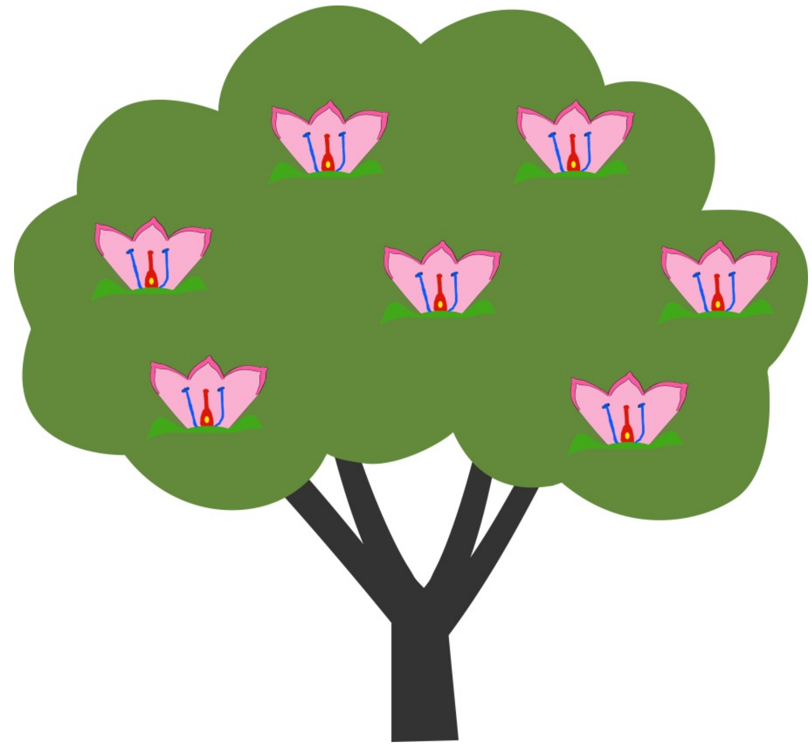
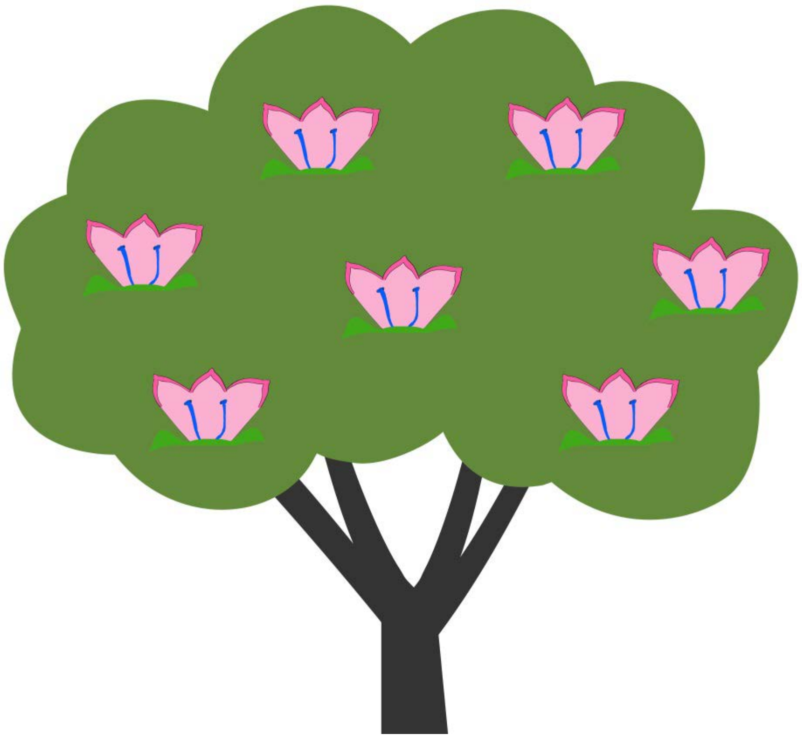


Monoecious species

- individuals are all hermaphrodites
- can have perfect or imperfect flowers

Monoecious vs. dioecious species



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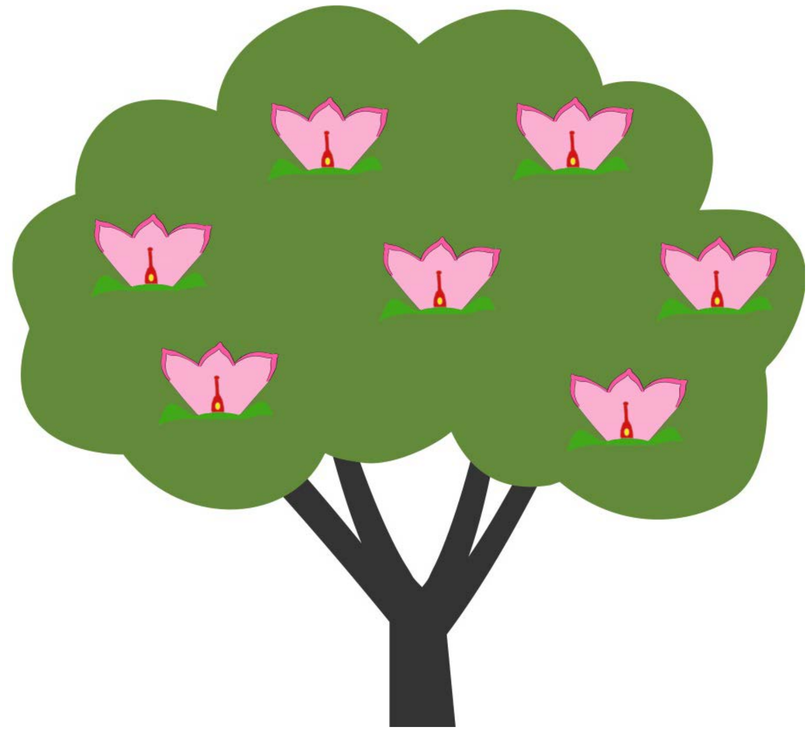
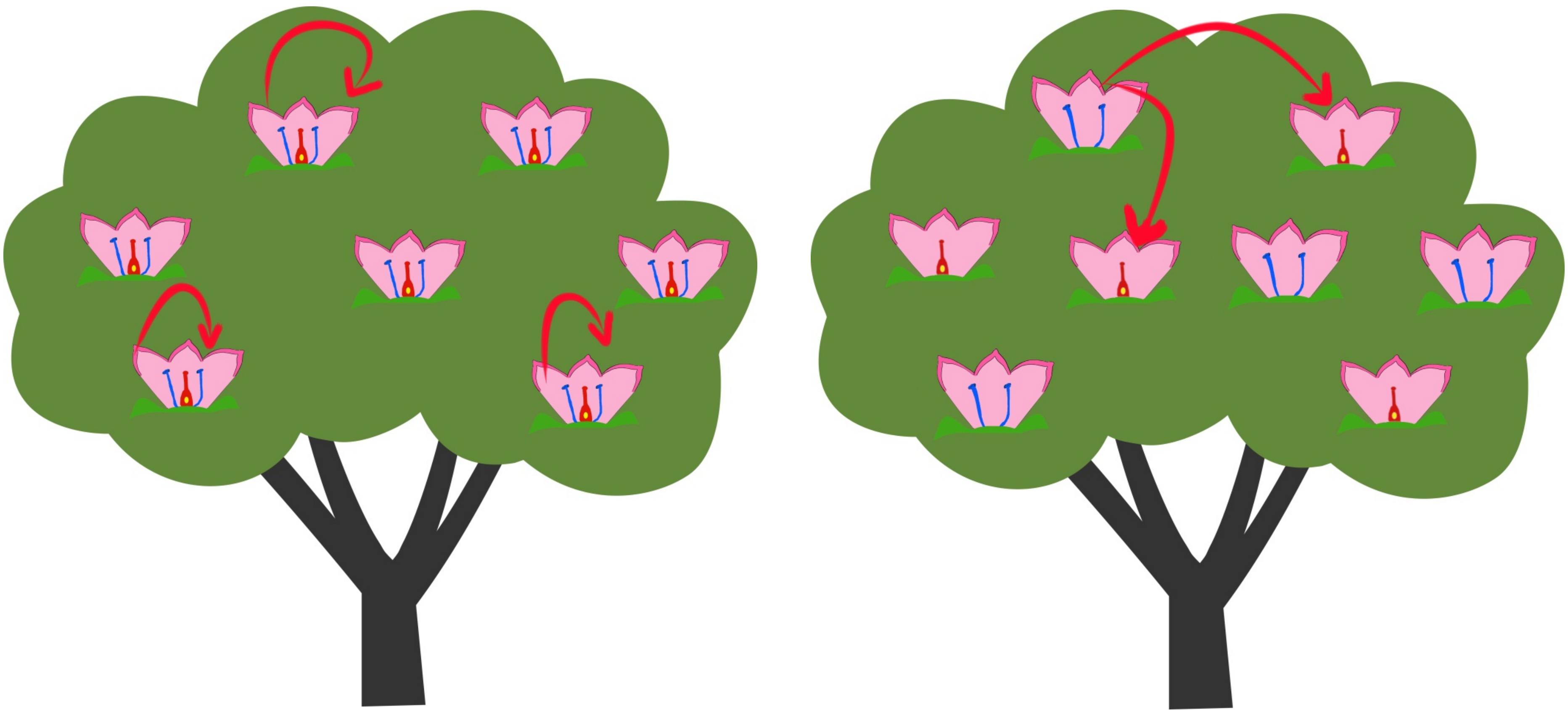


Dioecious species

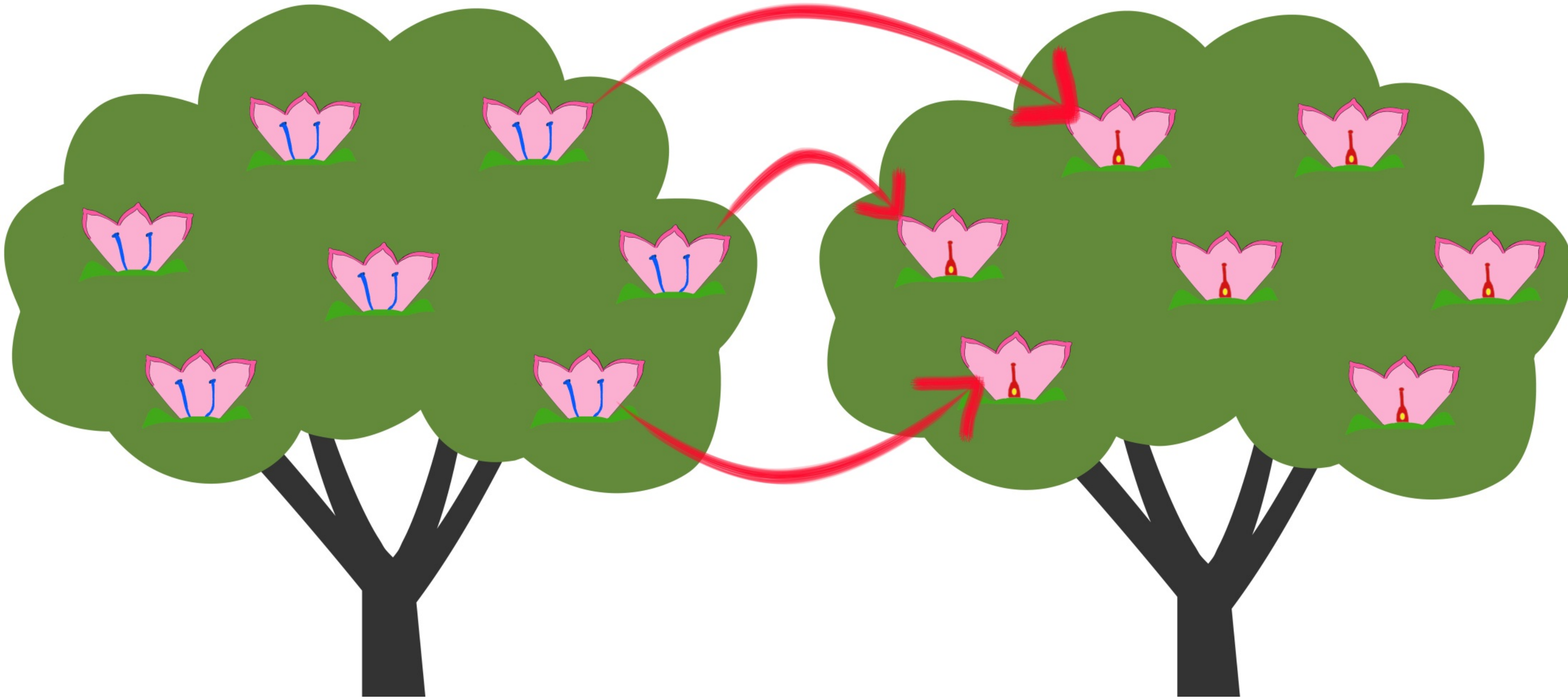
- individuals are **either** male or female

Pollen transfer in monoceious species



Pollen only has to travel short distances in monoecious species that have self-compatible pollen to fertilize an ovule.

Pollen transfer in monoceious and dioecious species



Pollen travels longer distances in dioecious species to fertilize an ovule.

Lecture outline

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2. Flower and fruit development
   - Vegetative and floral tissue
   - Floral bud development and fruit quality problems
3. Pollination
   - Pollination and common modes of pollen transport
   - What happens after pollination?
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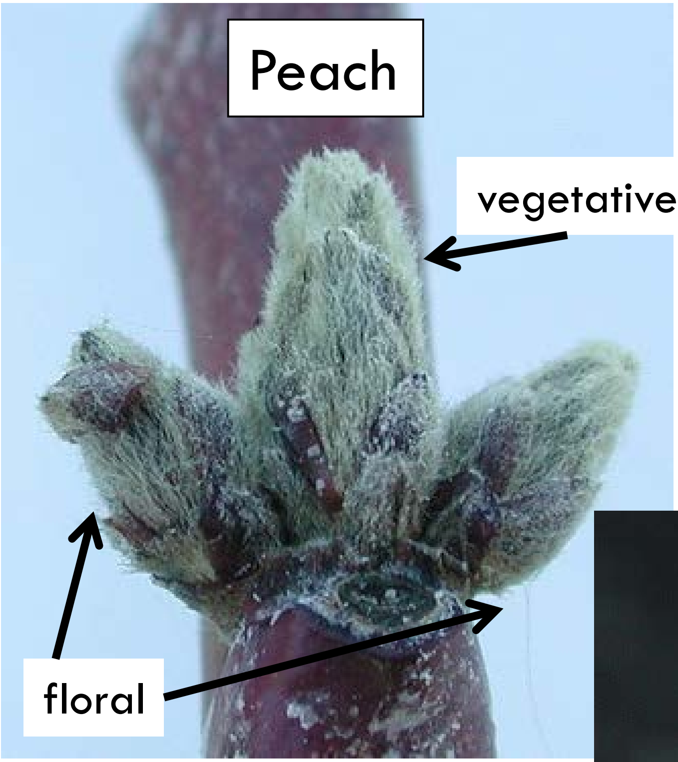
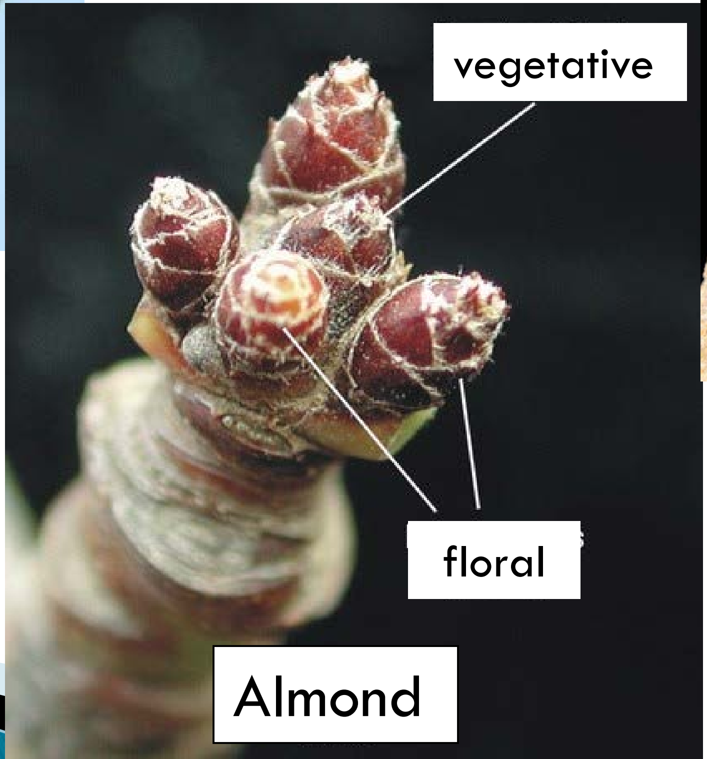
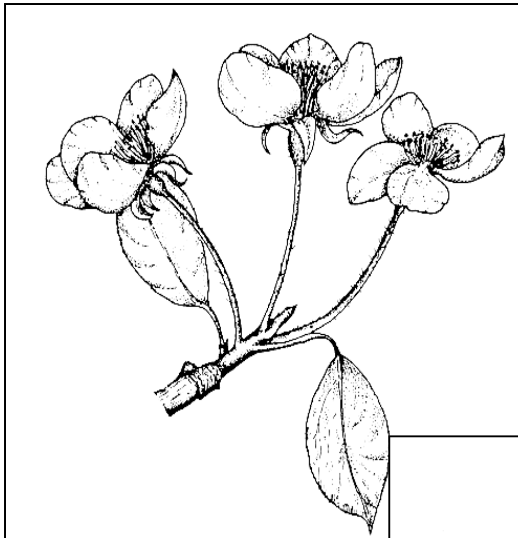
Two primary tissue types

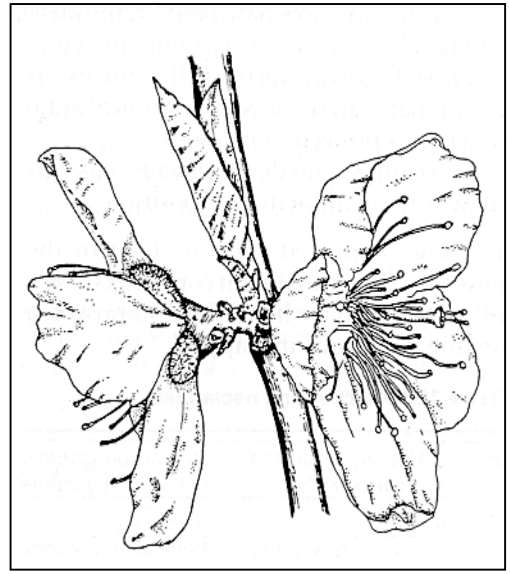




Two primary bud types



Pear



Peach

Pome fruits: <u>mixed</u> buds with leaves and several flowers borne on the terminal tips of shoots

Cherry

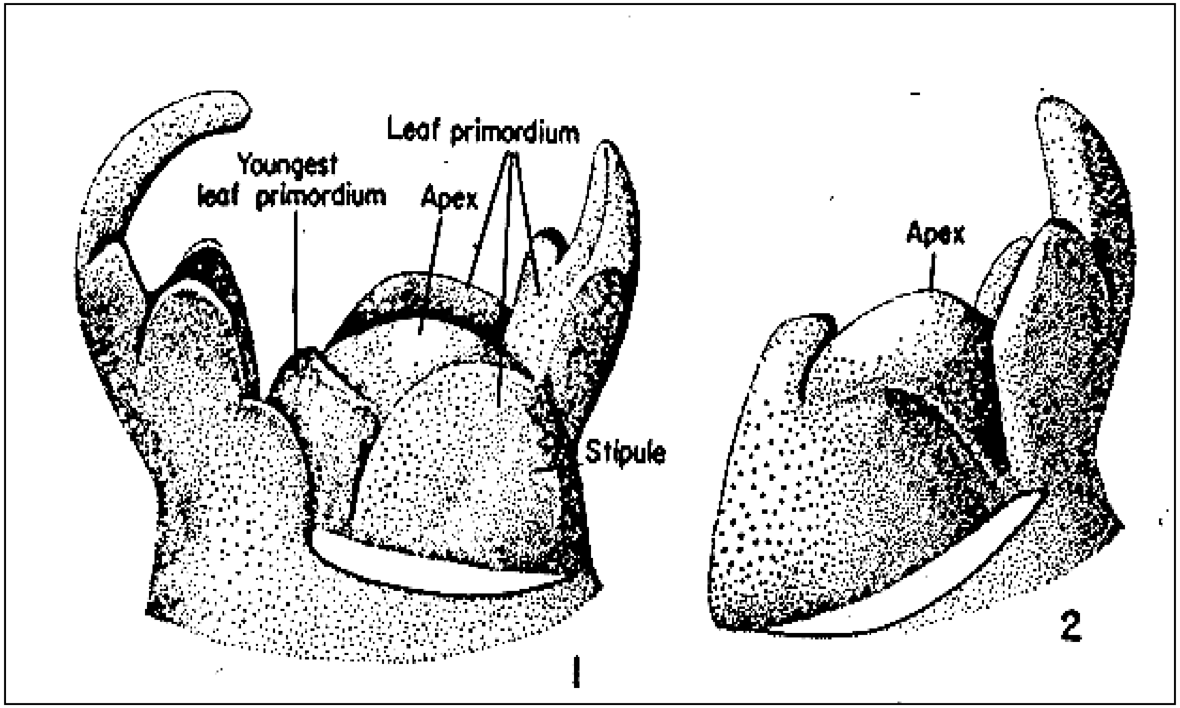
Stone fruits: solitary flowers borne in simple buds (peach) or multiple flowers borne laterally in compound buds (plum, cherry)

Lateral bearing on shoots and spurs

Peach: lateral bearing on one year old shoots

Almond and cherry: lateral bearing on spurs

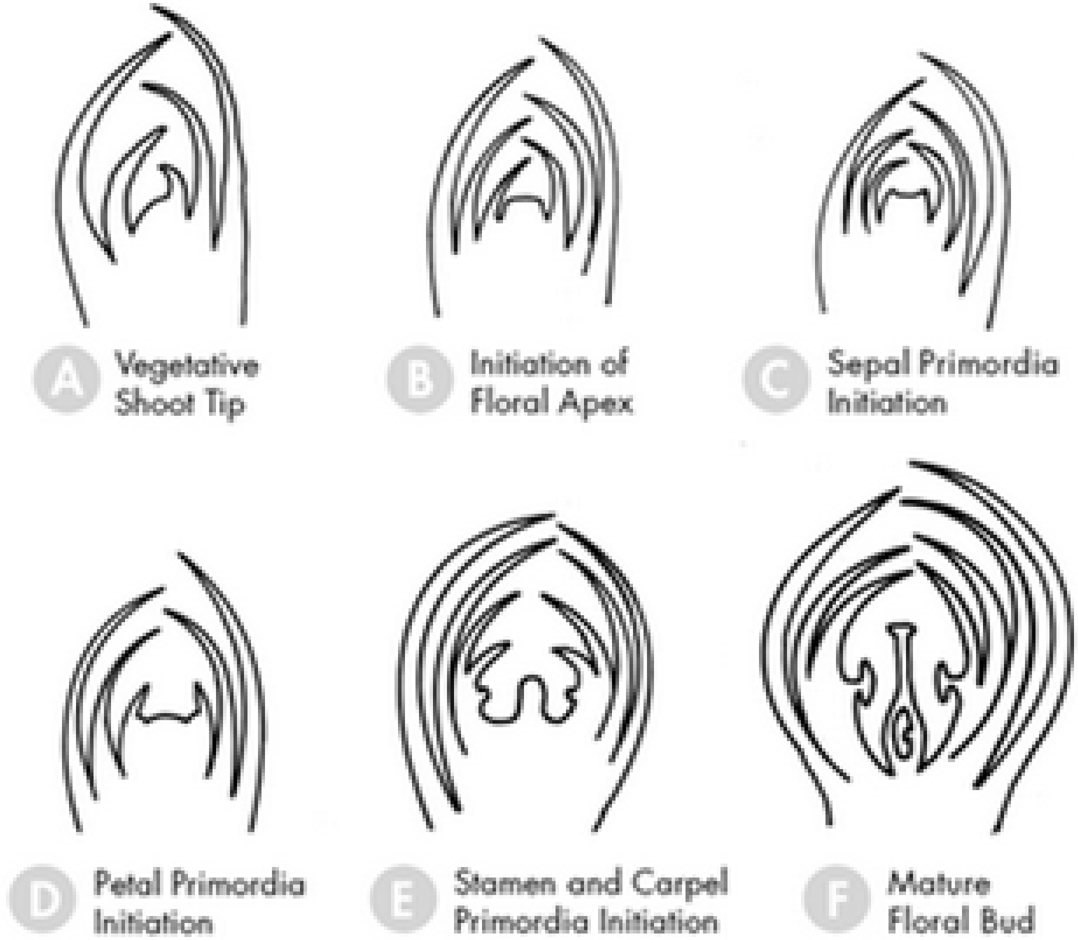
Meristem produces vegetative and floral buds



Inside developing buds all growth comes from a terminal cluster of cells called **apical meristem**

