

Reproductive Growth



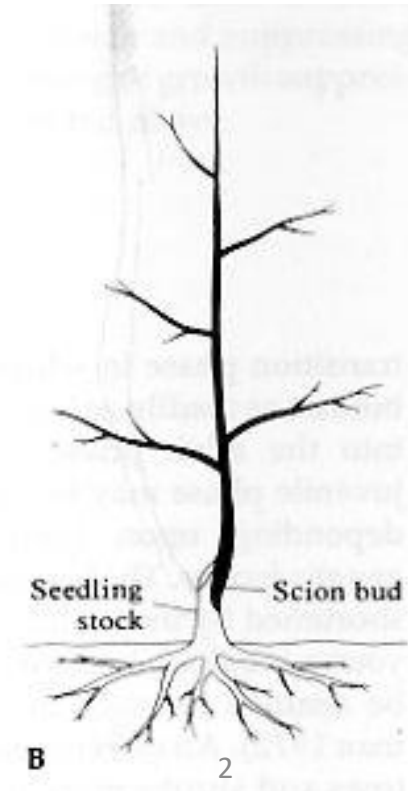
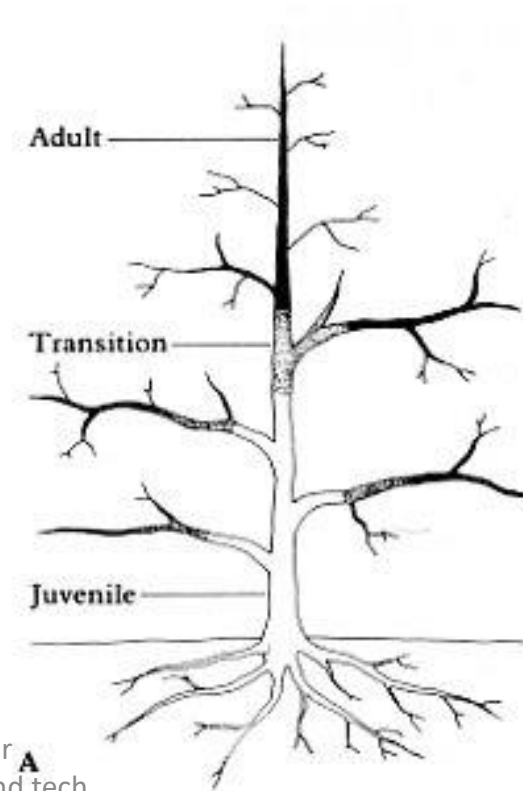
Flowering / Pollination /
Fertilization / Fruit Set

Juvenility/Transition/Adult

Juvenility → Physiological state at which a plant cannot be induced to flower
→ Environmental and Genetic Factors
→ Increased Growth Rate is necessary to reduce juvenility period

→ Trees maintain juvenile tissues...

What are the implications of selecting buds from this tissue for grafting purposes?