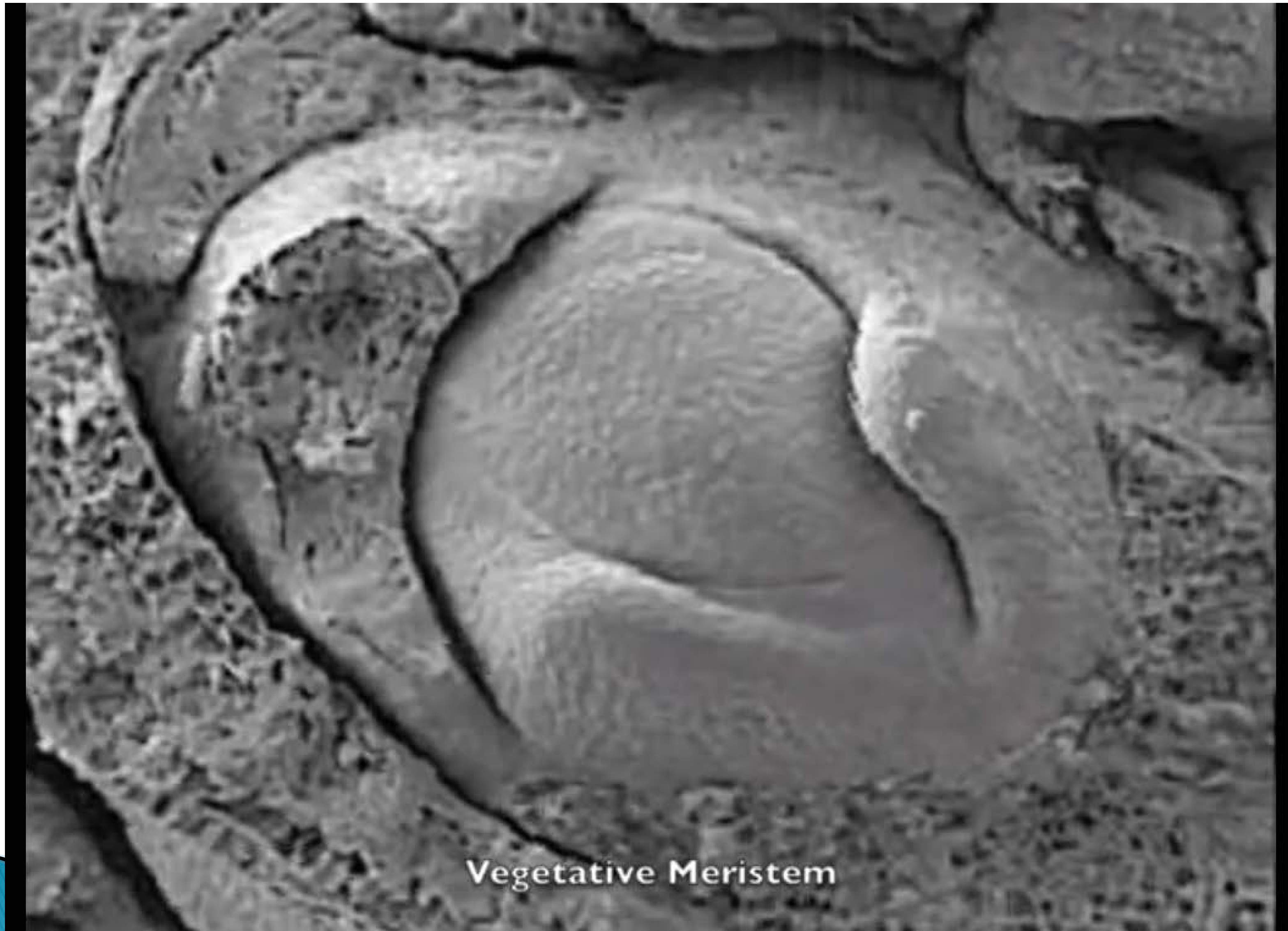
Vegetative apical meristems form bud scales and leaves

Floral buds derive from vegetative meristem



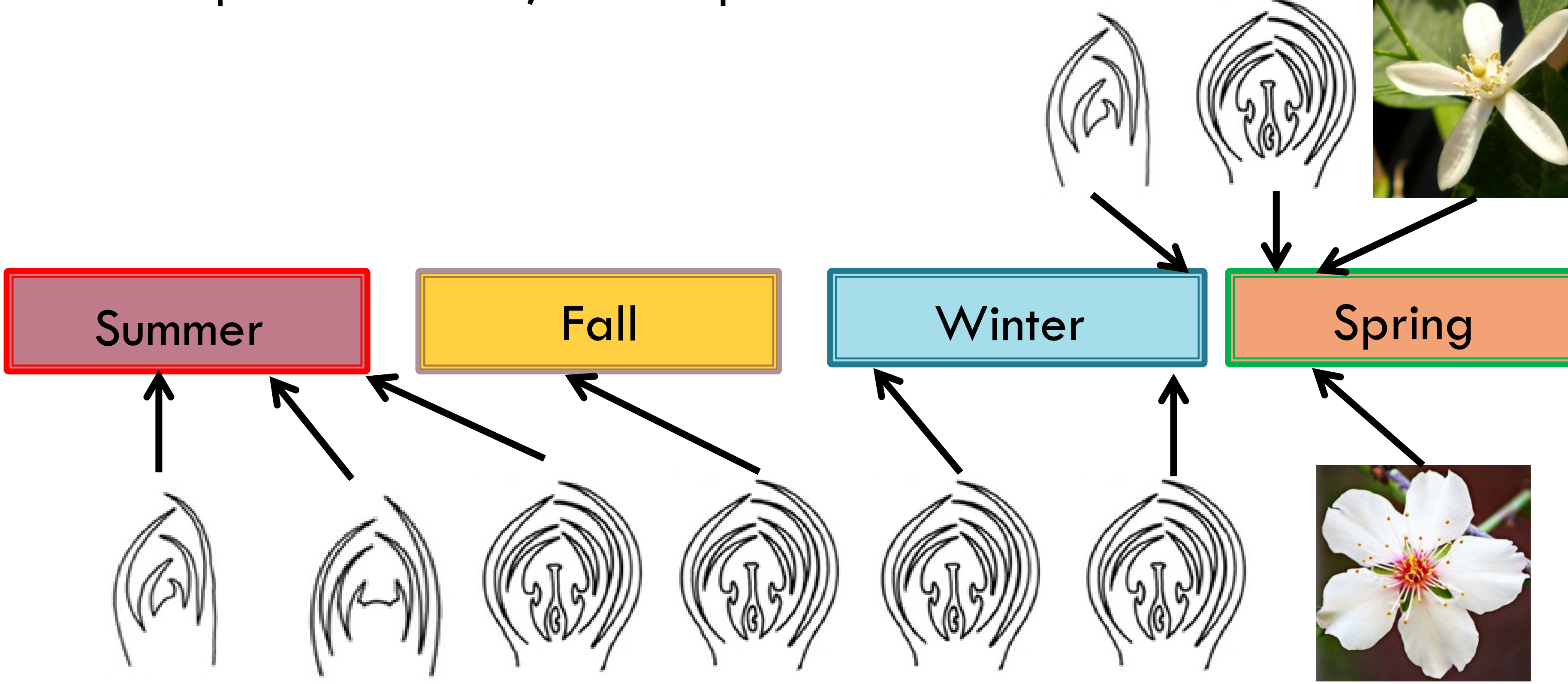
Vegetative meristem can also develops into floral buds

Almond flower bud differentiation



What are some practical implications of the timing of flower bud development in deciduous species?

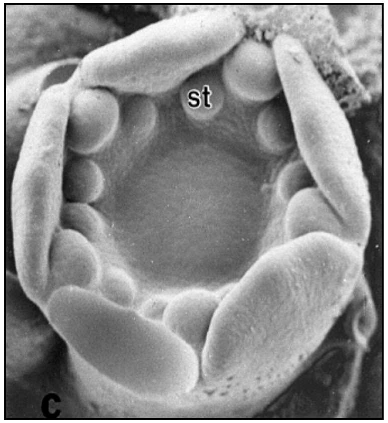
Evergreen trees (olives and citrus): Flowers form in the buds a few weeks prior to bloom, not the previous season.



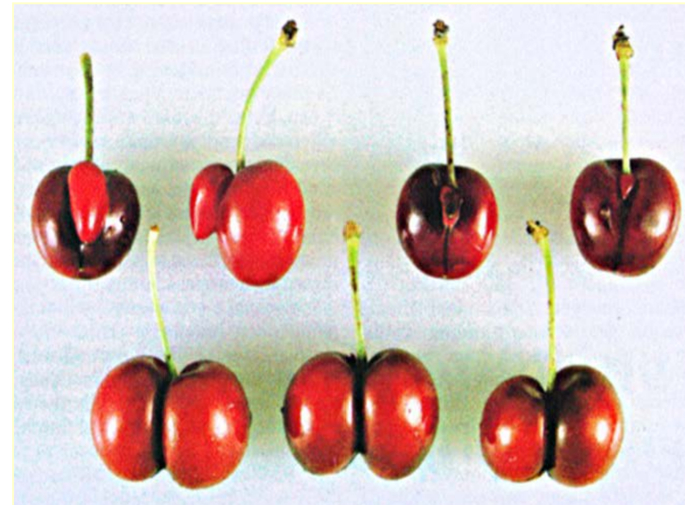
Deciduous trees (most but not all): Flower buds form in the growing season prior to bloom. All parts of the flowers are fully formed as the tree enters dormancy.

Flower bud development and fruit quality

Spurred and double fruits occur when multiple pistils develop within a bud.



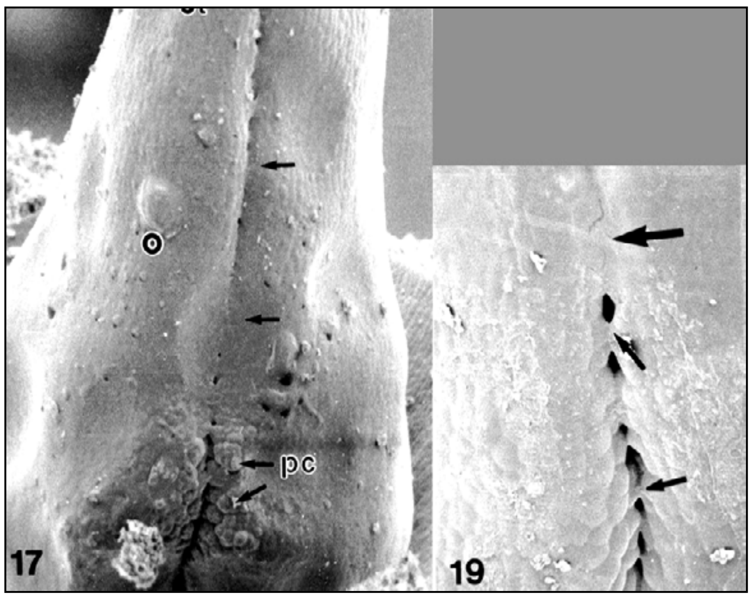
Double pistils at early flower development stage



Fruit developmental abnormalities

Flower bud development and fruit quality

"Zippering" and "incomplete sutures" occur when two sides of the carpel do not fuse properly.



Flower developmental stage

Fruit developmental abnormality

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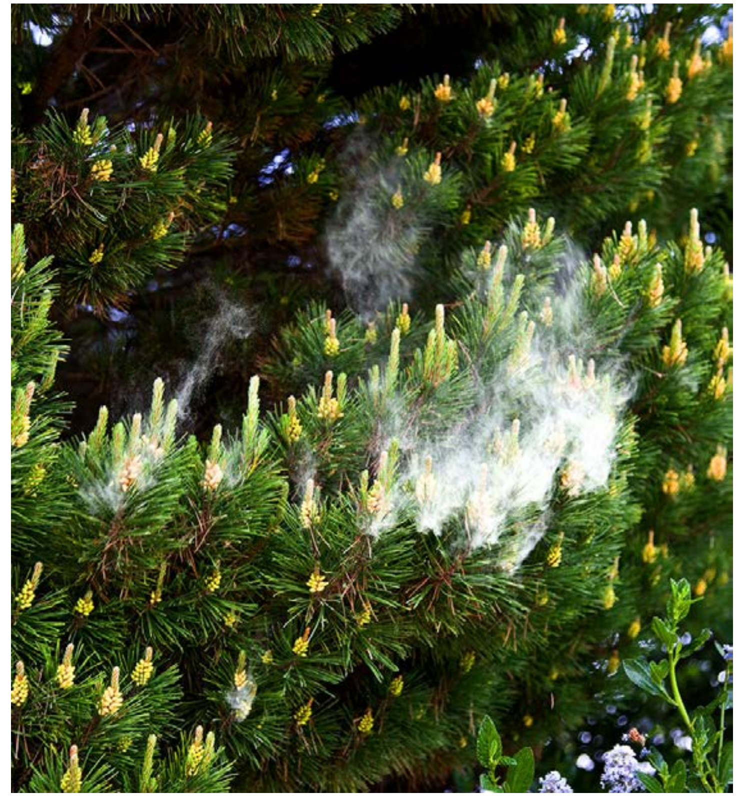
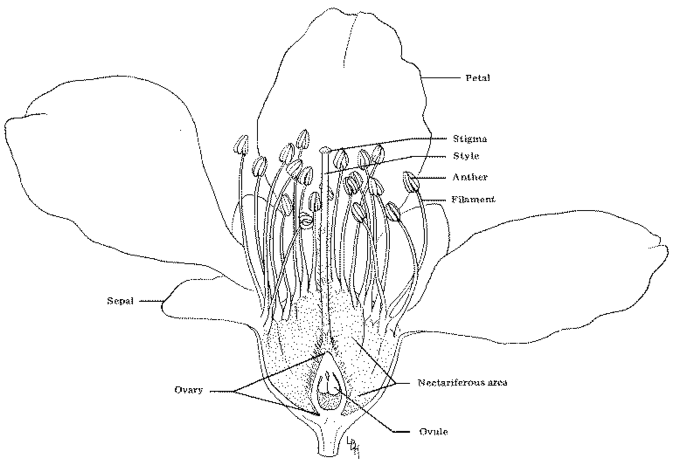
Pollination and pollen transfer

Pollination: transfer of pollen from anther to a stigma

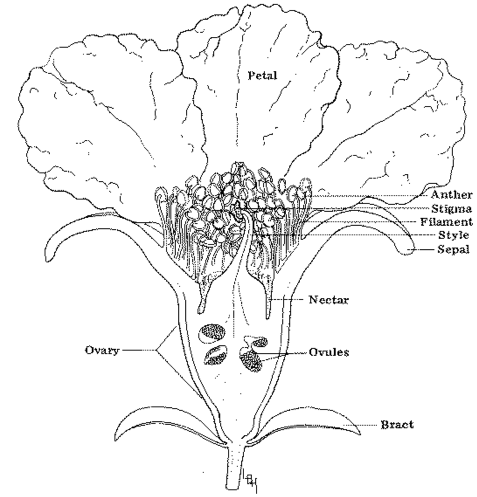


Insects and **wind** are the two primary modes of pollen transport in fruit and nut tree crop species grown in California.

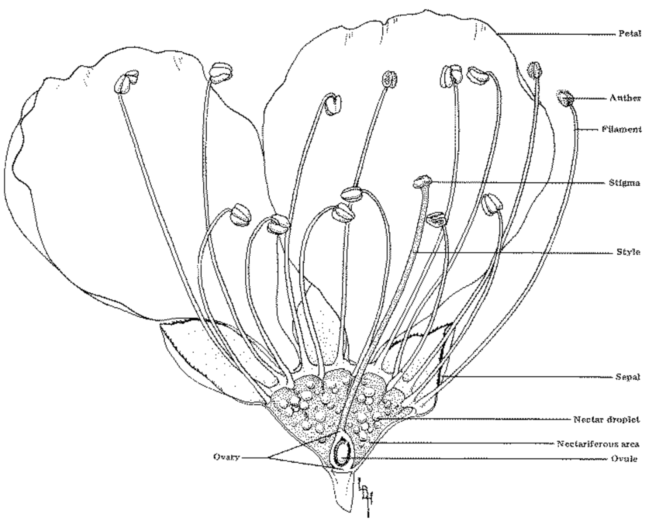
Insect pollinated flowers



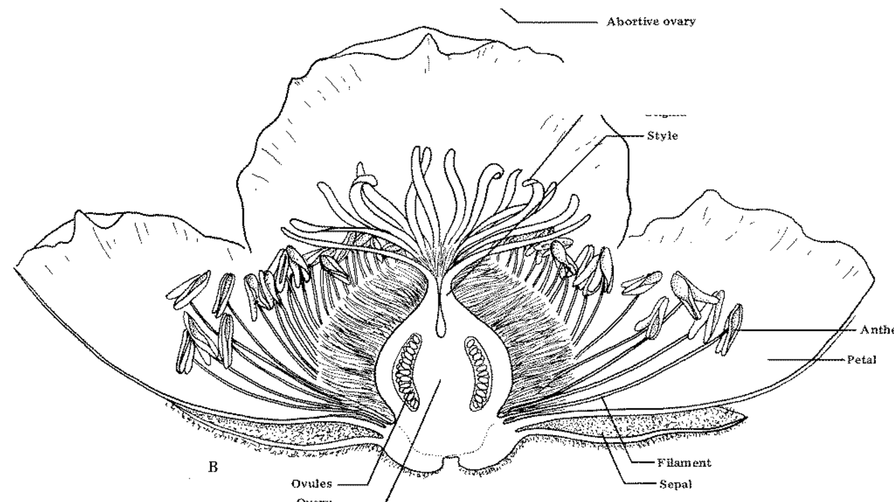
Almond



Pomegranate



Plum

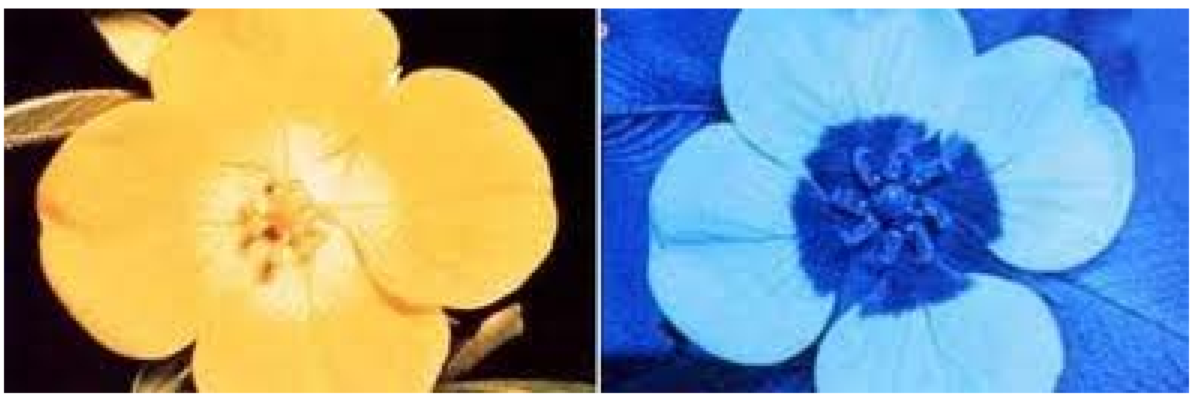


Kiwifruit

Insect pollinated flowers typically have showy petals, nectar and scent

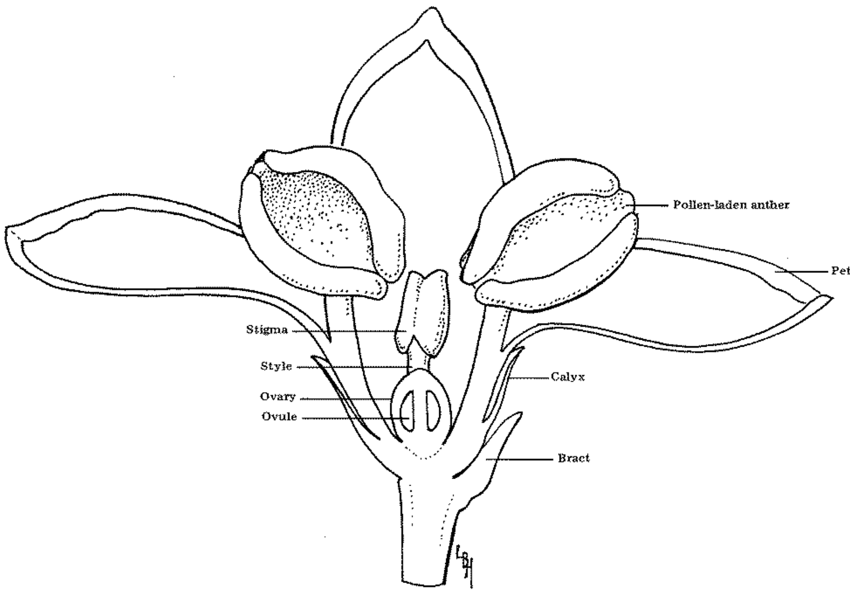
Insect pollinated flowers

Insect pollinated flowers

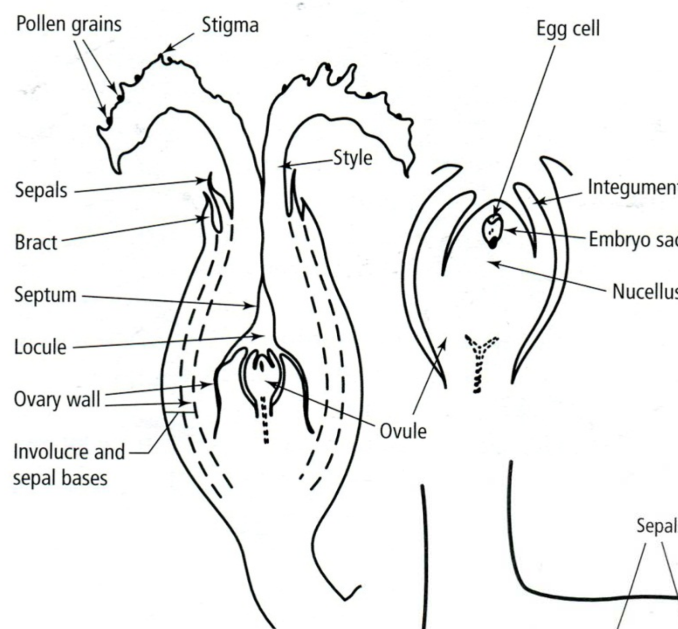


Nectar guides visible in the ultraviolet spectrum

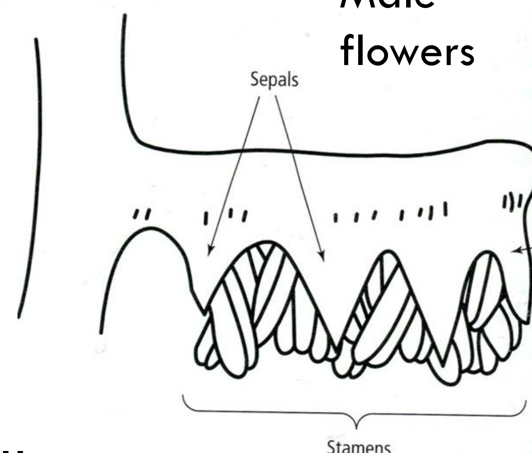
Wind pollinated flowers



Olive



Female flower



Male flowers

Walnut

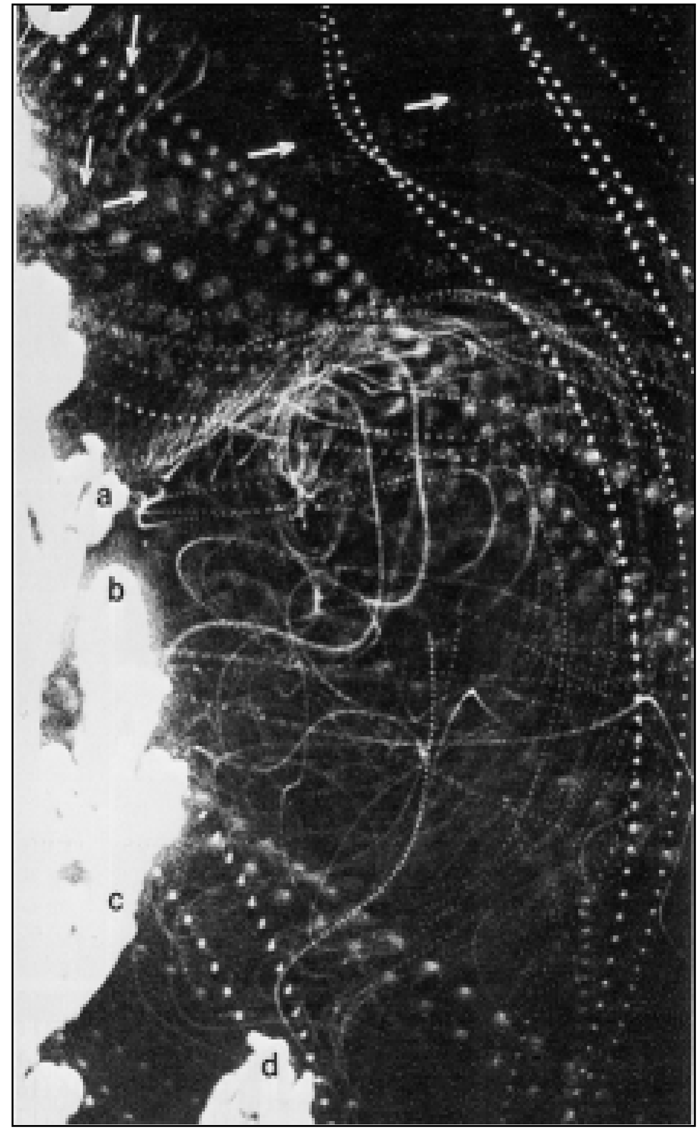
Wind pollinated flowers typically:

- Lack petals, nectar and scent
- Large feathery stigmas to catch pollen from air flow
- Large exerted anthers

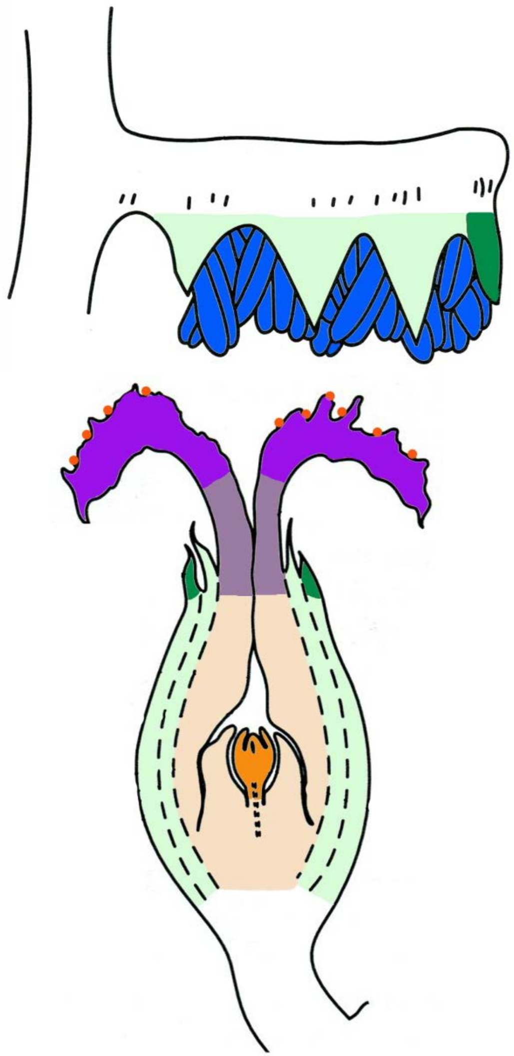
Pollen capture in wind pollinated flowers

Micro-scale wind tunnel experiments

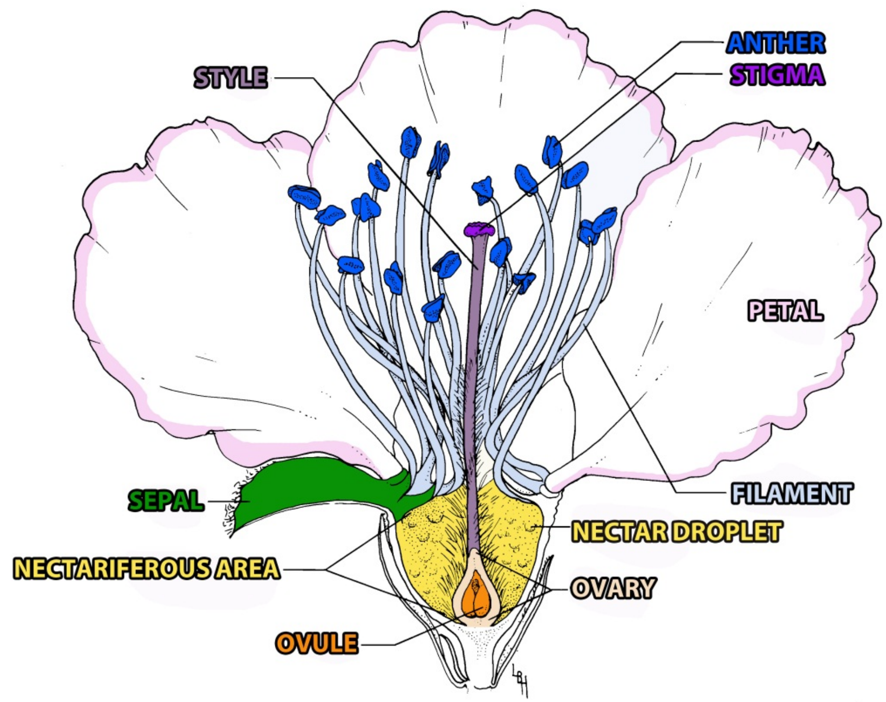
- pollen is not captured at random
- shape and form of the flower structures create air flow patterns that direct the pollen to the stigma surfaces



Similarities between walnut and peach flowers



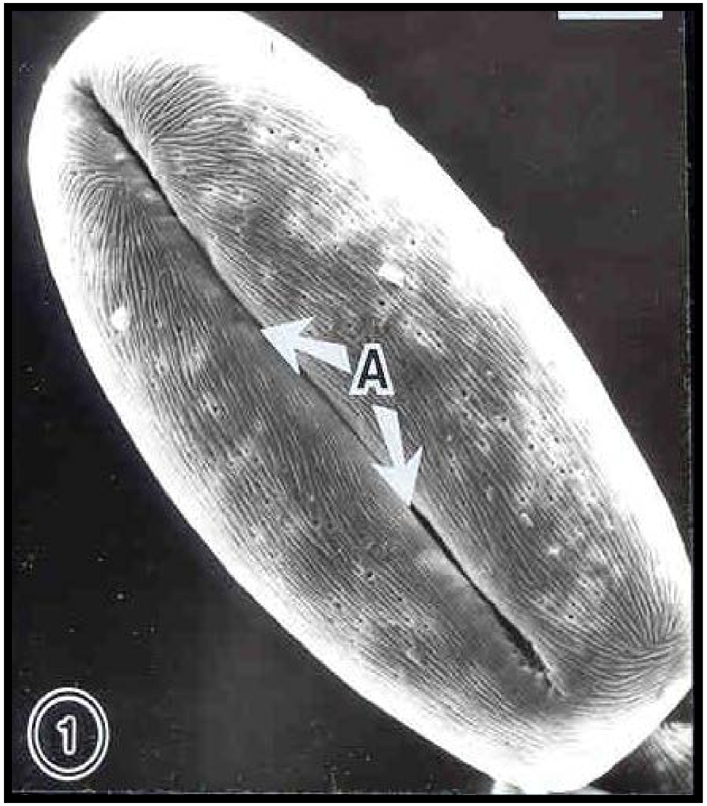
Walnut (wind pollinated)

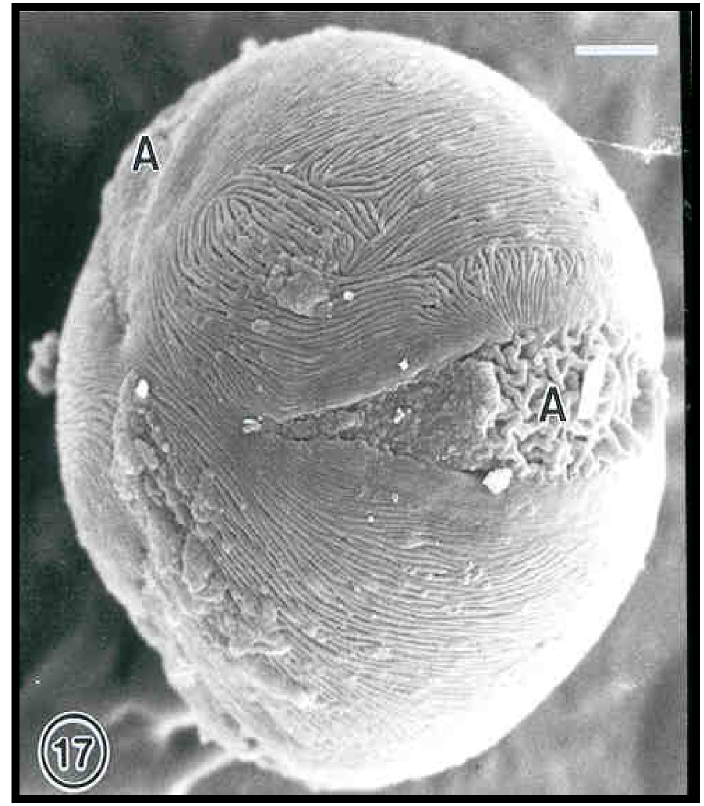


Prunus (insect pollinated)

Crop	Flower type	Dioecious or monoecious?	Pollen transport
Almond	Perfect	monoecious	insect (supplemental pollinator required)
Apple	perfect	monoecious	insect (supplemental pollinator required)
Apricot	perfect	monoecious	insect
Cherry	perfect	monoecious	insect (supplemental pollinator required)
Fig	imperfect	dioecious	wasp (supplemental pollinator required)
Kiwifruit	imperfect*	dioecious*	insect (supplemental pollinator required)
Olive	both perfect & imperfect**	monoecious	wind
Peach & Nectarine	perfect	monoecious	insect
Pear	perfect	monoecious	insect (supplemental pollinator required)
Pecan	imperfect	monoecious	wind
Persimmon	both perfect & imperfect	monoecious & dioecious***	insect
Plum	perfect	monoecious	insect (supplemental pollinator required)
Prune	perfect	monoecious	insect (supplemental pollinator required)
Pistachio	imperfect	dioecious	wind
Pomegranate	perfect	monoecious	insect (supplemental pollinator required)
Quince	perfect	monoecious	insect
Walnut	imperfect	monoecious	wind

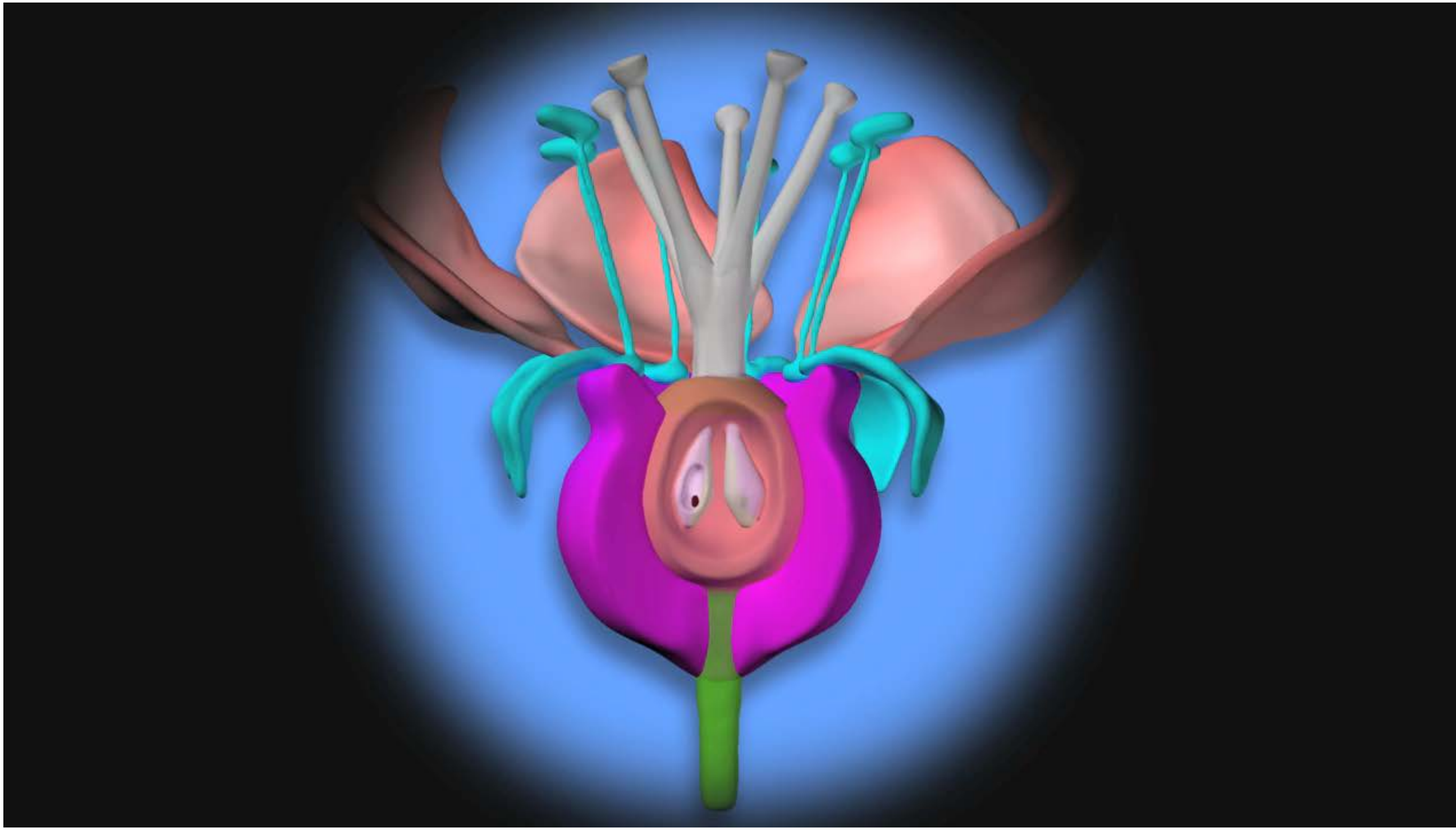
Pollen and pollination





- Pollen is released from the anther as a dehydrated cell.
- When pollen lands on a stigma it rapidly hydrates in the fluid present on the stigma surface.

What happens after pollination?



Pollination: pollen lands on stigma

1. Pollen tube germinates
2. Pollen tube grows down style
3. Pollen fertilizes an ovule

Relationship between pollination and quality

Insufficient pollination:

- Developing seeds provide signals to accessory tissue to develop
- Insufficient pollination results in small and/or asymmetrical fruit

Parthenocarpy

Parthenocarpy: Production of fruit without fertilization of ovules (seedless fruit)

- Bartlett pears in California are mostly set parthenocarpically
- Persimmon is commonly planted in solid blocks far away from other trees to encourage parthenocarpy

Parthenocarpy

California

Oregon

- Bartlett pears in Sacramento Delta and Clearlake , CA and produce parthenocarpic fruit
- In other growing regions, including Oregon, Bartlett requires cross pollination and fertilization to produce fruit
- Consistent differences in fruit shape between California and Oregon Bartlett pears

Mechanisms that limit self pollination in plants

Self pollination: pollen is transferred from the anther to a stigma within the same individual

1. Flower anatomy

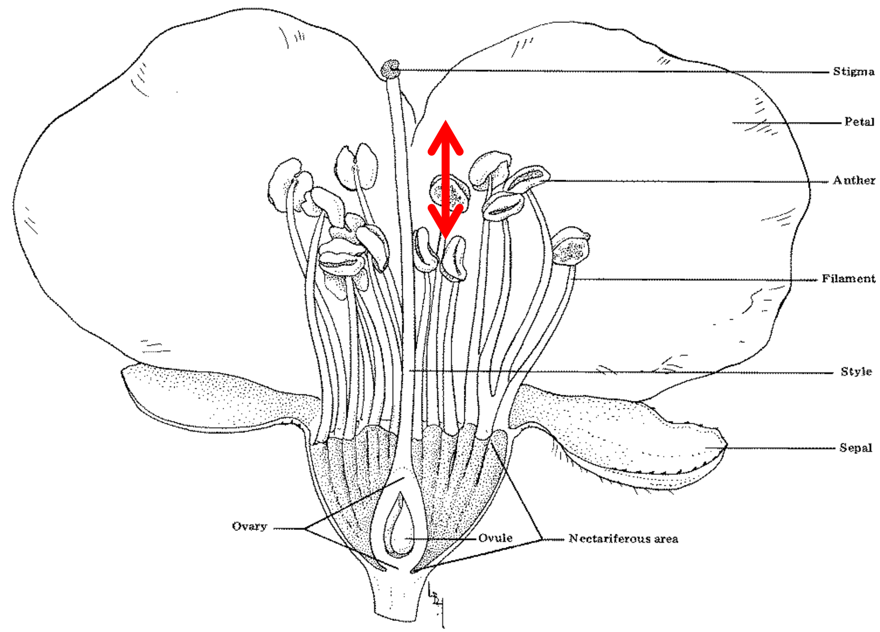
2. Spatial separation of imperfect flowers

3. Temporal separation

4. Self incompatibility

Mechanisms to limit self-pollination: Flower anatomy

Example: “heterostyly”



Example: prune

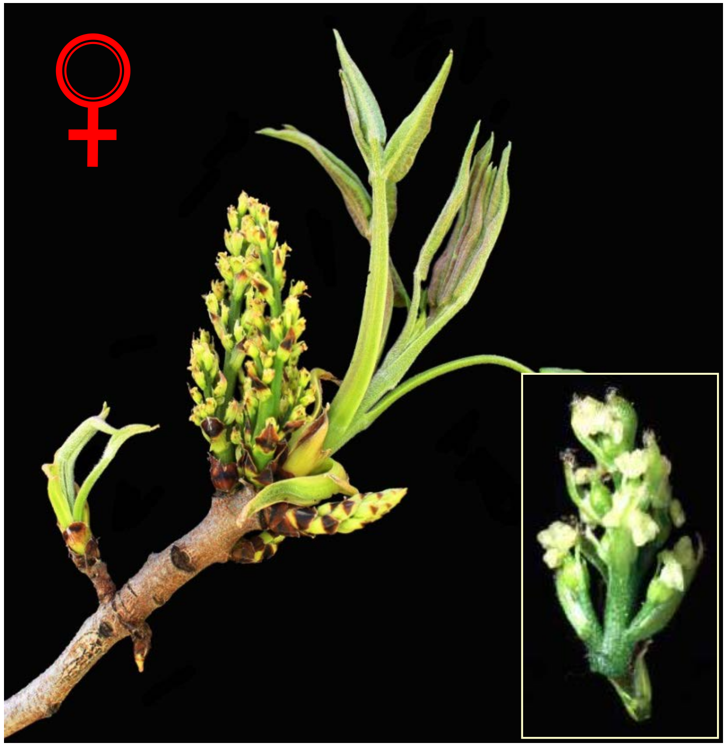
Chasmogamous flowers: anatomy that limits self-pollination

Mechanisms to promote self-pollination: Flower anatomy

Peach

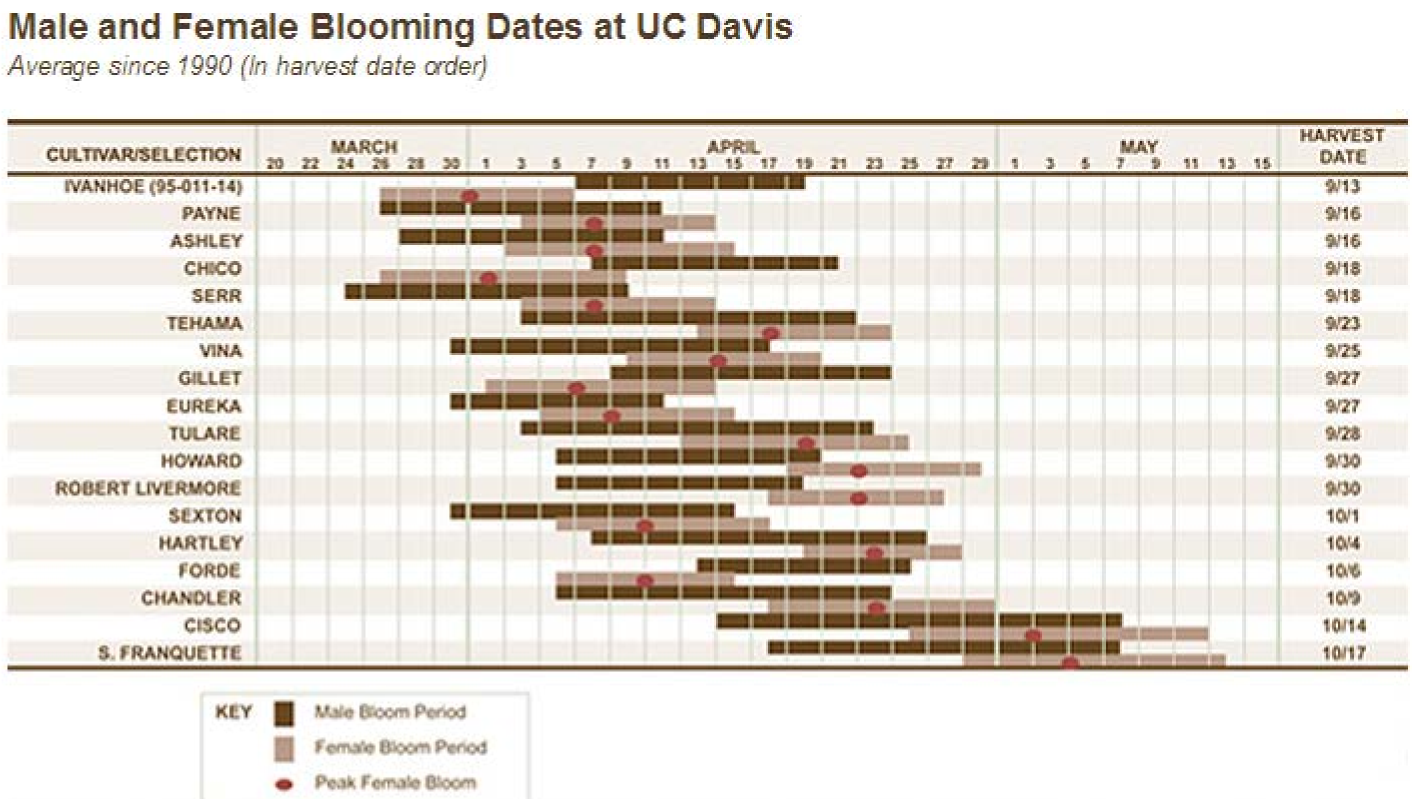
Cleistogamous flowers: anatomy that facilitates self-pollination

Mechanisms to limit self-pollination: Dioecy



Spatial separation: separate male and female individuals (technical term: dioecy) examples. pistachio, kiwifruit, and some persimmon

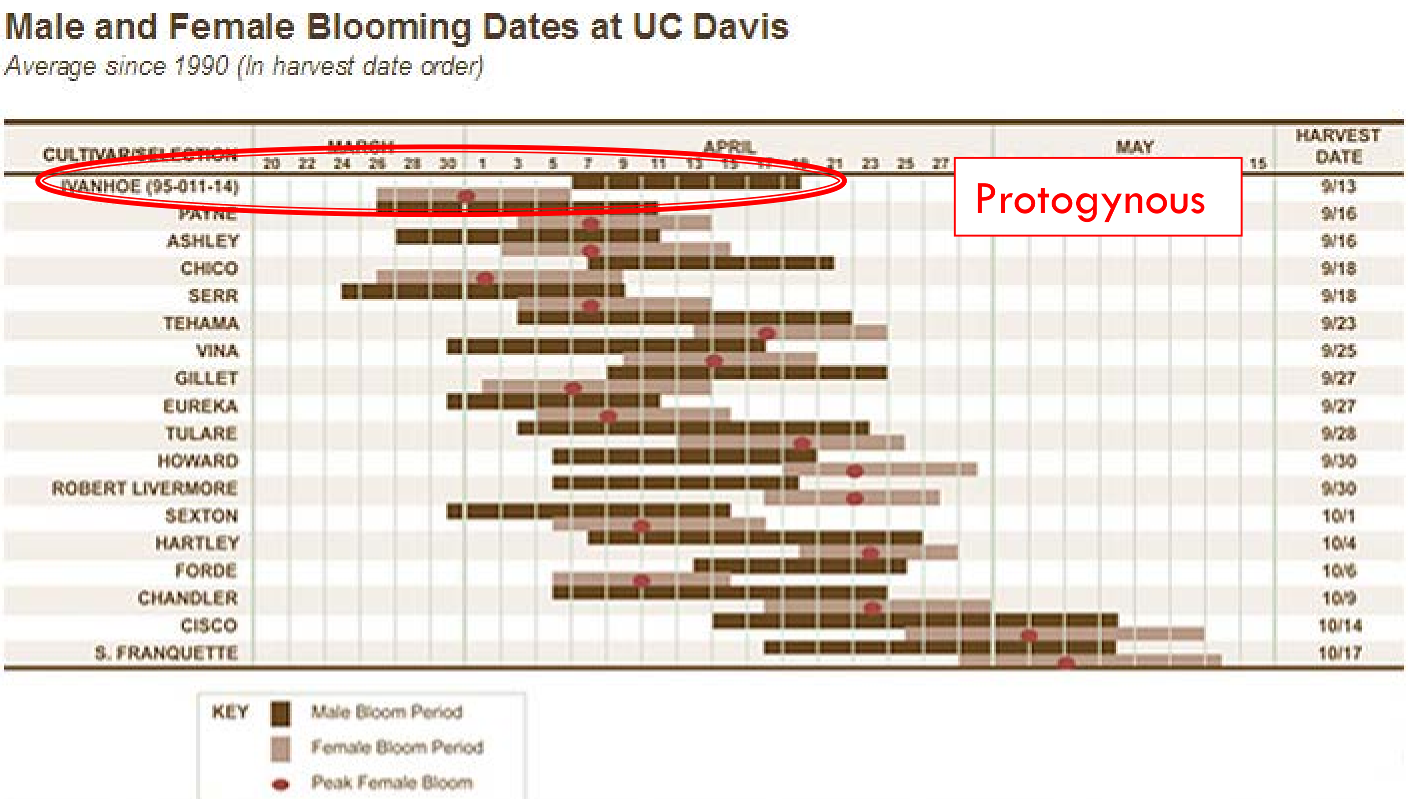
Mechanisms to limit self-pollination: Dichogamy



Temporal separation: male and female organs mature at different times (technical term: dichogamy) example: walnuts

Chart from www.BurchellNursery.com

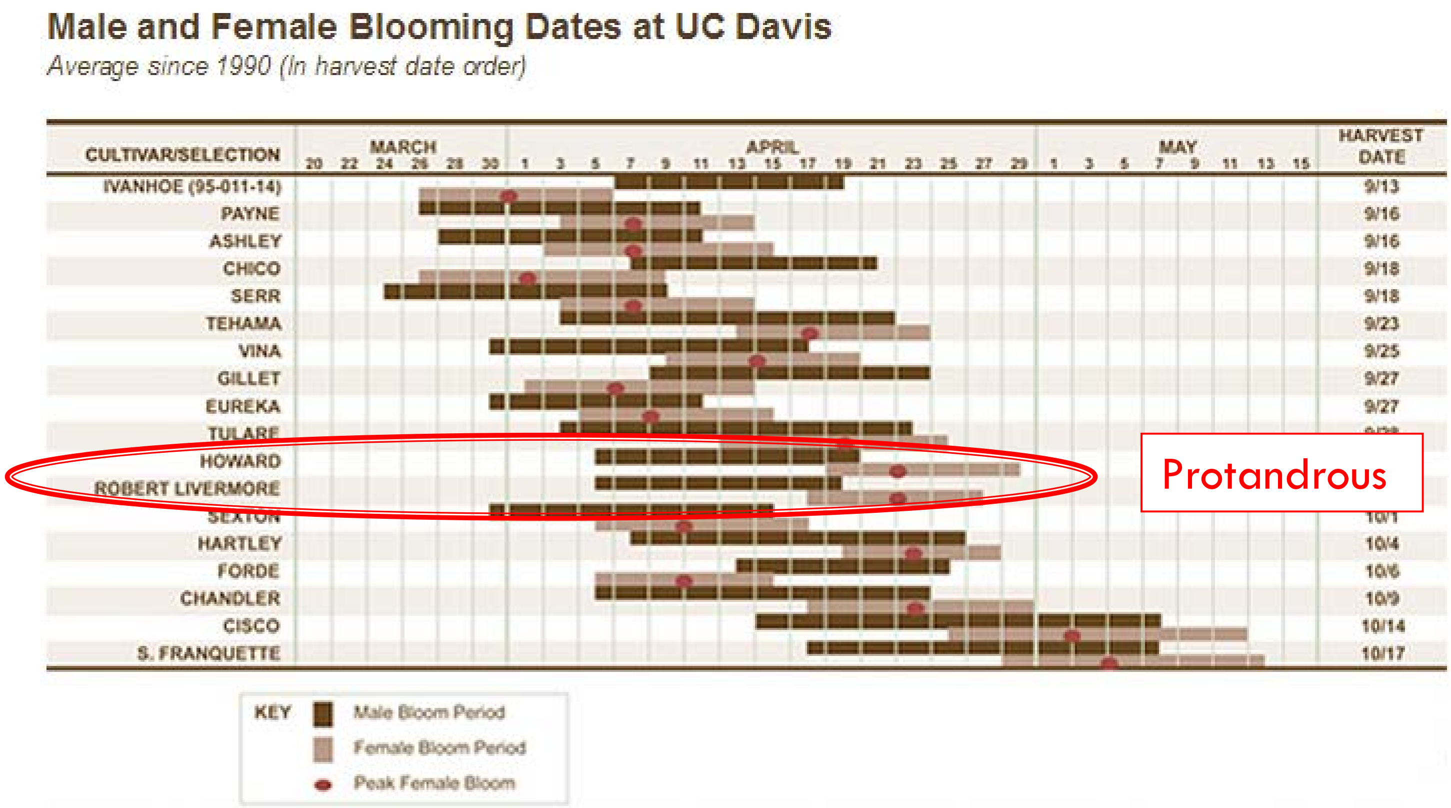
Mechanisms to limit self-pollination: Dichogamy



Temporal separation: male and female organs mature at different times (technical term: dichogamy) example: walnuts

Chart from www.BurchellNursery.com

Mechanisms to limit self-pollination: Dichogamy

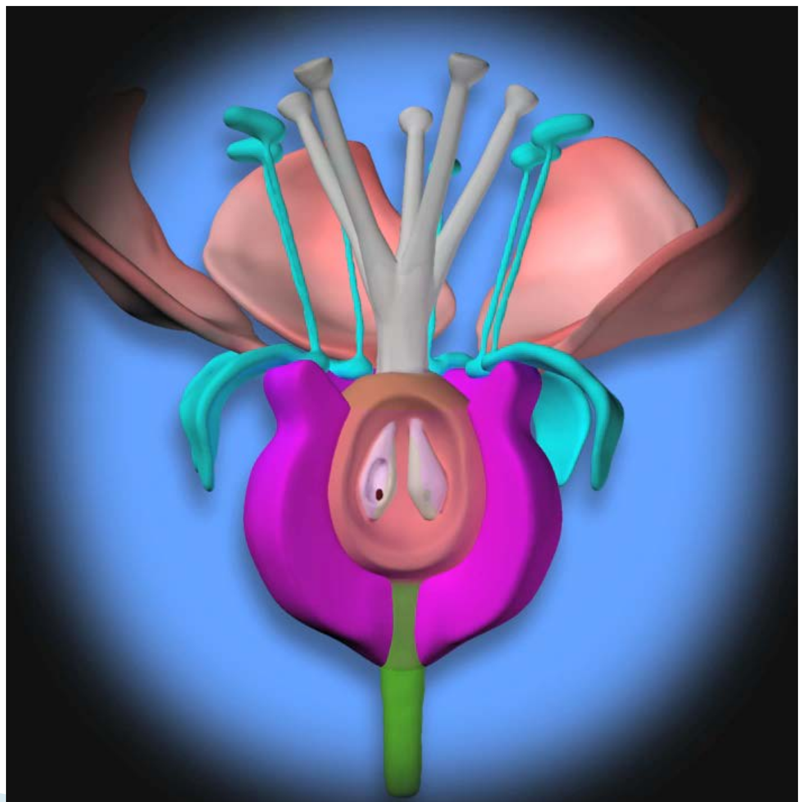


Temporal separation: male and female organs mature at different times (technical term: dichogamy) example: walnuts

Chart from www.BurchellNursery.com

Mechanisms to limit self-pollination: Self incompatibility

Does all pollen transferred to a stigma result in fertilization and fruit development?



Mechanisms to limit self-pollination: Self incompatibility

Does all pollen transferred to a stigma result in fertilization and fruit development? Not necessarily

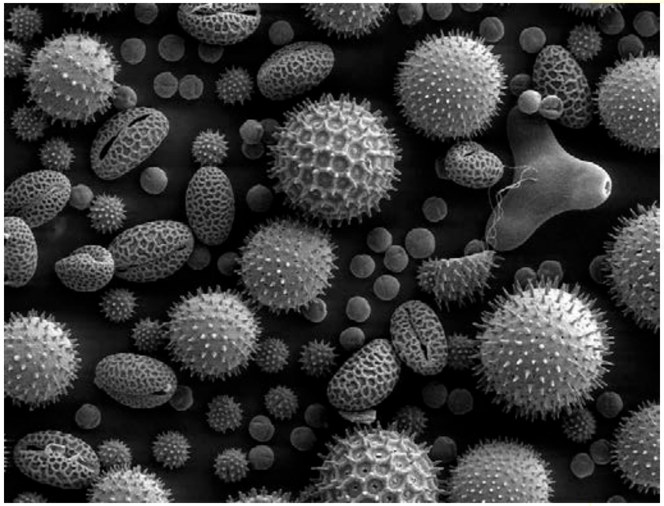
Self incompatibility: the inability of a flower to support growth of pollen from the same tree or cultivar

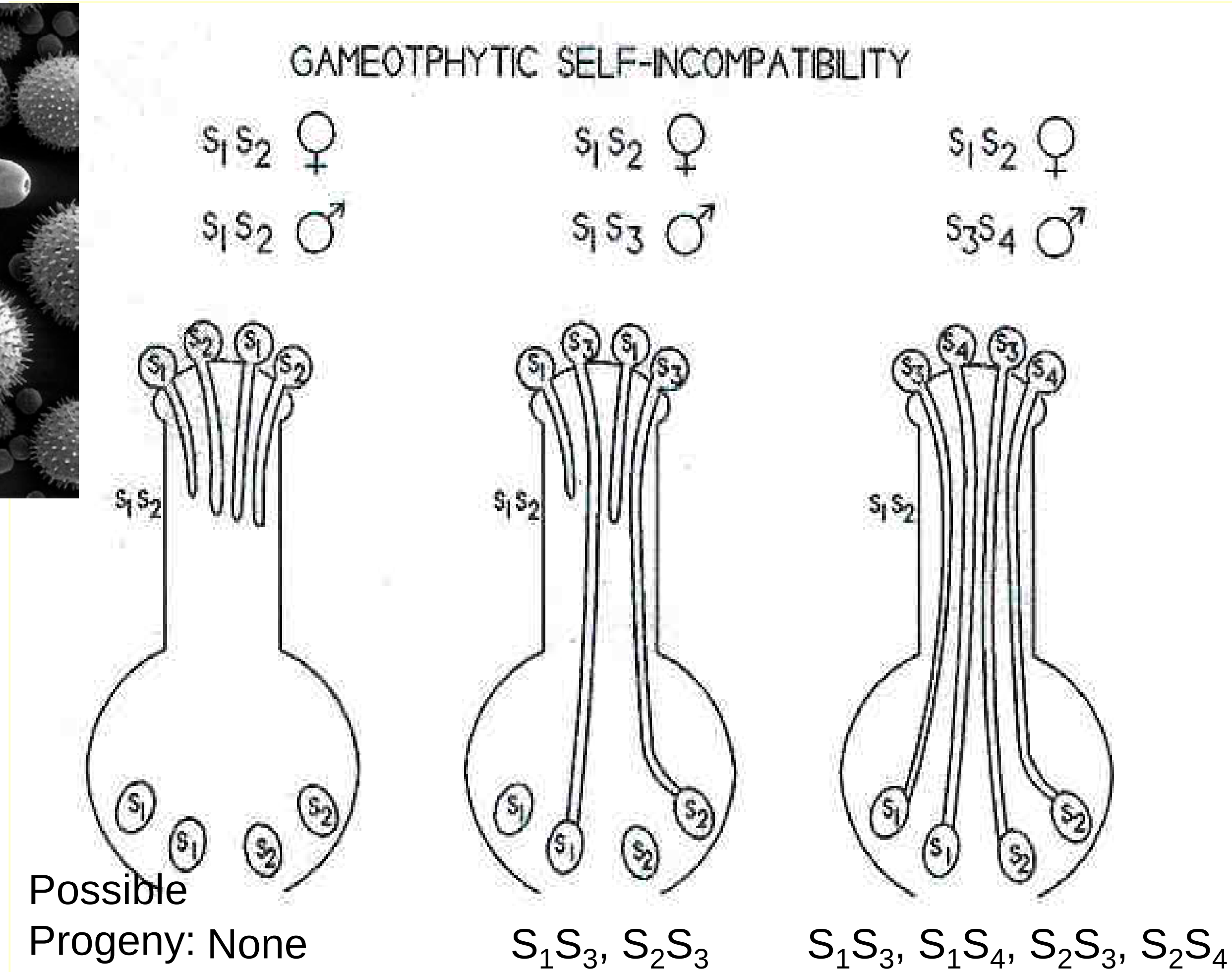
- Gametophytic self incompatibility is determined by the "S" locus on chromosomes.

- Pollination occurs when the allele carried by a pollen grain is different from either of the alleles in the stigma

- Pollen with the same allele as those in the stigma is rejected

Mechanisms to limit self-pollination: Self incompatibility





Example of gametophytic self incompatibility

Mechanisms that limit self-pollination in plants

1. Flower anatomy
2. Spatial separation of imperfect flowers
3. Temporal separation
4. Self incompatibility

These mechanisms only make life and reproduction more complicated for plants!

Why might it be advantageous for plants to have mechanisms that limit self-pollination and fertilization?

Self incompatibility in fruit and nut tree crops

Stone fruit

- Peach, nectarine and apricot are self compatible
- Sweet cherry, almond and plum are self-incompatible

Pome fruit

- Apples are partially self incompatible and require pollinizers for optimum fruit size and quality.
- Some apple cultivars accept self pollen at the end of bloom.
- Pears are self-incompatible (but in some areas most fruit produced is parthenocarpic)

Other

- Olives are self compatible at low temperatures but reject self-pollen at high temperatures

Managing self incompatibility

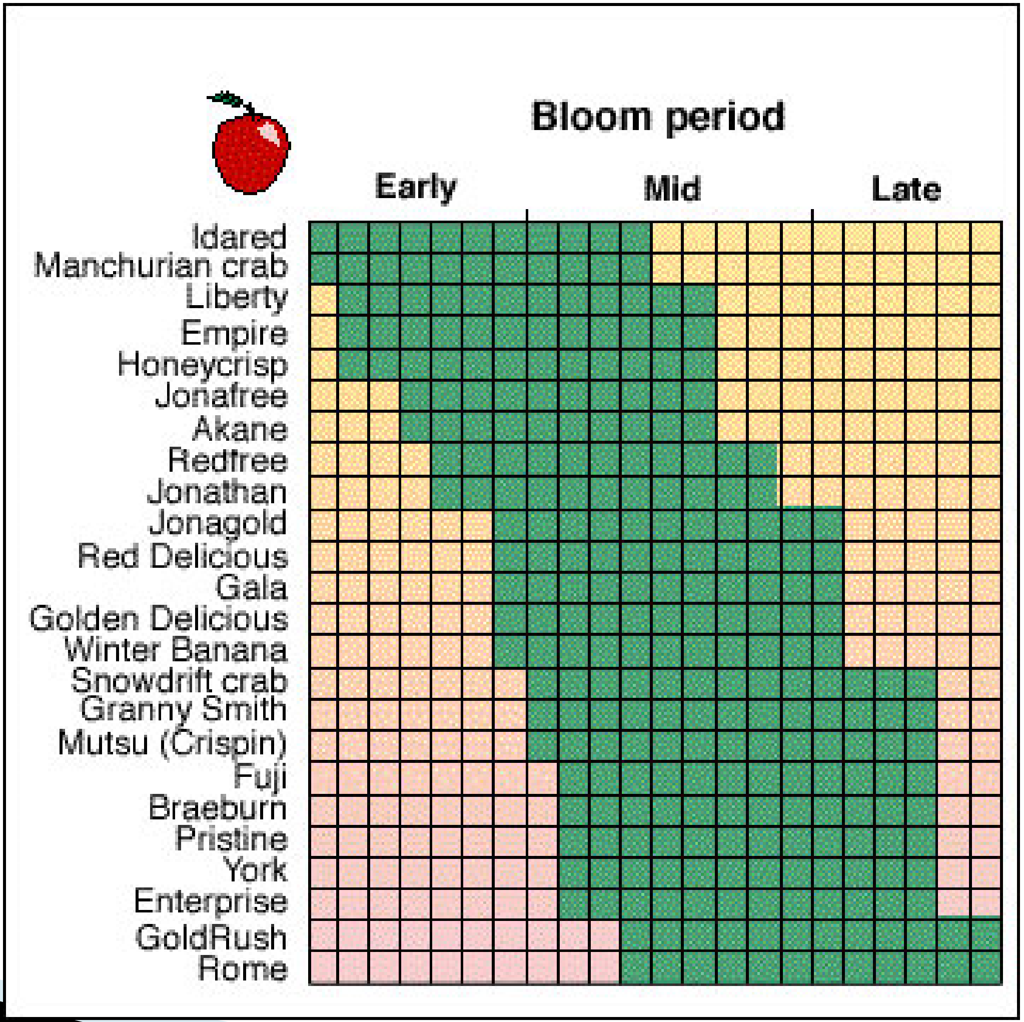
1. Plant compatible pollinizer cultivars along with the primary fruit bearing cultivar

Pollinizer row trained to a single upright trunk

Pollinizer cultivar grafted onto center of fruiting cultivar

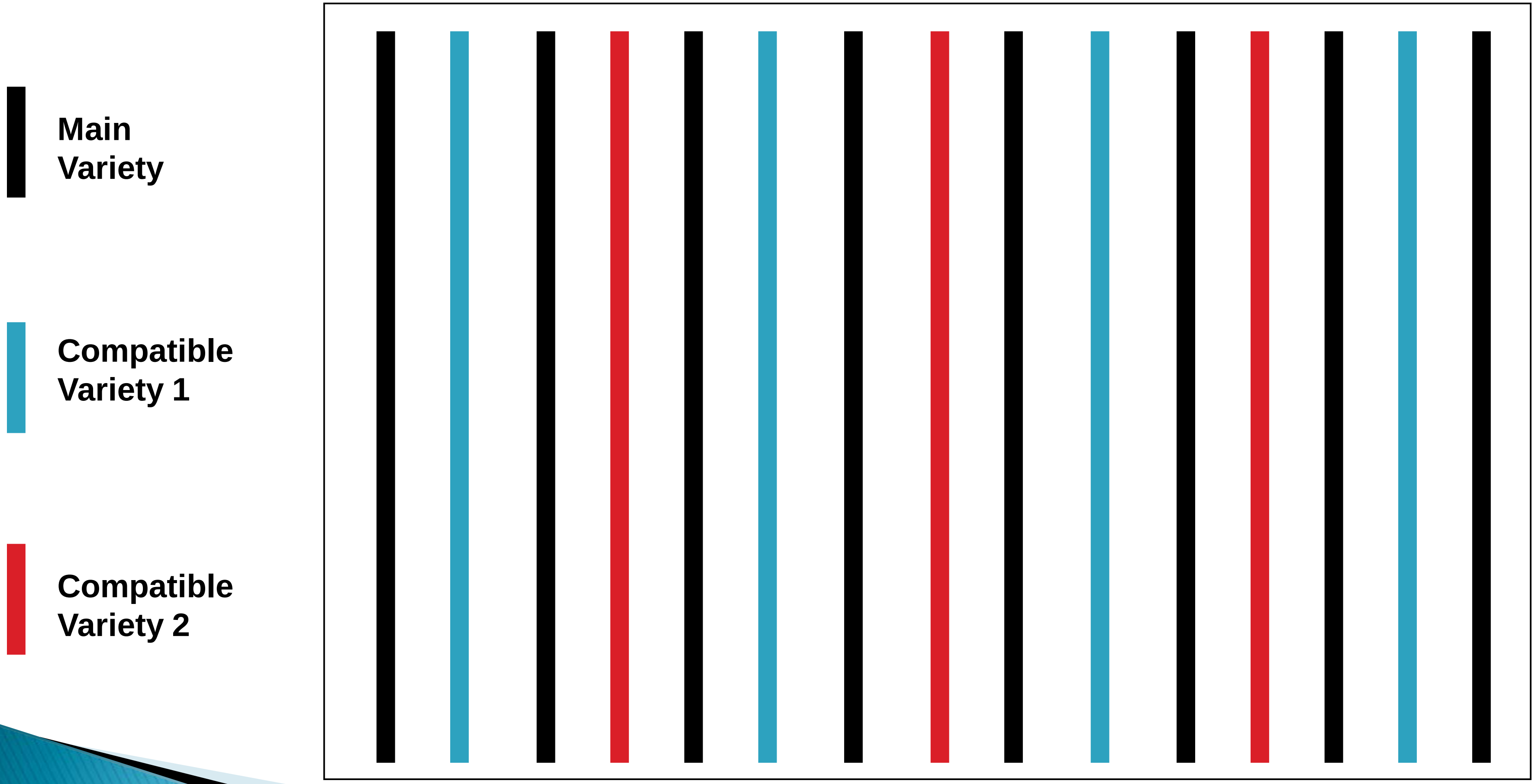
Managing self incompatibility

2. Select compatible cultivars with sufficient overlap in bloom time.



Managing self incompatibility

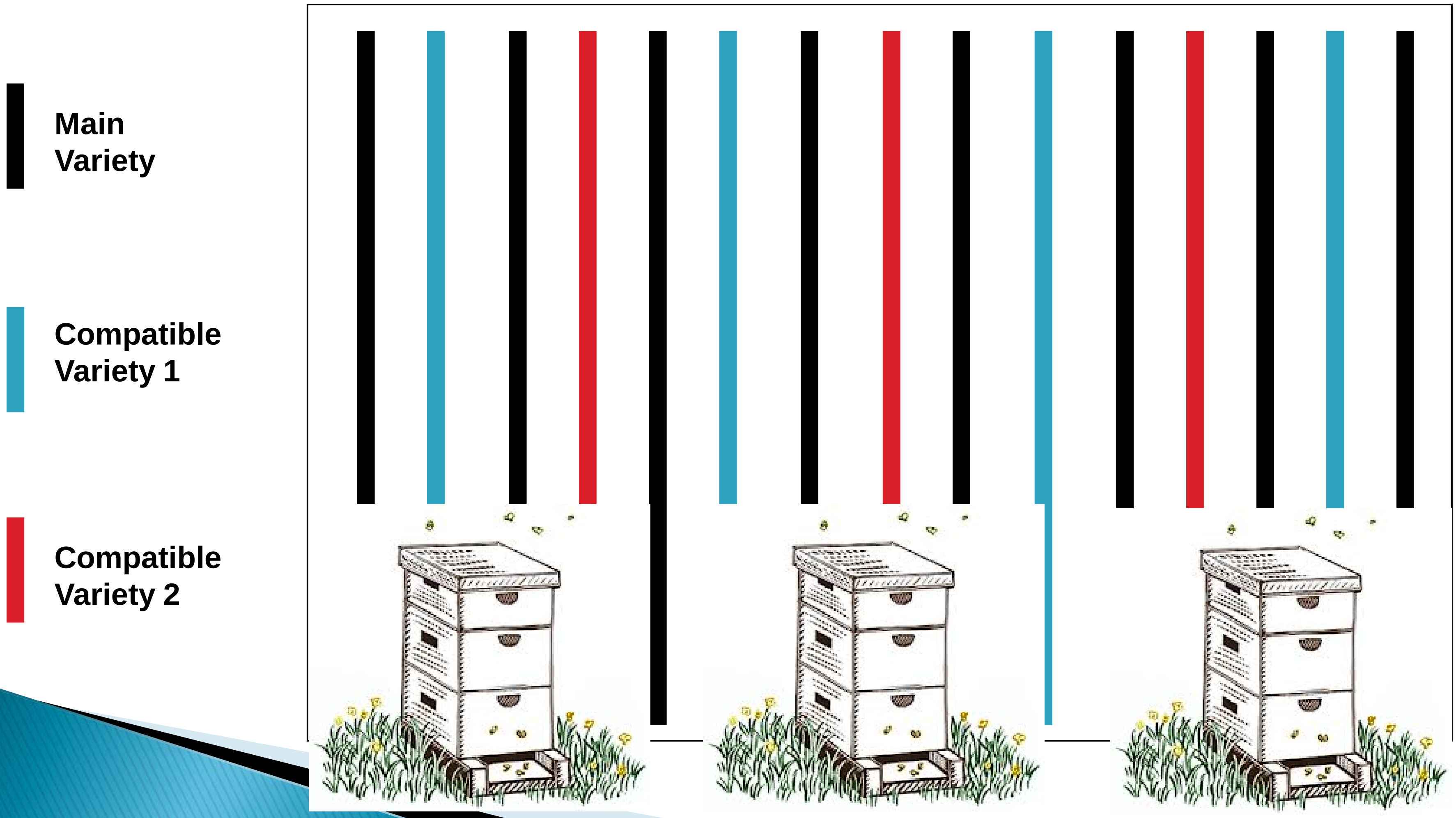
3. Orchard layout must facilitate pollen flow. Honeybees tend to fly up and down rows, not across.



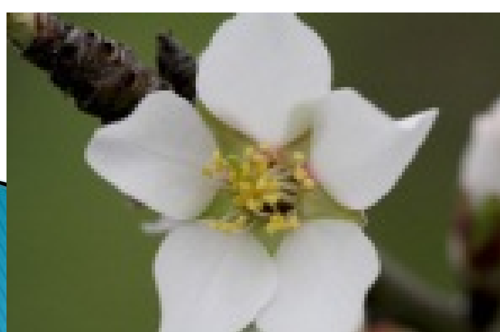
Example of an almond orchard layout

Managing self incompatibility

4. Supplemental honey bees to ensure effective movement of pollen among compatible cultivars.



Managing self incompatibility



Independence® Almond

Independence® Almond ▼

Nut Category
Independence® and California Type

Estimated Chilling Requirement
400 hours below 45°F

Bloom Timing
blooms with Nonpareil

Harvest Timing
with Nonpareil

Approximate Harvest Dates
August 28 to September 13
(approximate for Fresno, CA area)
Almond Maturity Chart

Shell
well-sealed, brittle

Kernel Size & Shape
very large size, high quality, light color, sweet flavor, blanches well

Pollination
self-fertile

Tree Characteristics
upright to moderately spreading and vigorous, a prolific bloomer & excellent producer

Comments
New high quality self-fertile almond, exclusively from Dave Wilson Nursery. Growers are enthusiastic about this variety for its early, heavy production and because it requires only one shaking and one harvest. Research shows that Independence® can set full commercial crops with fewer bees.

Independence® Almond Production Statistics

Developed by Zaiger Genetics. U.S. Plant Patent No. 20295.

New release, success to be determined.

Lecture outline

1. Flower anatomy
   - Structures within a flower
   - Perfect flowers, imperfect flowers, monoecy, and dioecy
2. Flower and fruit development
   - Vegetative and floral tissue
   - Floral bud development and fruit quality problems
3. Pollination
   - Pollination and common modes of pollen transport
   - What happens after pollination?
   - Effective Pollination Period (EPP)
   - Fruit and nut quality issues related to pollination
   - Mechanisms that limit self-pollination
4. Link between flower and fruit anatomy
   - Three primary flower "types"
   - Fruit anatomy

Link between flower and fruit anatomy

Three primary flower types

Three primary flower types in California tree crops:

1. Perigynous

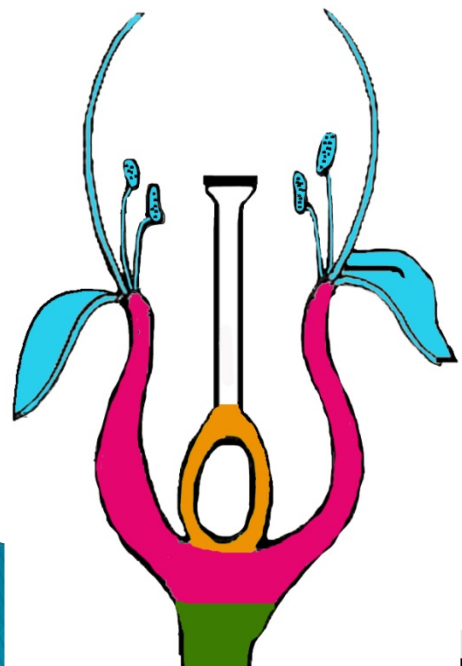
2. Epigynous

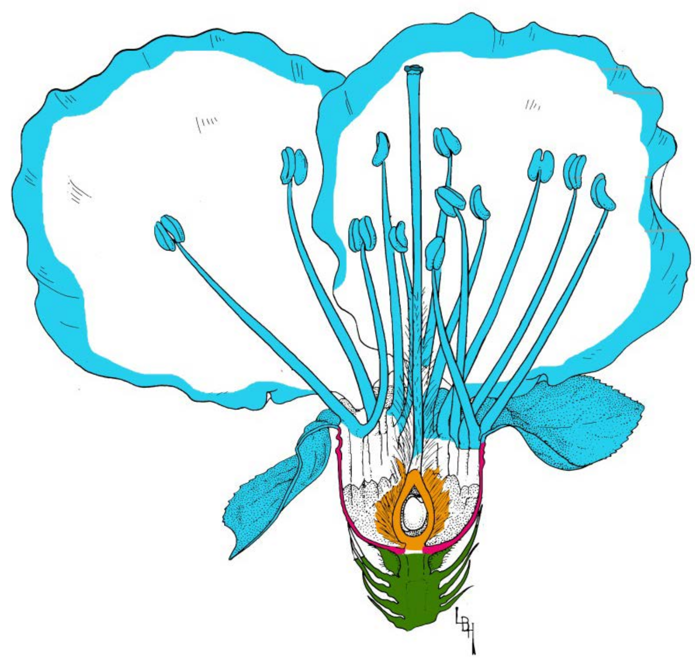
3. Hypogynous

Hypanthium: tissue composed of fused petals, sepals, and stamen

1. Perigynous flowers

Hypanthium forms a cup-like structure surrounding, but not attached to, the ovary

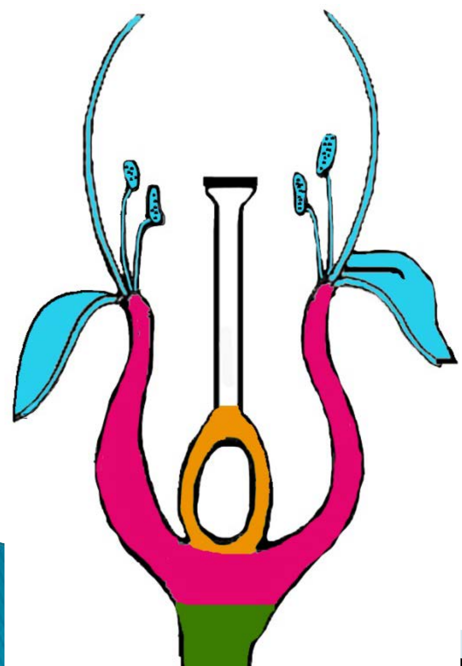


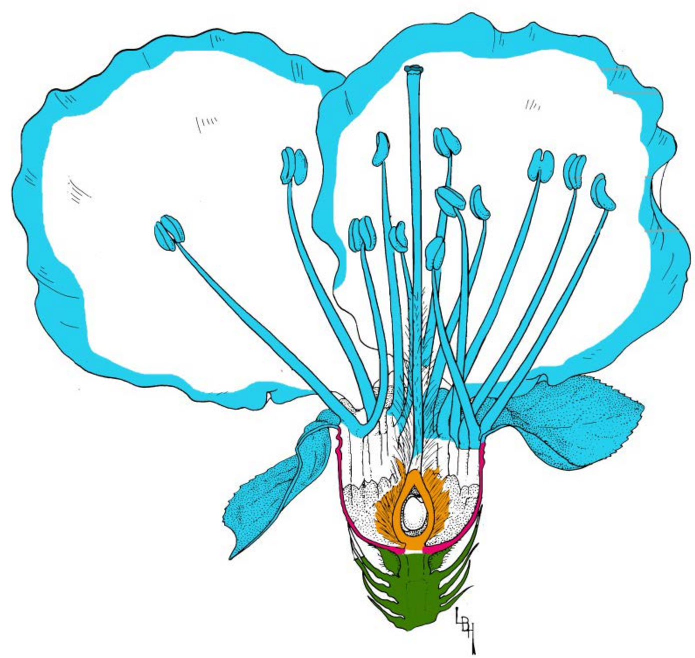


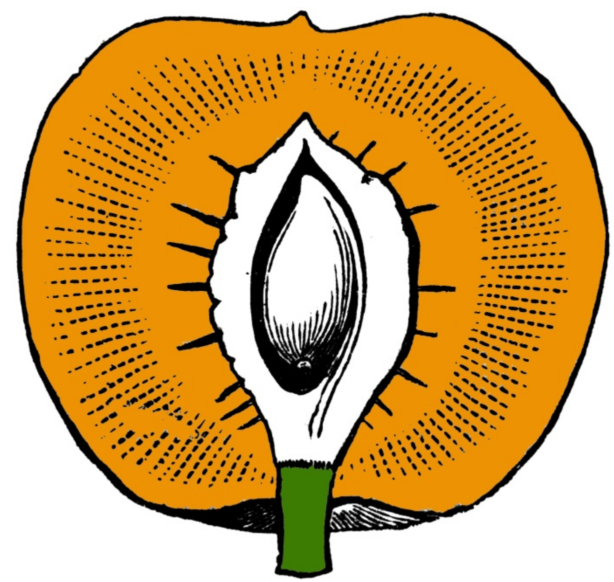
1. Perigynous flowers

After fertilization the hypanthium is shed when the ovary develops into fruit tissue.

As a result, petals and stamen do not remain attached to the fruit.





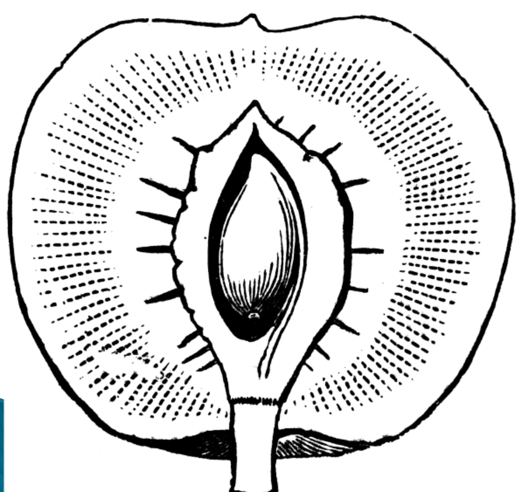


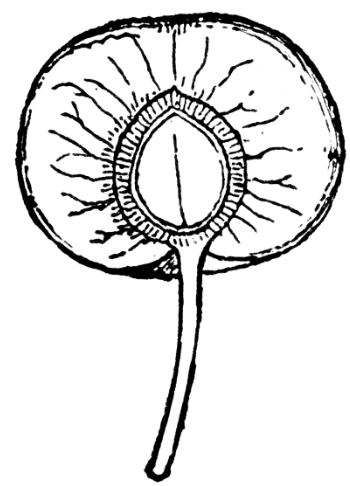
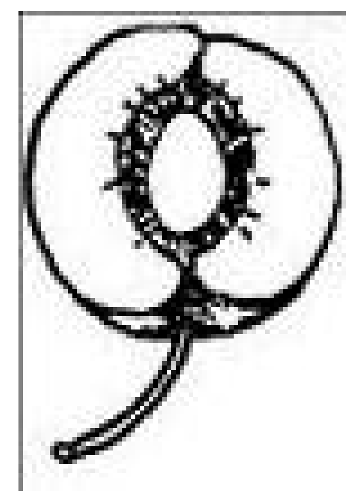
1. Perigynous flowers

Fruit associated with perigynous flowers

Perigynous fruit develop from a single carpel and contain one or two seeds.

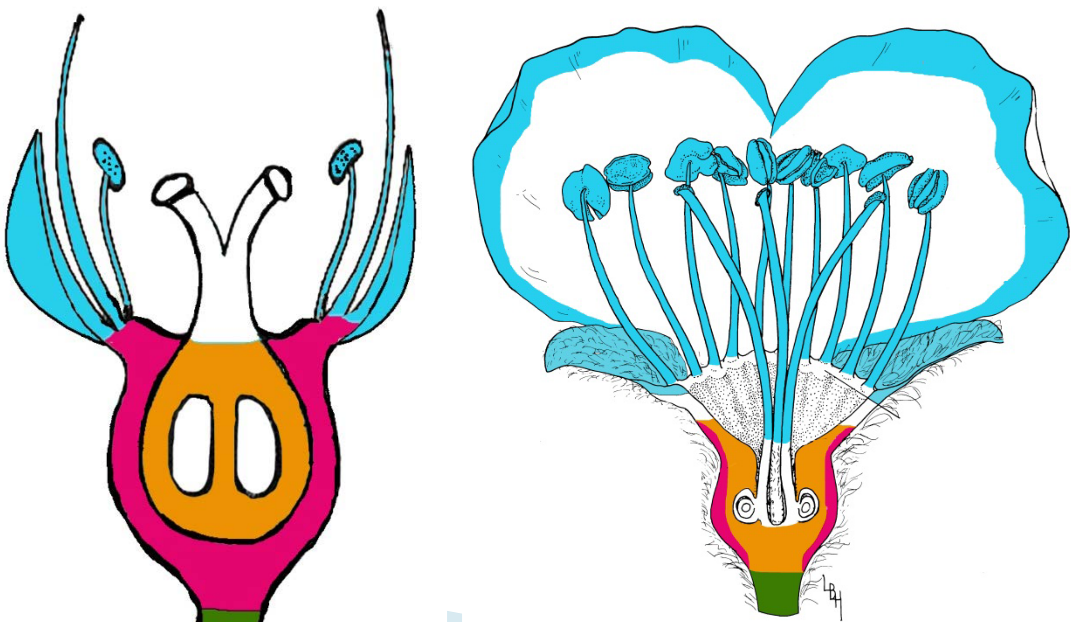
Examples: peach, olive, cherry, plum, apricot and almond



2. Epigynous flowers

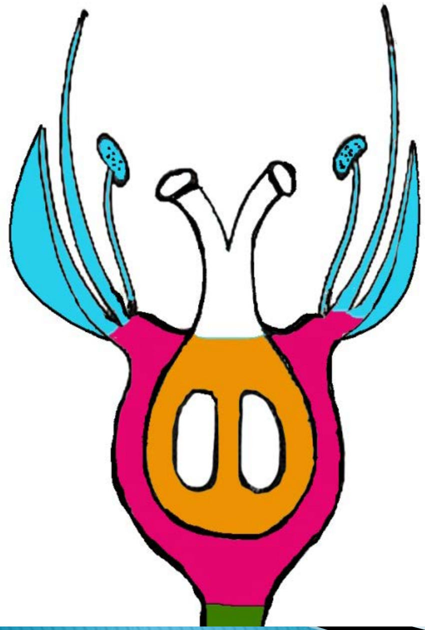
The ovary is inferior and fused to the hypanthium tissue.

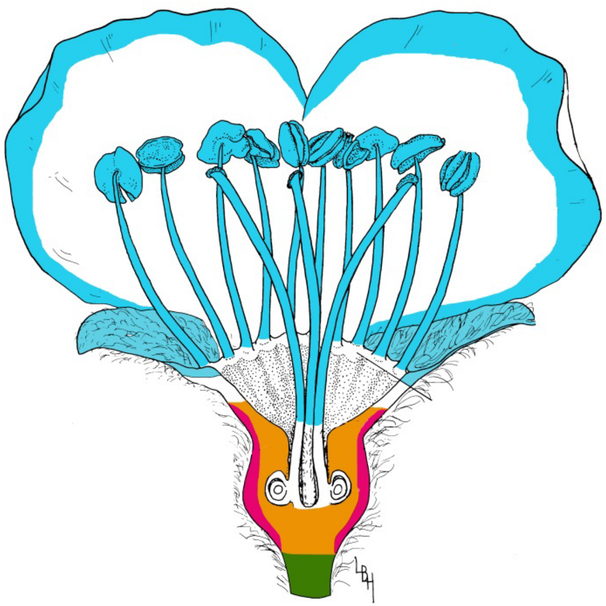


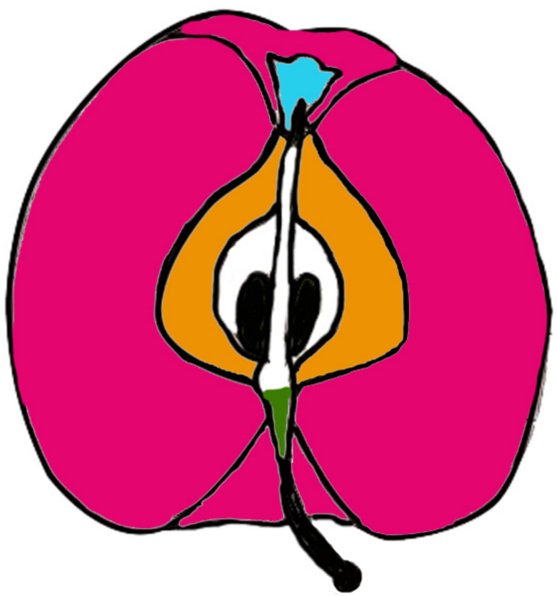
2. Epigynous flowers

After fertilization the hypanthium develops into fruit tissue.

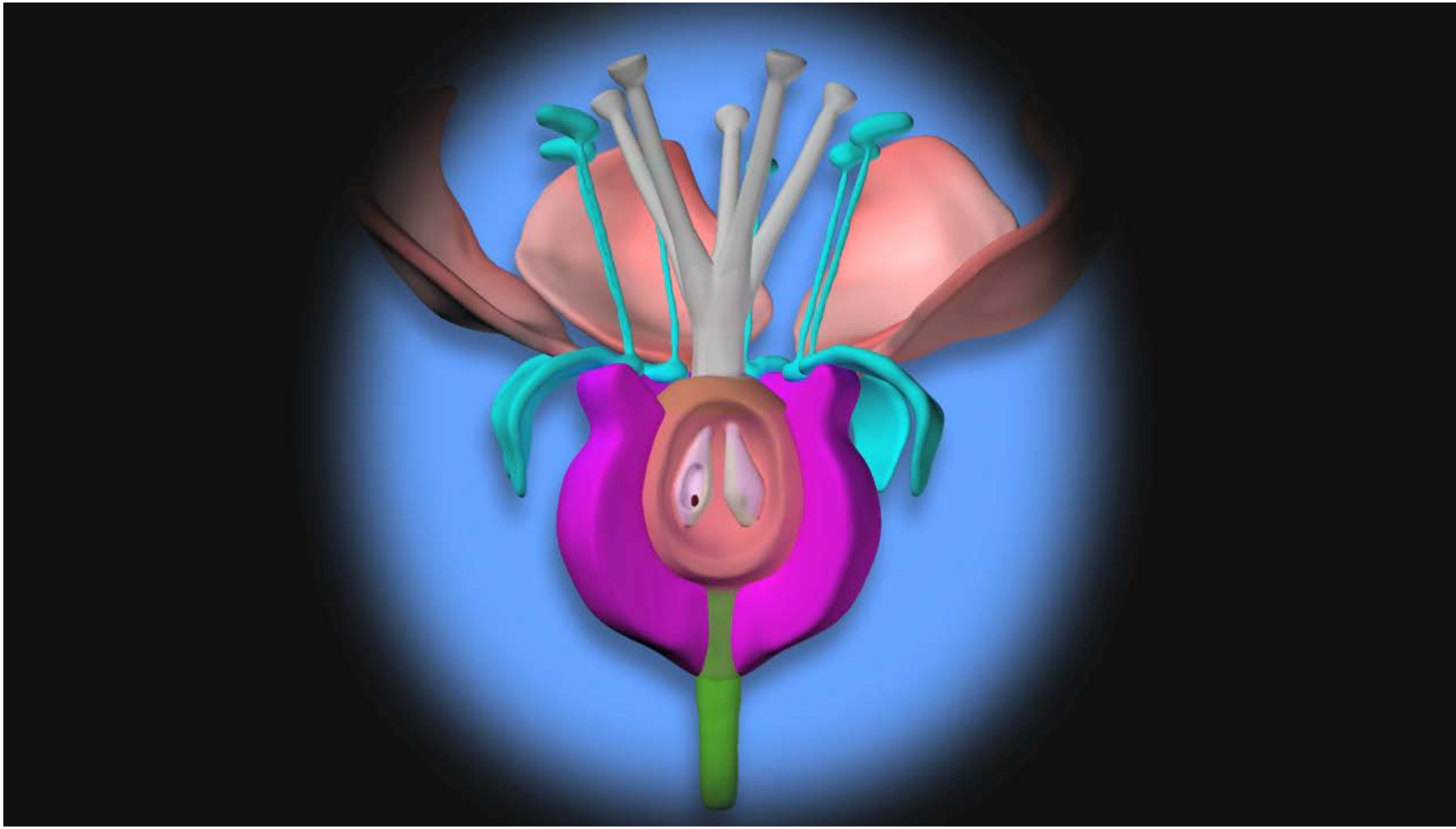
Remnants of the sepals, stamen and style remain attached to the fruit.







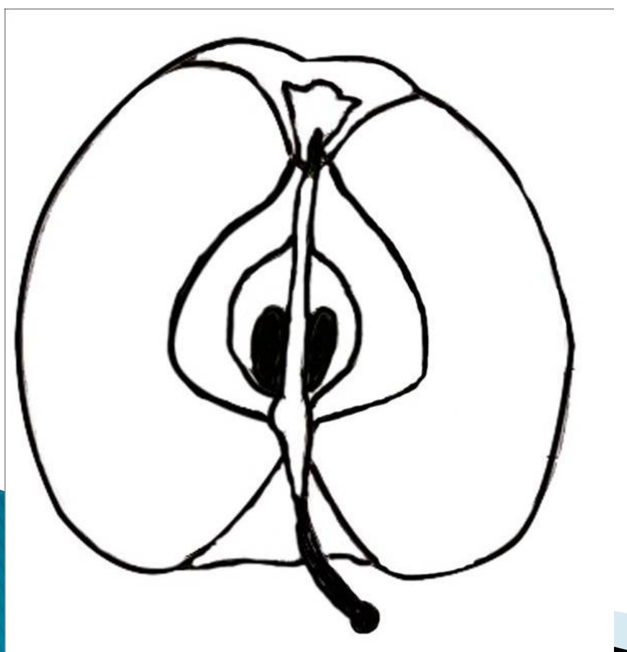
2. Epigynous flowers

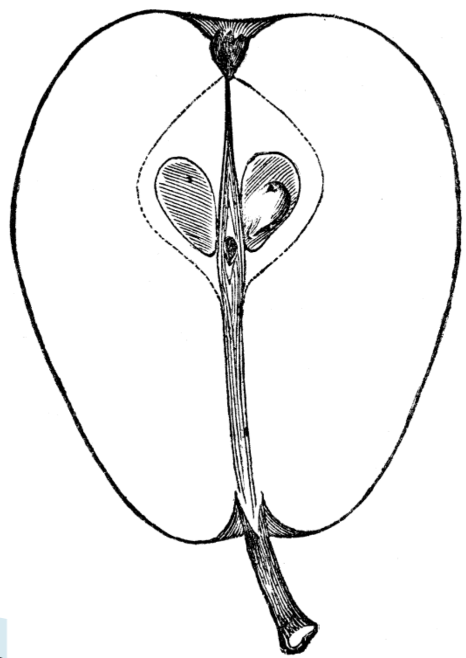


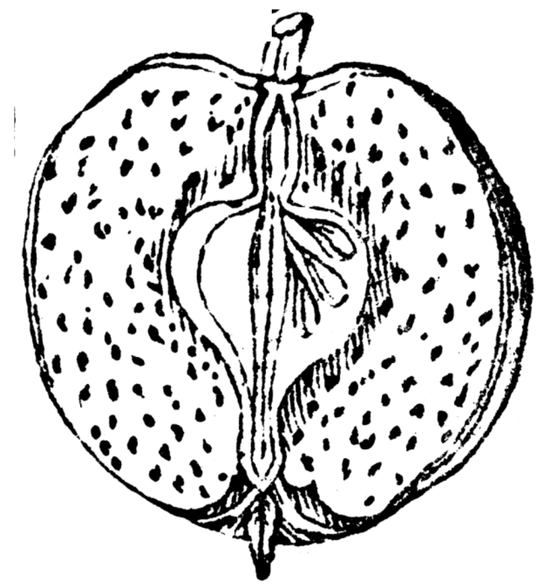
2. Epigynous flowers

Epigynous fruit develop from multiple fused carpels and contain more than two seeds and accessory tissue.

Examples: apple, pear and quince



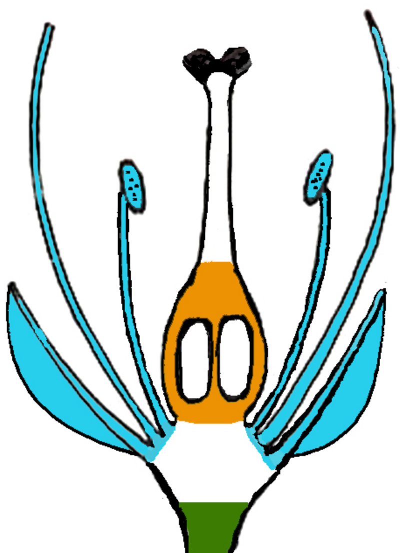


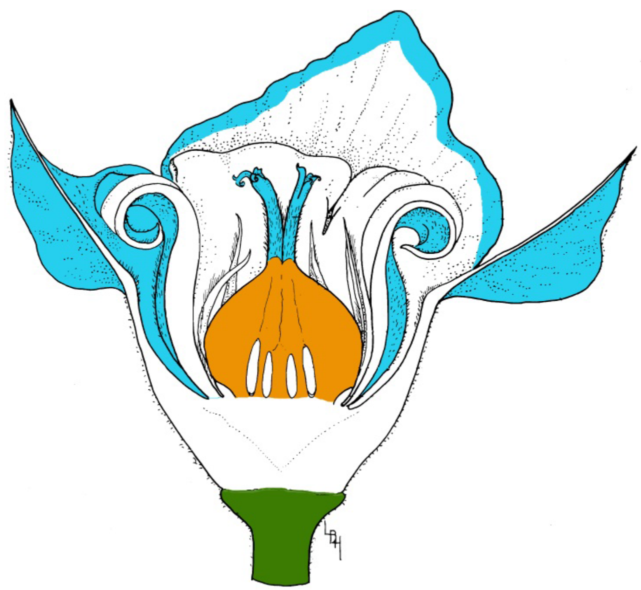


3. Hypogynous flowers

Hypogynous flowers lack a hypanthium.

Instead, the petals, stamen and sepals arise from the receptacle below the ovary.

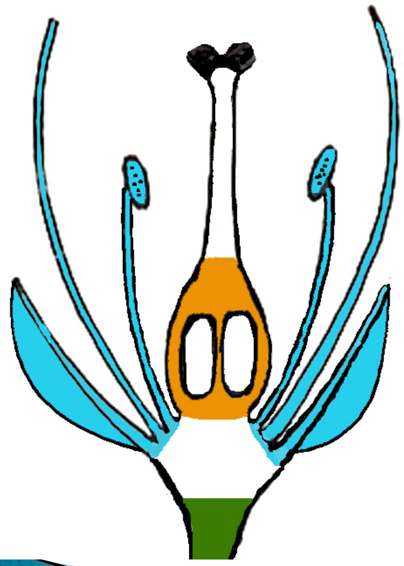


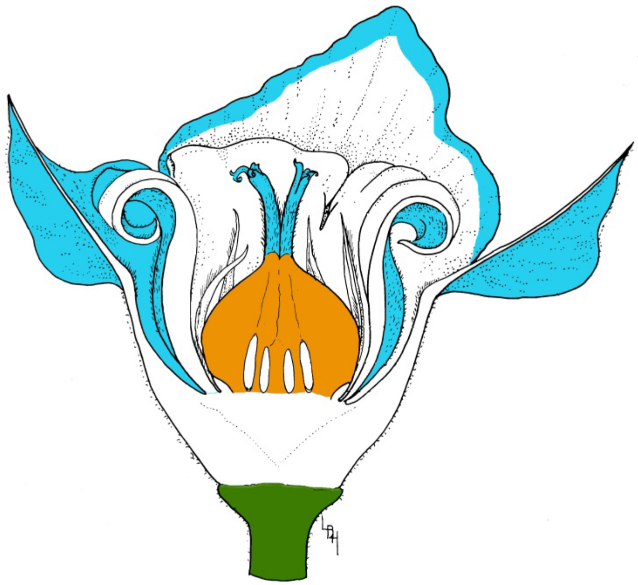


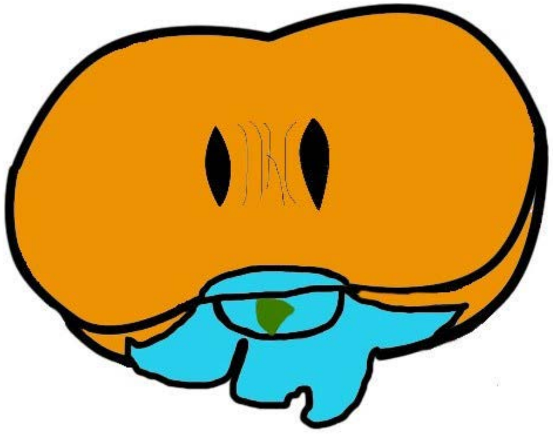
3. Hypogynous flowers

After fertilization the ovary develops into fruit tissue.

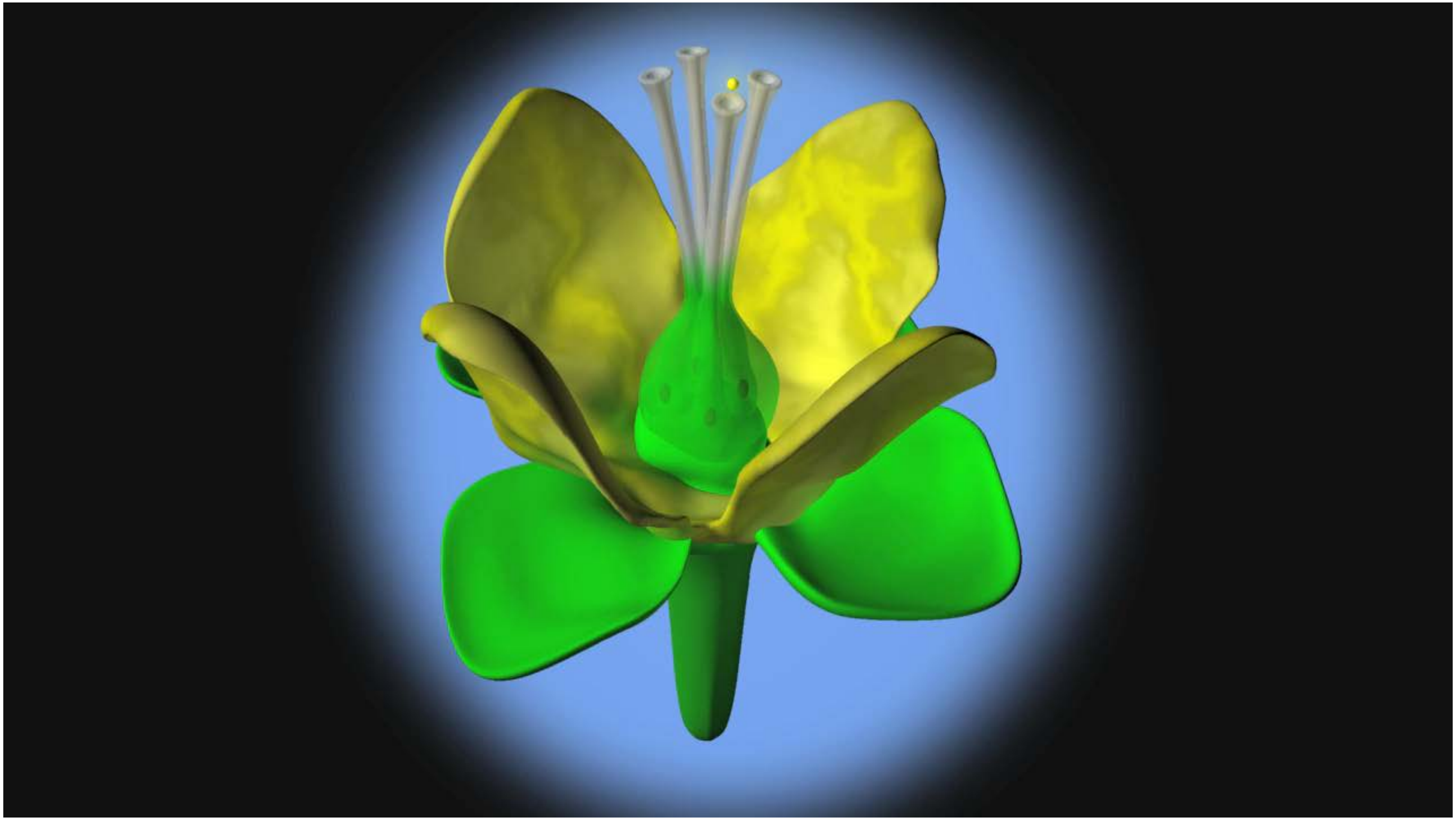
The sepals remain attached to the base of the fruit and receptacle.







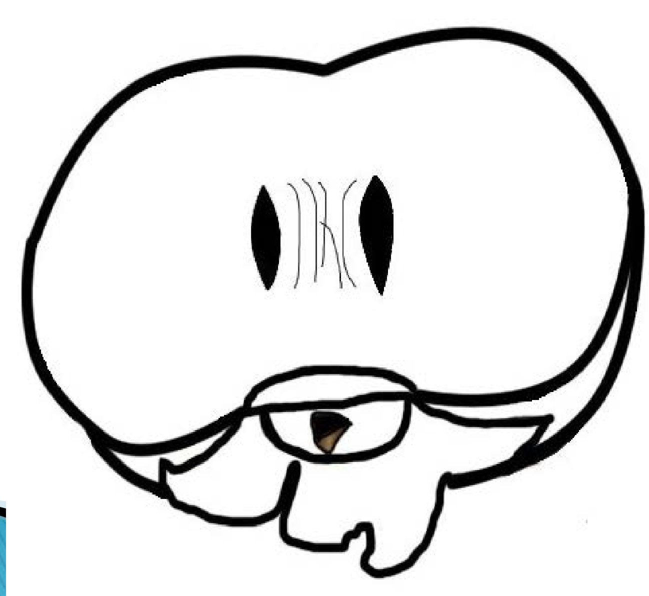
3. Hypogynous flowers

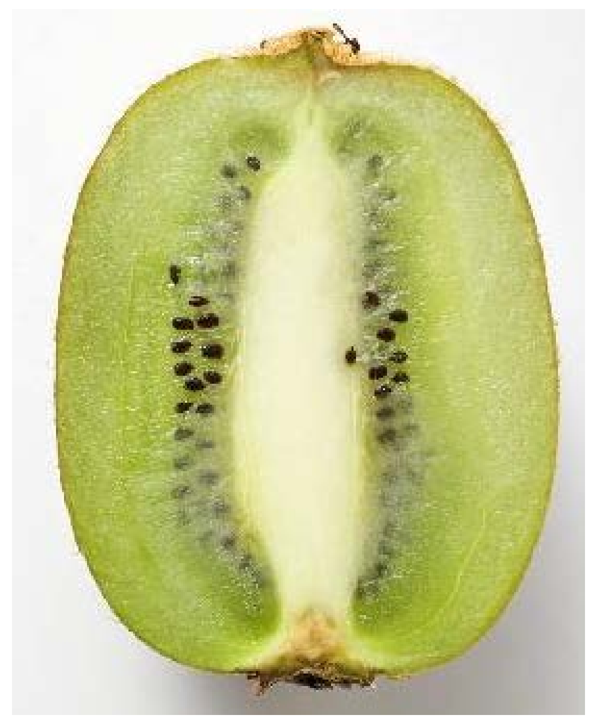


3. Hypogynous flowers

Hypogynous fruit develop from multiple fused carpels and contain more than two seeds.

Examples: persimmon and kiwifruit





PRINCIPLES OF FRUIT GROWTH

Ted DeJong
Department of Plant Sciences
UC DAVIS

UCDAVIS PLANT SCIENCES

UCDAVIS FRUIT & NUT RESEARCH & INFORMATION

Lecture outline

1. Phases of fruit growth: cell division and cell enlargement
   - Examples of variation in development phases among fruit and nut crops
2. Determinants of fruit growth and yield
   - Developmental processes
     Evidence: effects of thinning on yield
   - Assimilation processes
     Evidence: effects of environmental conditions on yield
3. Take home lessons

Fruit growth and yield are dependent on two separate, but interdependent, sets of processes:

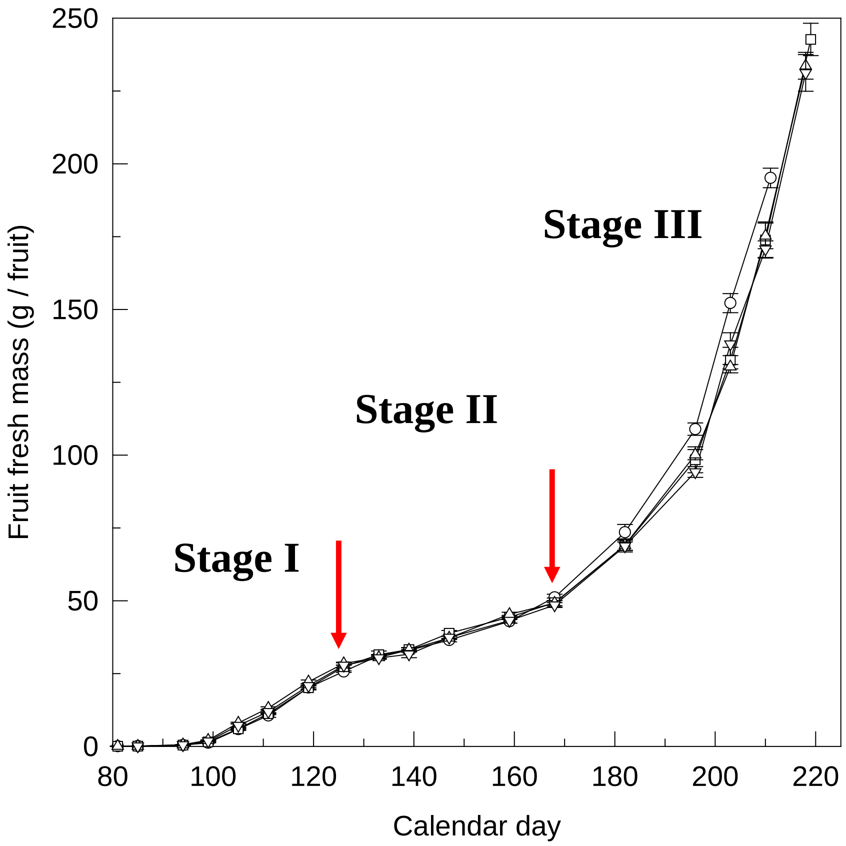
- **Developmental processes** drive rates of fruit maturation and demand for carbohydrates and nutrients
- **Assimilation processes** determine the supply of carbohydrates and nutrients available to support growth and development

What do we know about fruit developmental processes?

- The individual fruit growth potential of a given cultivar is governed by a **relative growth rate** (compound interest rate) function.
- Rates of fruit maturity (time between bloom and harvest) are mainly controlled by **heat unit accumulation** between bloom and 30 days after bloom.
- When early spring temperatures are high, fruit development rates are rapid but final fruit size can be negatively affected.

Fresh fruit mass

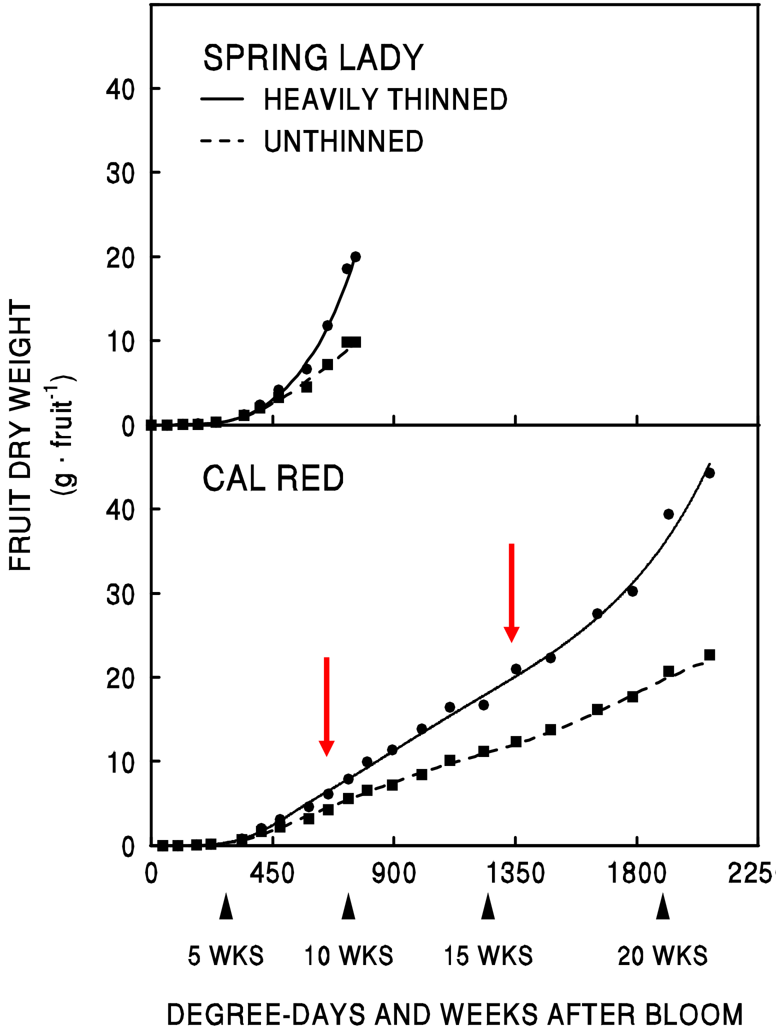
- Peaches and other stone fruit are described as having a “double sigmoid growth curve”
- This pertains mainly to the increase in fresh fruit mass of later (July – Sept.) maturing cultivars.
- These fruits are described as having three stages of fruit growth.



Fruit mass on a dry weight basis

- If fruit mass is expressed on a dry weight basis the double sigmoid nature of peach fruit growth becomes less obvious.

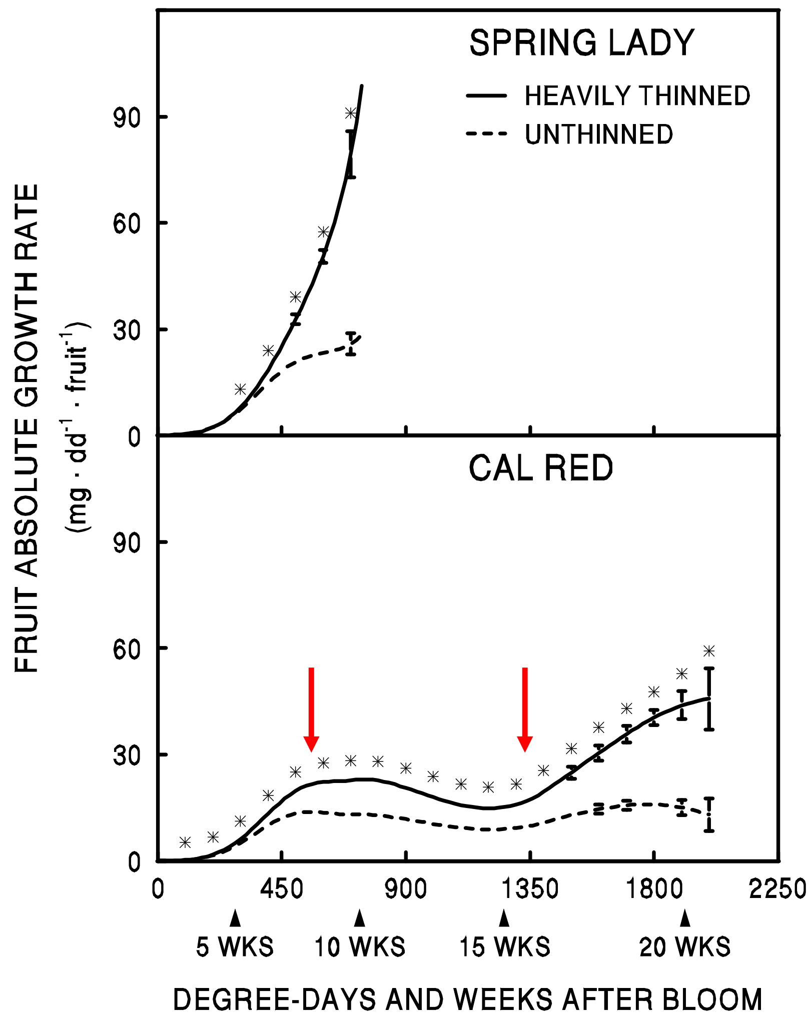
- It disappears entirely in early maturing cultivars analyzed on a dry weight basis.



Absolute fruit growth (rate per unit time)

When fruit growth is expressed as a rate per unit time the biphasic pattern of growth becomes clear even on a dry weight basis in late maturing cultivars but it is not apparent in very early maturing cultivars.

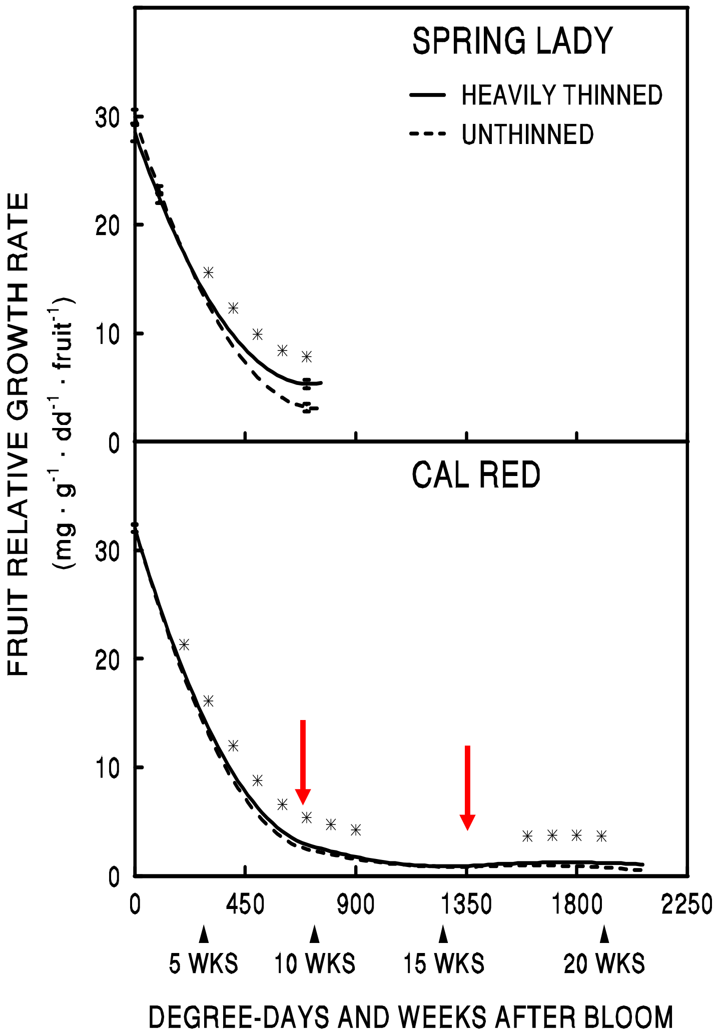
It is generally thought that breeding for early maturing cultivars has cut out the middle stage of fruit growth.



Fruit growth potential

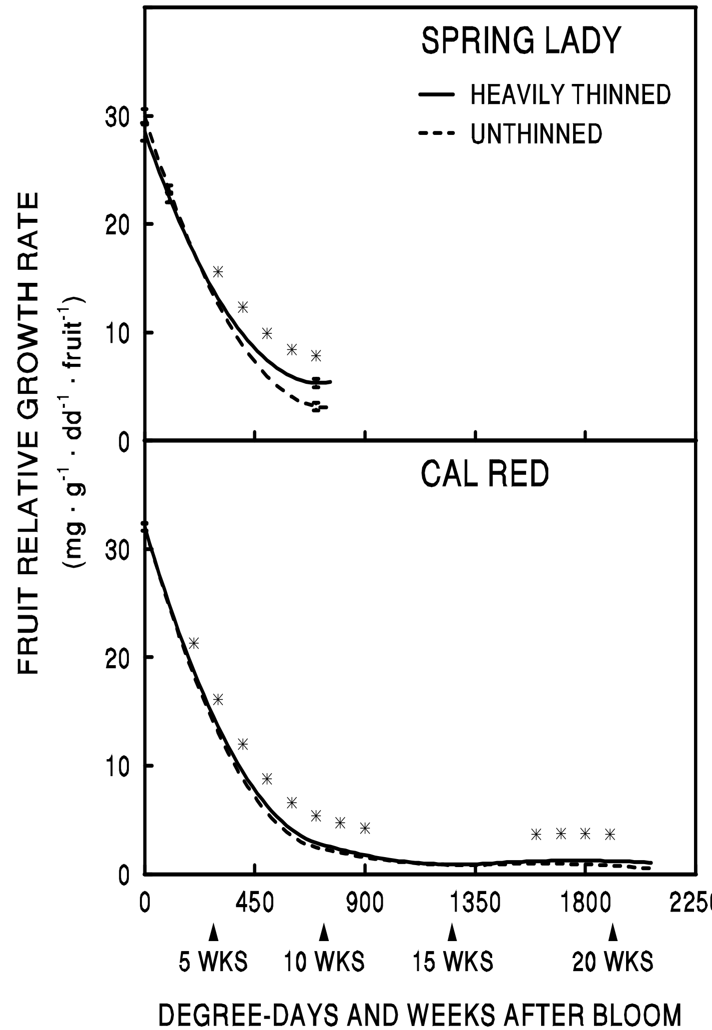
Why does fruit growth peak twice during a growing season?

- This is primarily an outcome of the development patterns of fruit over daily (or smaller) time steps relative to their size, or development state, at the beginning of a time step
- The growth potential of an organ over any given time interval is a function of its size at the beginning of the interval and its development pattern over the interval



Fruit relative growth rate (RGR)

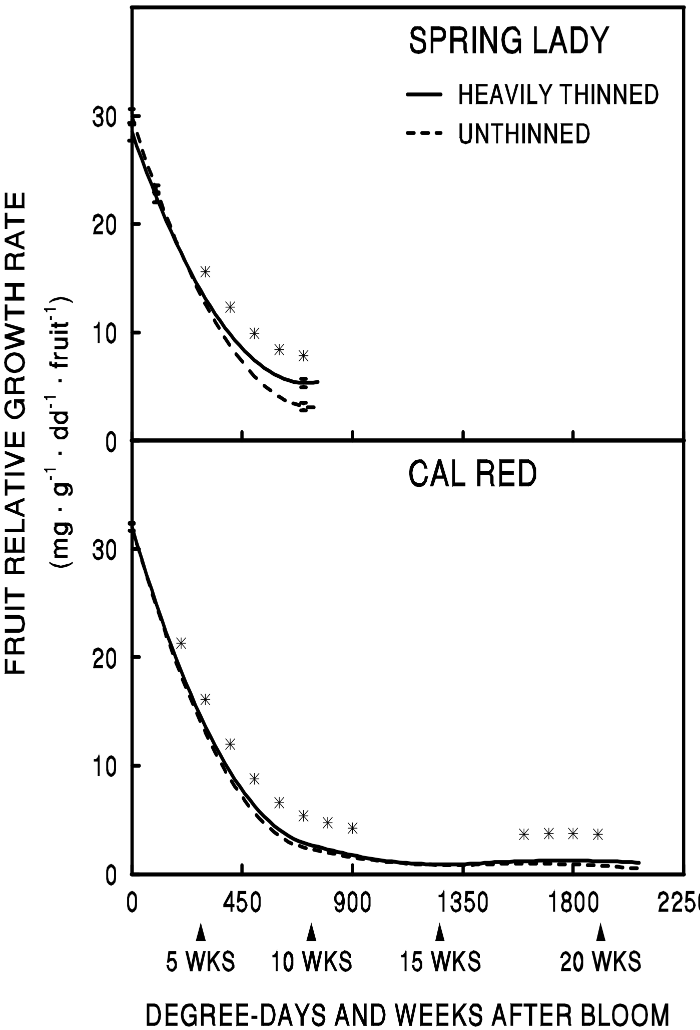
- Expressing fruit growth as a relative growth rate (**RGR**) (mass/unit mass/unit time) explains fruit growth potential
- **RGR** is essentially the same as a compound interest rate and the same principles hold—account grows as a function of the interest rate, starting principal, and time.
- When analyzed as RGR the curves of the early and late maturing fruit look similar except that the early cultivar RGR remains higher, longer but is then truncated



RGR and fruit growth potential

Why is this important?

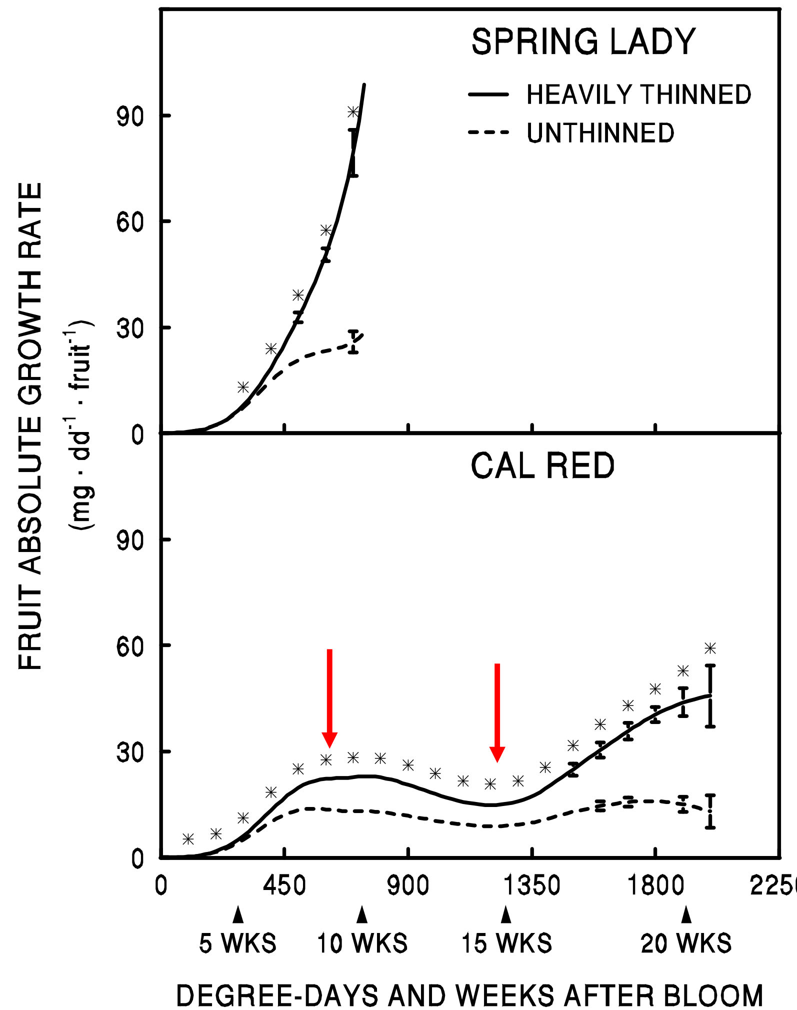
- RGR provides a way to understand fruit growth and the responses of fruit growth to crop load, thinning and weather in different years
- The asterisks in the slides on the right indicate periods when the RGR of the fruit on heavily thinned trees was different than on unthinned trees.
- Fruit on the heavily thinned trees represent the *fruit growth potential* since resources should not be limiting growth of these fruits. The fruit on unthinned trees show the RGR response to excess crop load.



Absolute growth rate and fruit growth potential

- Spring Lady (early variety): In early spring the absolute growth rate (AGR) of the unthinned fruit departed from the thinned fruit curve at the same time RGR became different in the previous slide

- Cal Red: AGR of unthinned fruit remained different than the AGR of the thinned fruit during Stage II even though RGR's were the same. This is because the fruit mass was different at the beginning of each interval, and thus the AGR was different.

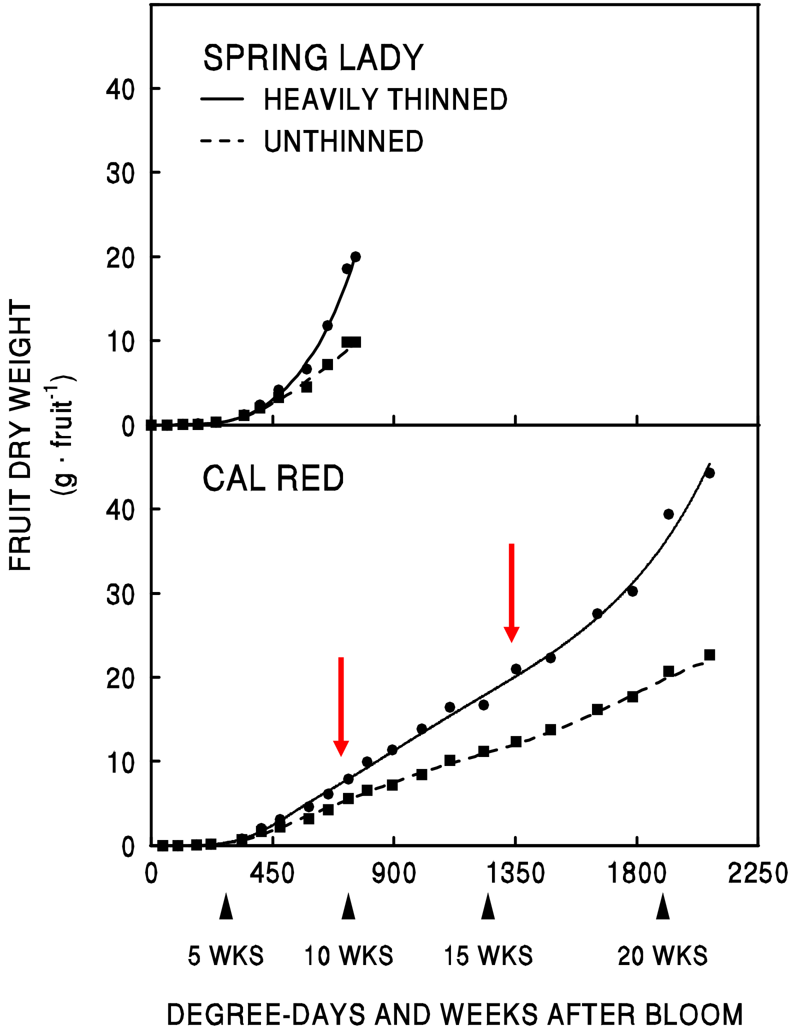


Absolute growth rate and fruit growth potential

This results in an increasing departure of the cumulative dry weight of the unthinned fruit relative to the thinned fruit over the season.

By reviewing the RGR and AGR curves we can see that this was the result of two interacting factors:

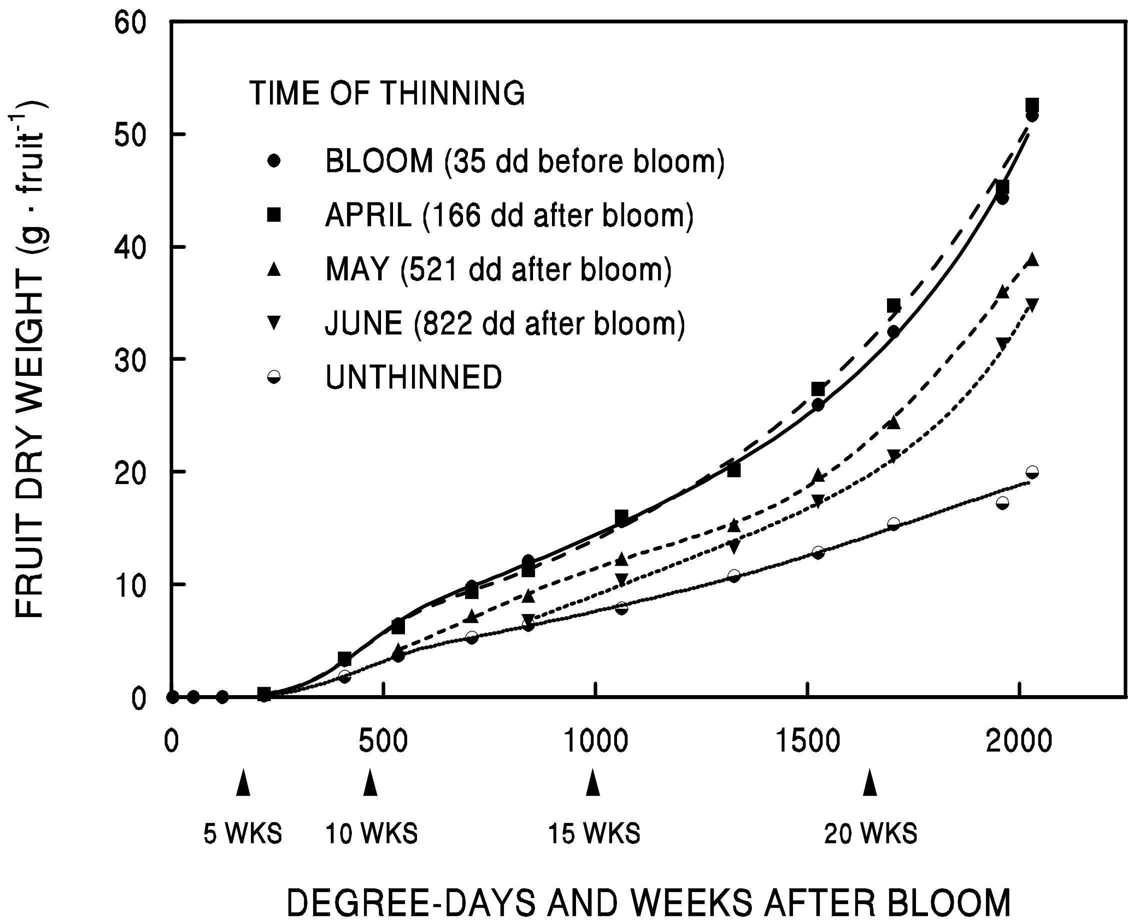
1. Excessive crop load causing a lack of resources to support *potential growth rates* at specific time intervals
2. Decreases in *potential growth rates* subsequent to any interval when a potential RGR was not achieved.



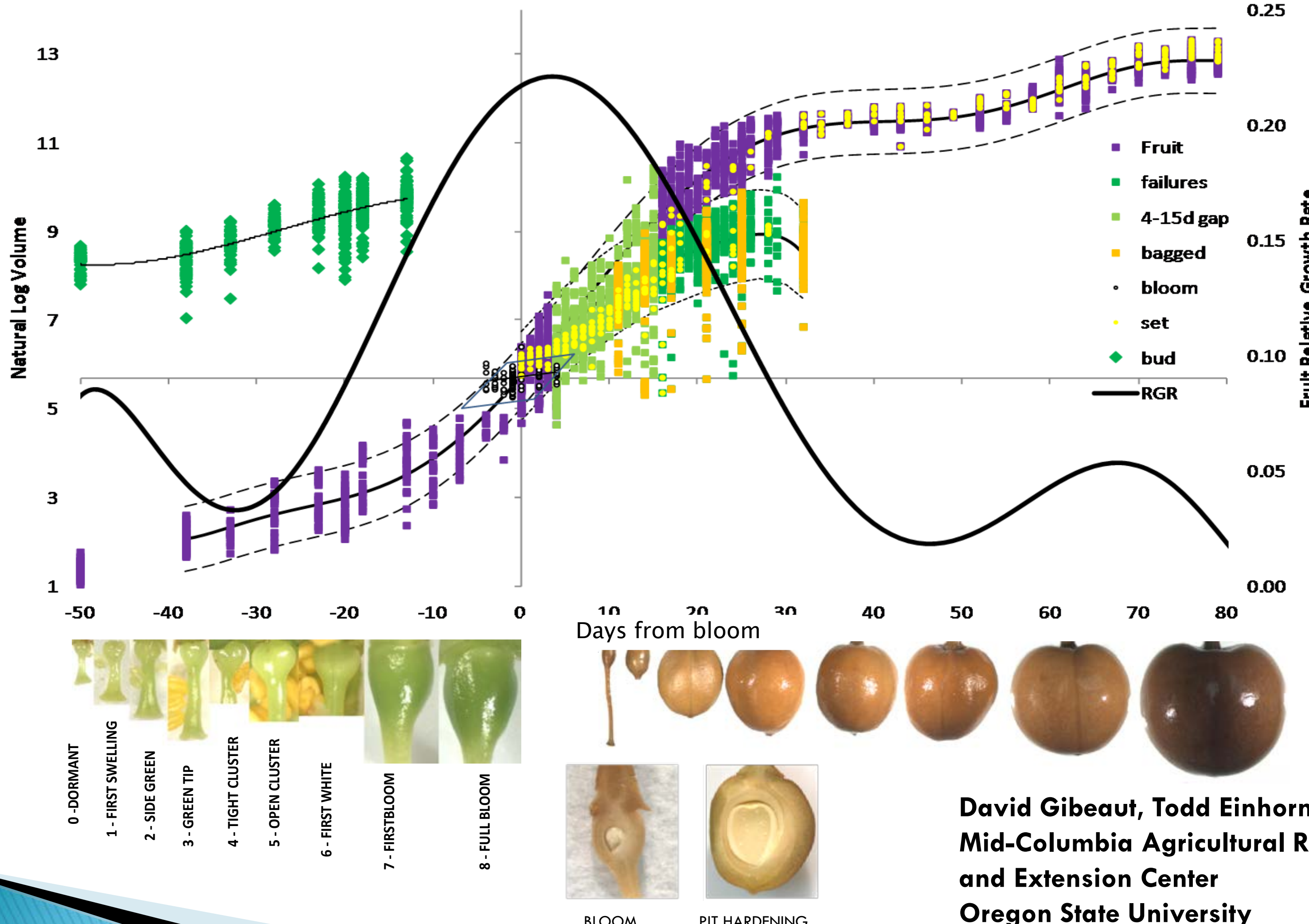
Timing of thinning and final fruit size

What happens when crop load "stress" is relieved by fruit thinning at different times?

- Cumulative fruit mass never fully recovers
- When growth falls behind potential for any interval, additional growth is compounded on the actual mass at the beginning of each interval, not on the potential mass



Cherry Growth from Dormancy to Harvest



David Gibeaut, Todd Einhorn
Mid-Columbia Agricultural Research and Extension Center
Oregon State University

L-peach model: Simulated fruit thinning

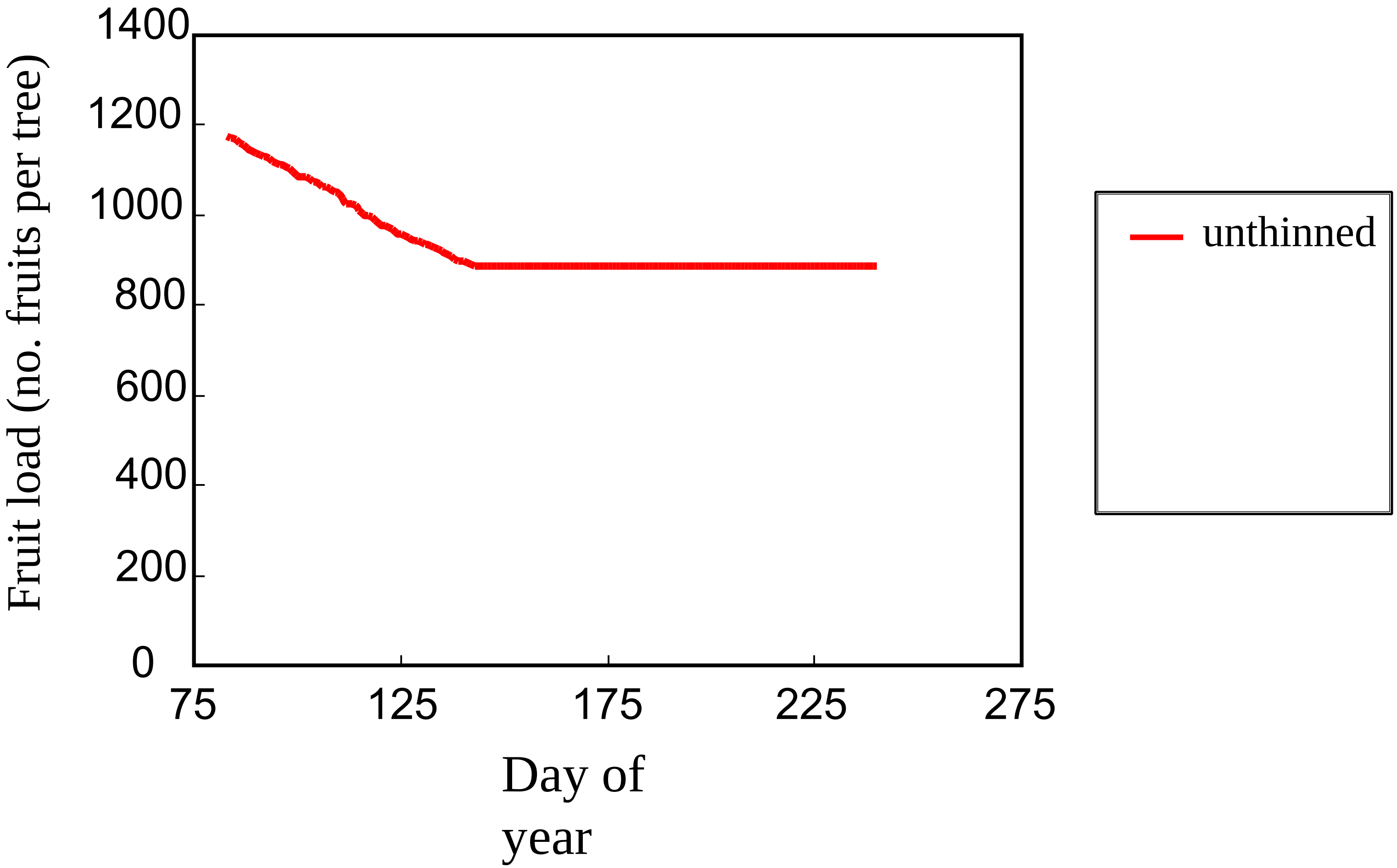
Fruit thinning treatments can be done manually in an orchard by selectively removing individual fruit.

Or, fruit thinning treatments can be simulated in a model by specifying the date of thinning and the minimum distance (number of metamers) between fruit at the beginning of a simulation.

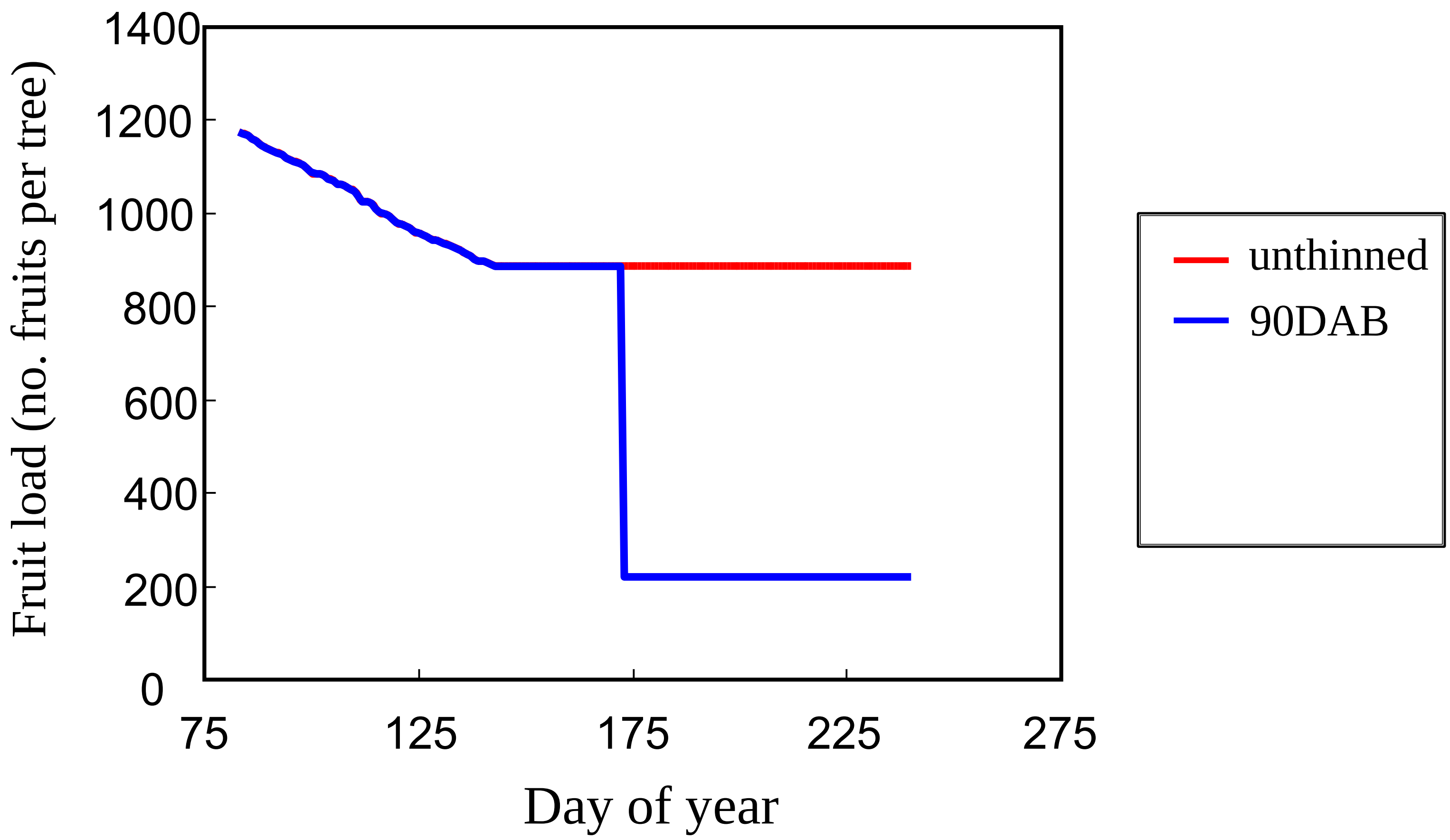
Unthinned branch

Thinned branch

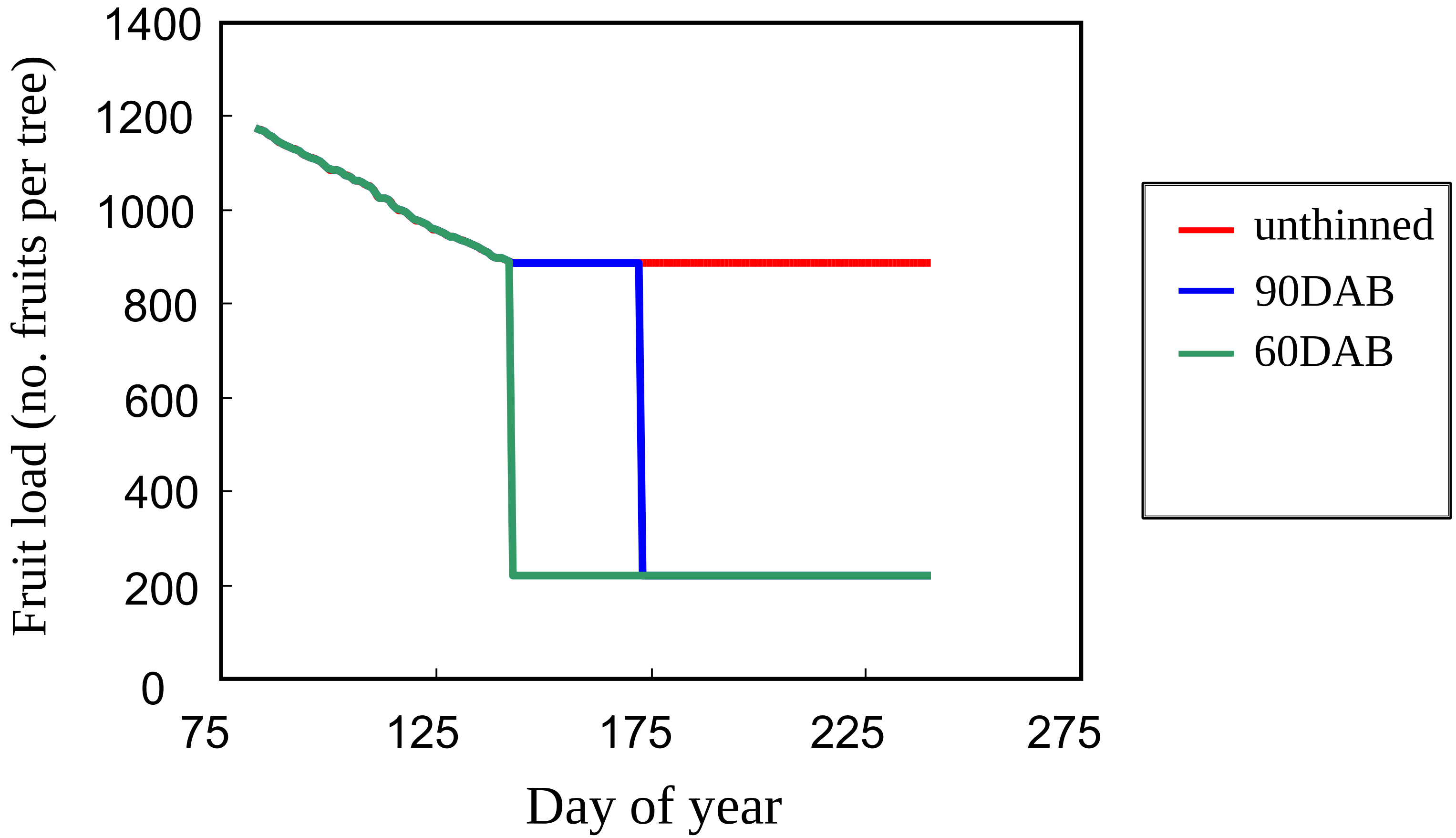
Simulated fruit load with no thinning



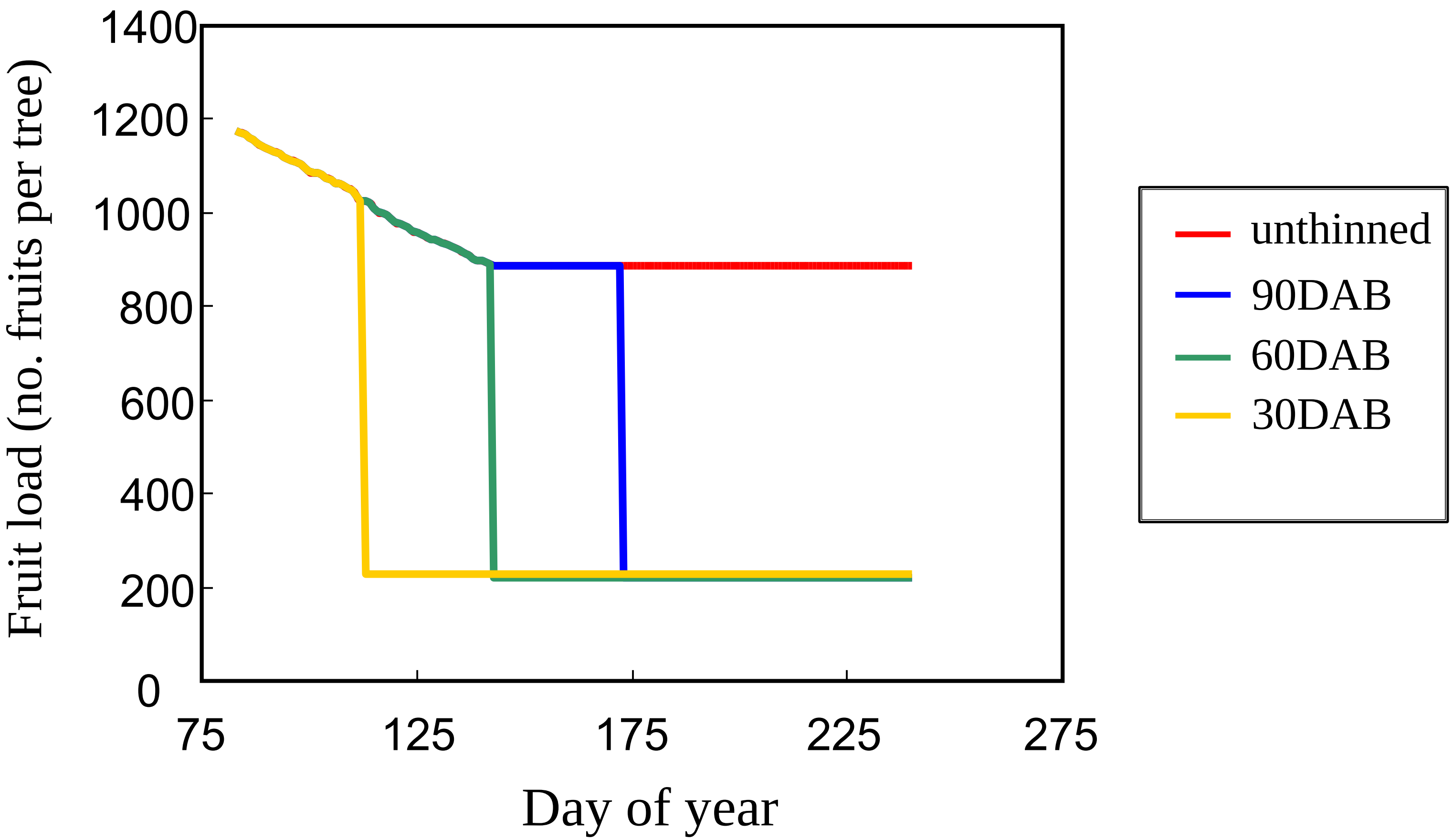
Fruit load load thinned 90 days after bloom (DAB)



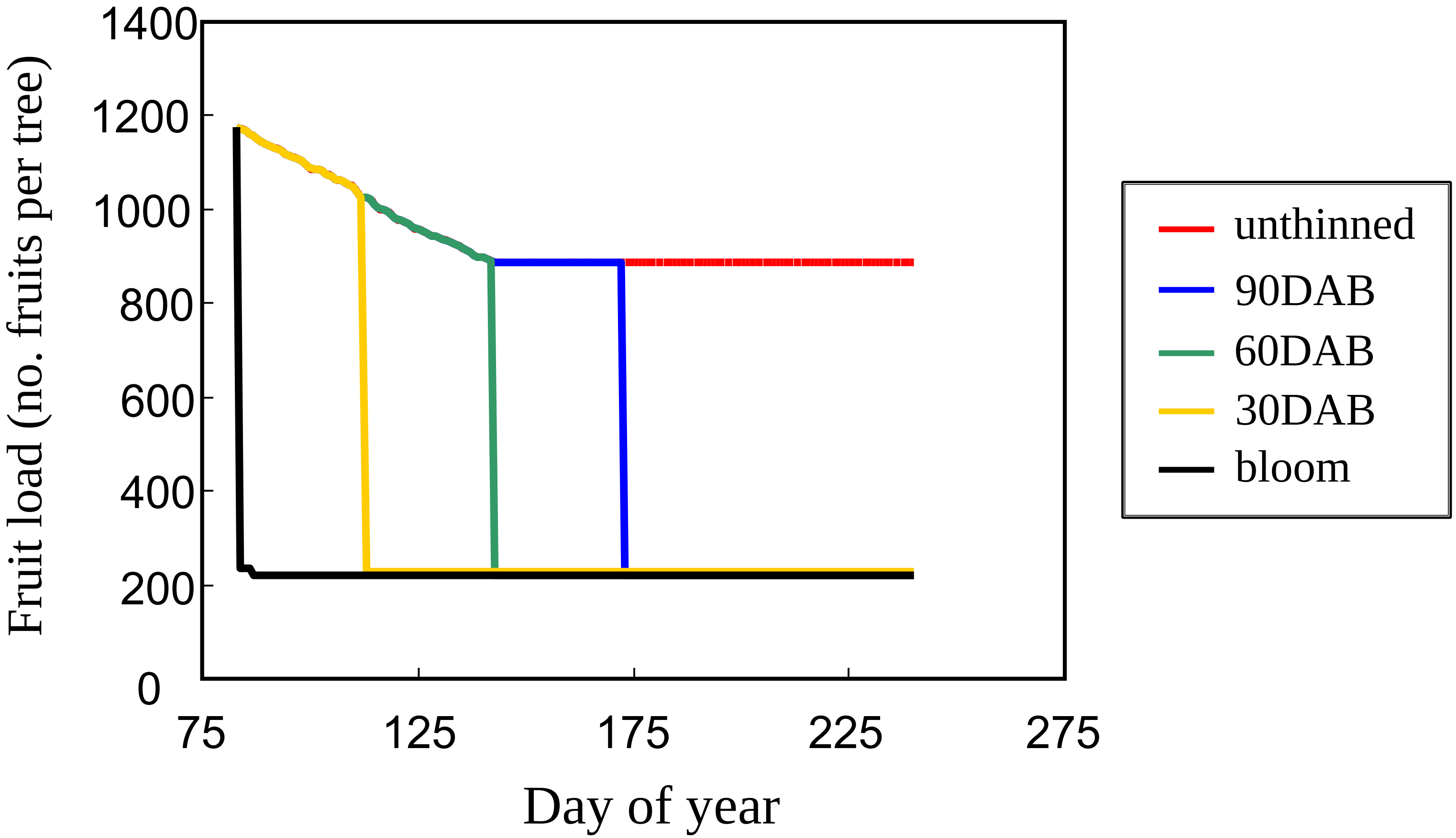
Fruit load thinned 60 days after bloom (DAB)



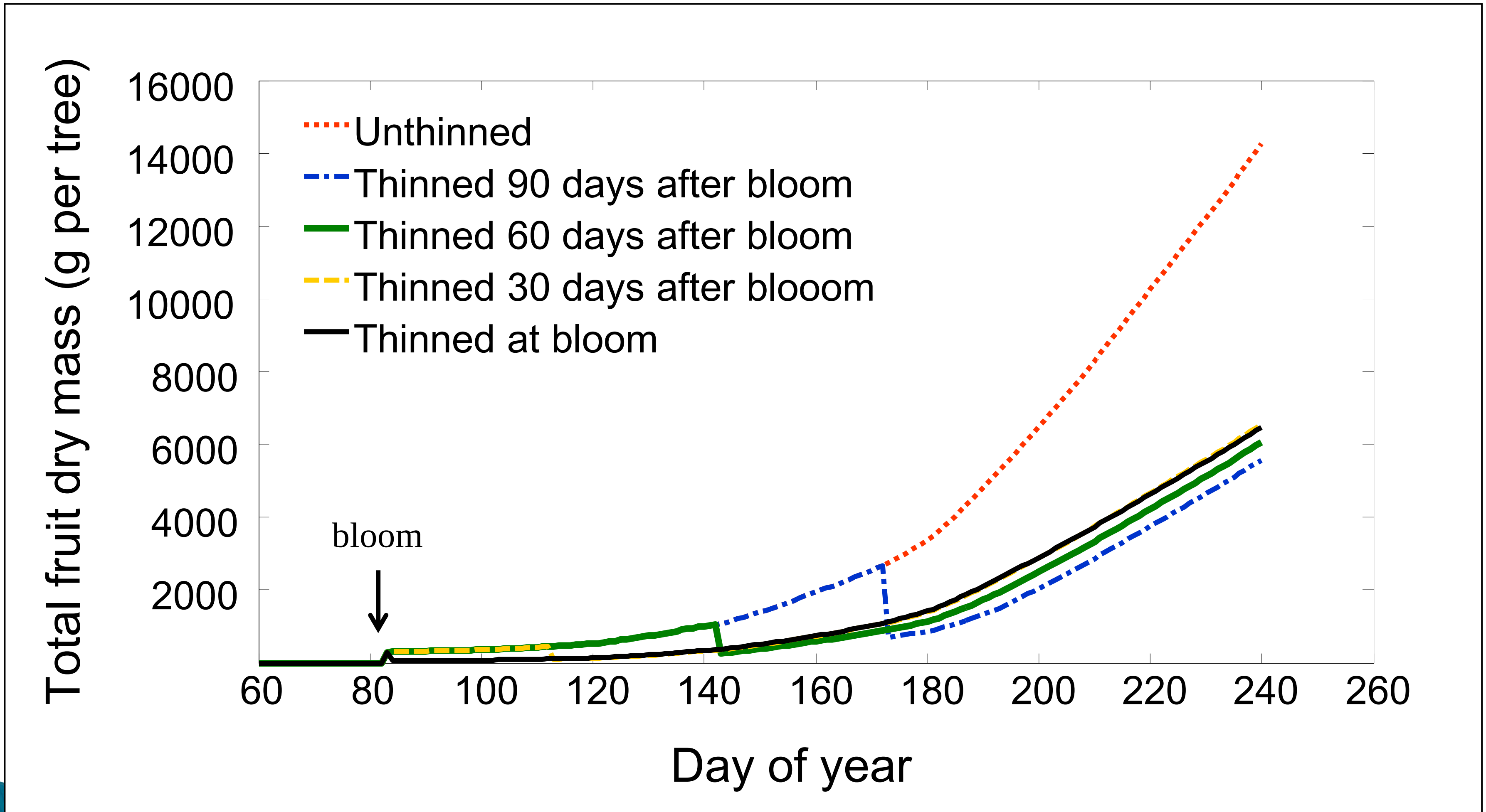
Fruit load thinned 30 days after bloom (DAB)



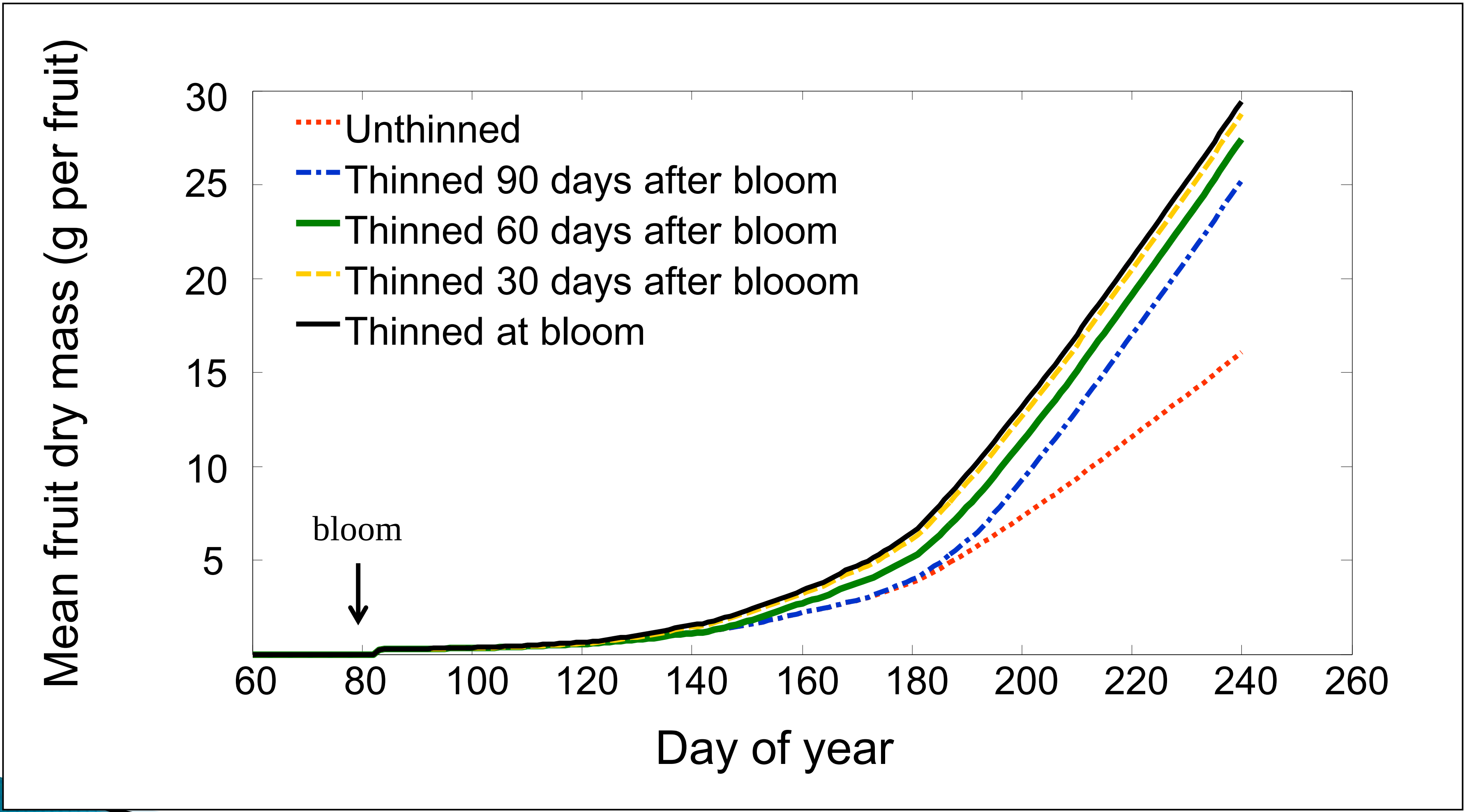
Fruit load thinned at bloom



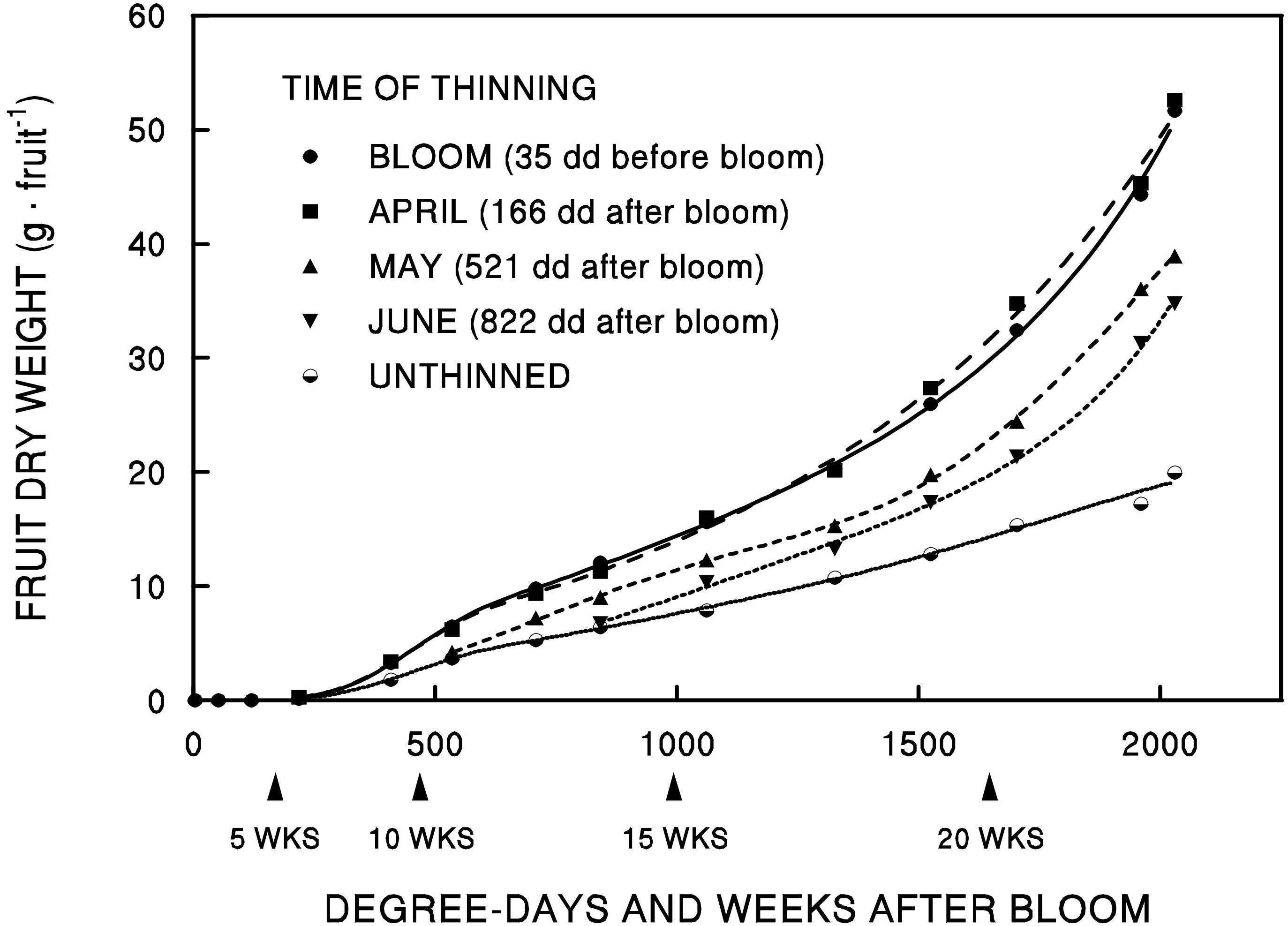
Total fruit dry mass per tree: Thinned 30 DAB



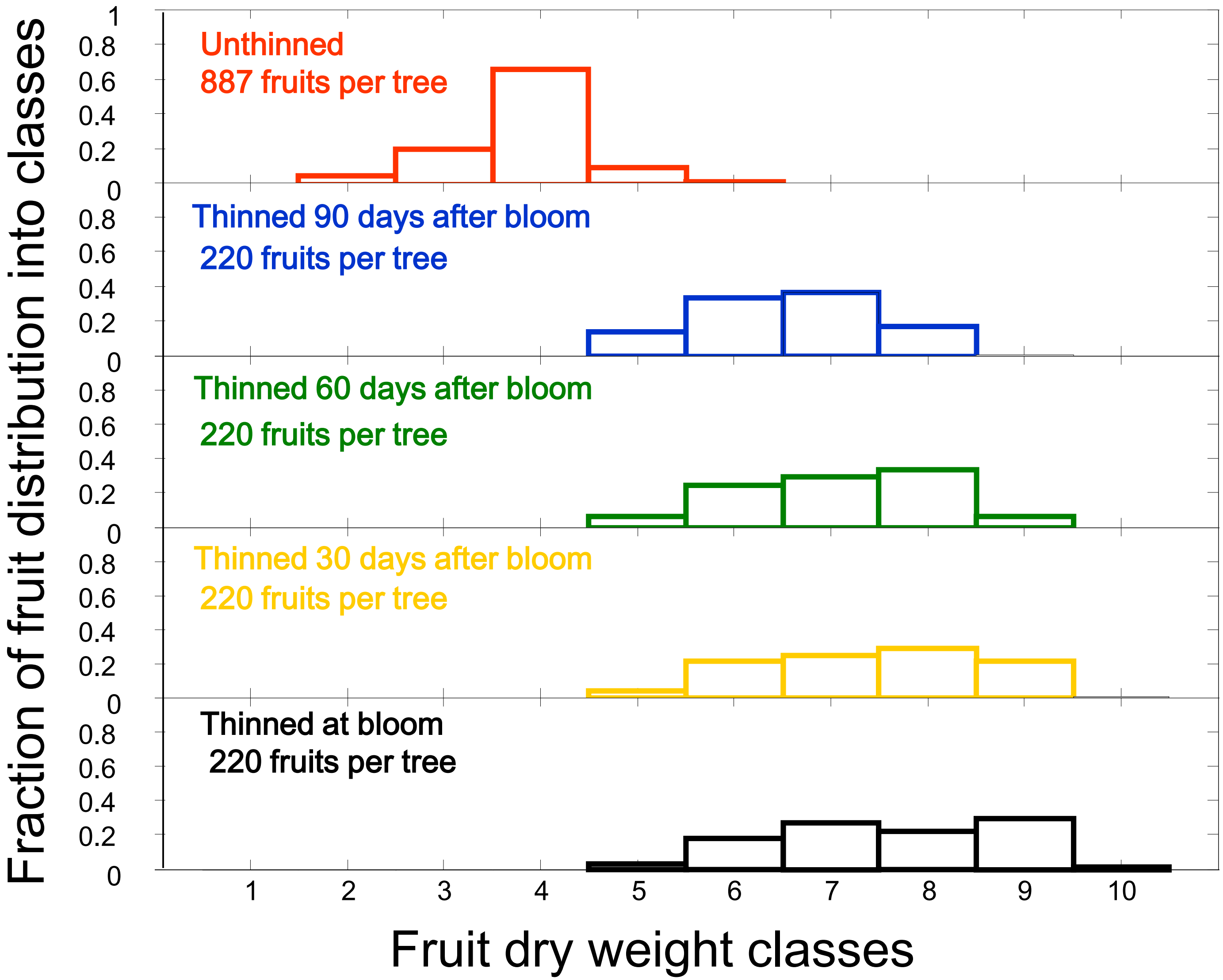
Average individual fruit weight: Thinned 30 DAB



Thinning trial done in an orchard



Grossman and DeJong 1995, Tree Physiology

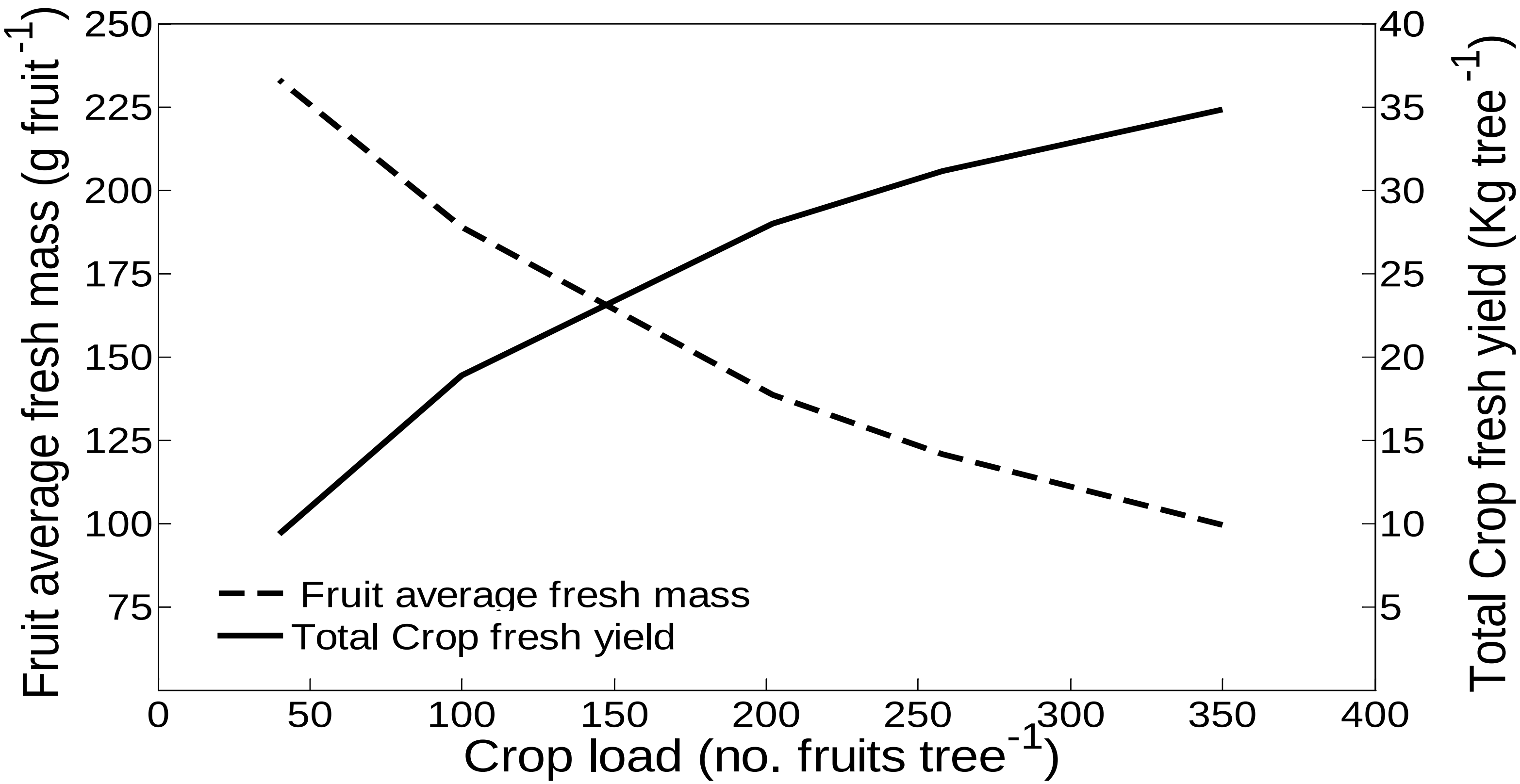


Unthinned
887 fruits per tree
Thinned 90 days after bloom
220 fruits per tree
Thinned 60 days after bloom
220 fruits per tree
Thinned 30 days after bloom
220 fruits per tree
Thinned at bloom
220 fruits per tree
Fraction of fruit distribution into classes
Fruit dry weight classes
0
0.2
0.4
0.6
0.8
1
1
2
3
4
5
6
7
8
9
10

Fruit yield data from four clingstone peach cultivars in commercial orchards near Kingsburg California that were thinned on two different dates in 1992. Data indicate means +- se for six, four-tree replications per cultivar and thinning date.
Adapted from DeJong et al. 1992.

Cultivar/Thinning Date	Fruit size (gFW/fruit)	Crop Load (fruit/tree)	Yield (tons/Ha)
Loadel			
20th March	113.3 ± 1.4	1681 ± 64	56.7 ± 2.0
18th May	91.9 ± 2.4	1649 ± 40	45.3 ± 1.6
Carson			
20th March	127.8 ± 4.7	1576 ± 74	59.4 ± 2.0
18th May	108.2 ± 2.5	1427 ± 53	46.0 ± 2.0
Andross			
21st March	123.6 ± 2.1	1888 ± 96	69.3 ± 2.7
18th May	115.0 ± 1.7	1766 ± 58	60.8 ± 2.7
Ross			
27st March	163.9 ± 7.0	1862 ± 99	80.7 ± 2.5
19st May	163.9 ± 3.2	1638 ± 69	72.2 ± 3.1

Effect of crop load on fruit size and total yield



As the number of fruits per tree increases, total yield increases, but average fruit size decreases.

Classes (g)

1 = < 30

2 = 30 - 60

3 = 60 - 90

4 = 90 - 120

5 = 120 - 150

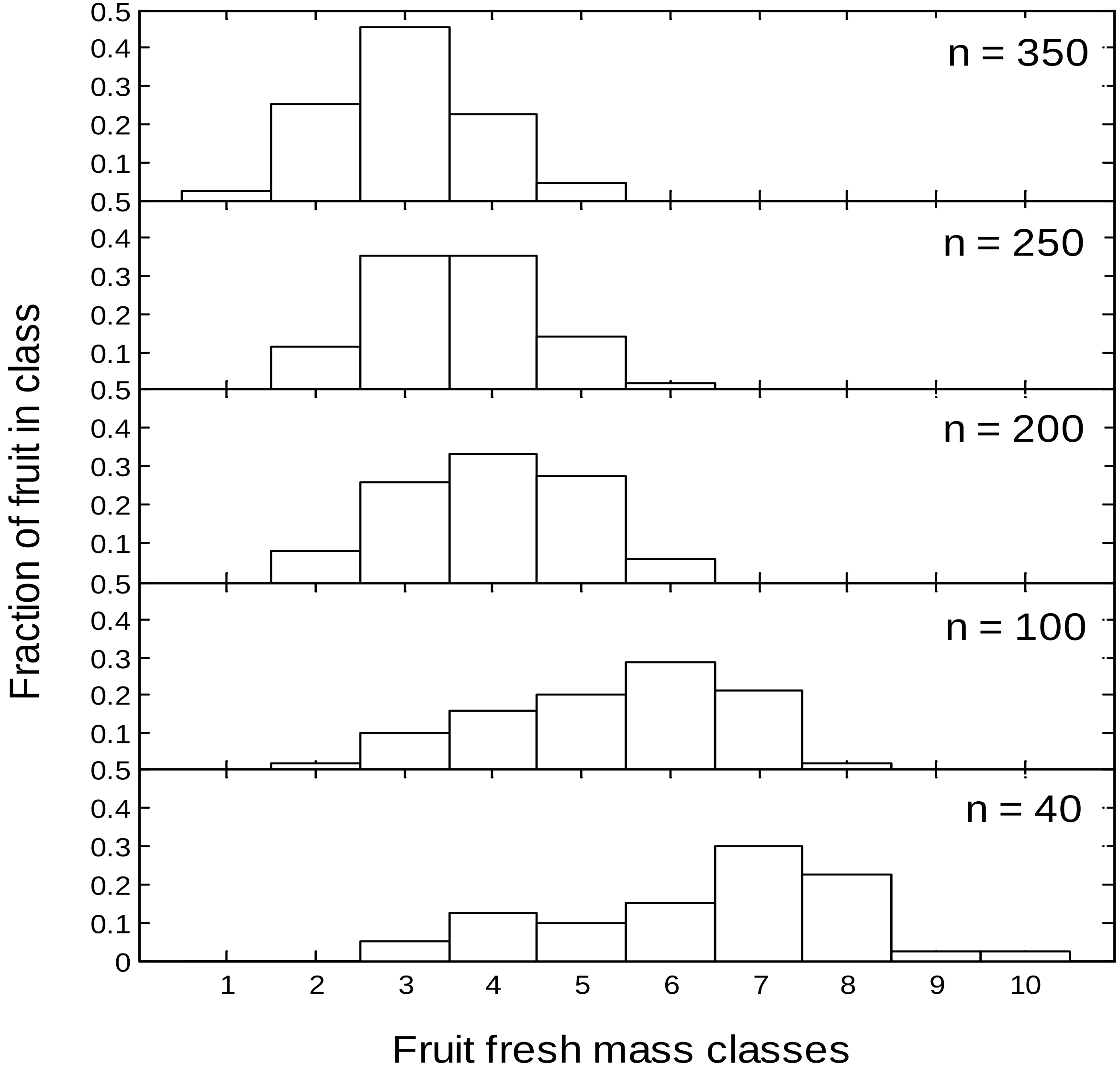
6 = 150 - 180

7 = 180 - 210

8 = 210 - 240

9 = 240 - 270

10 = > 270



Thankyou for your attention!

Questions?

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