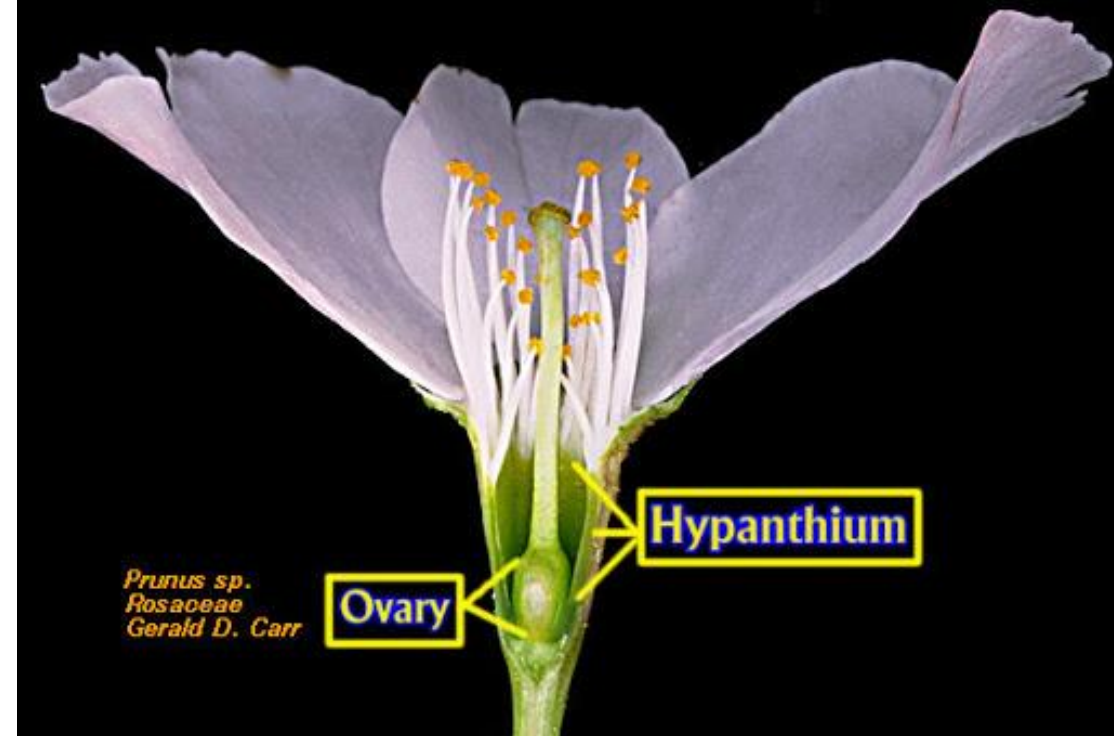
Flowering

Flower bud Induction → change from vegetative phase to reproductive phase
→ 'Switch' occurs in mid summer through early autumn

Initiation → initiate flowers near the end of the 'grand'
growth period in summer
→ Bloom is in the following season

Flowering Habit and Structure

- Almond flower is called a Perfect flower → which has both sexes present
- Spurs can support upto 6 flower buds in a season
- Spurs are autonomous: Meaning they support flower buds with their own carbohydrate storage
- Higher leaf area on a spur >> higher chances of it producing flowers next year
- Non-bearing spur with >50cm² leaf area >80% probability of flowering next year
- Spurs in low light, need more vegetative years before they can bear flowers



Spur survival

- Spurs remain viable for 3-5 years,
- Good light in outer canopy > 10 years
- Spur life:
 - Light exposure
 - Bearing status
 - Prior season leaf area

Management decisions

- Growers need optimum water and nutrient program
- Excessive vegetative growth > causes shading > reduces spur life
- Push some annual growth to produce new spurs
- Remove criss-crossing branches, dead wood to reduce shading

Factors which Increase Flower Development

→ Scoring / ringing / girdling– WHY?

→ Also used in sizing early-season peach/nectarine varieties



→ Ringing/girdling has been tried successfully in California almonds as a concept but doing it on large scale is very labor intensive

→ Bending branches toward the horizontal

Factors which Decrease Flower Development

Chill Units (CU) → Required to break rest (Latitude defines temperate-zone fruit production)
→ Retarded development, late bud-break, erratic bloom periods, pollination problems, delayed vegetative bud break

Depressed Vegetative growth

→ Some apple cultivars require 20-24 nodes prior to floral bud initiation

Flower inhibition from Heavy crop loads the previous year

→ Biennial bearing → apples, pistachio, orange, olive

(development is impaired by embryo development and compounds produced within (GAs))

→ 'Spencer Seedless' cv of apple, 'Anjou' Pear (facultatively parthenocarpic)

→ Fruit must be thinned early (response declines as thinning is delayed)

Pollination

Fruit set is due to successful pollination/ fertilization and failure to set fruit is due to...

- 1) Lack of pollination due to lack of pollen and/or pollinators
- 2) Pollen does not provide fertilization: pollen sterility, egg cell sterility, incompatibility (inability for style penetration by pollen tube, stigmatic receptivity, pollen tube growth is slowed (Boron deficiency?), etc.)
- 3) Seed abortion (nutrition, low temperature)
 - High N status results in superior pollen grains Low N often results in weak set
 - Boron is critical in pollen tube growth
 - Potassium (K) is also important in pollination and fruit set

Pollination

Pollinizers and pollinators:

Pollinizers: varieties which cross pollinate each other. Conventional almond varieties do not set crop by themselves, so they need a pollinized variety to pollinate each other (Cross pollinated)

Honeybees as pollinators:

- Bees work the first flowers they see
- 1-2 hives/acre is usually sufficient
- Minimum air temps (55-60°F), ideally clear conditions and low wind

California Almond industry:

Each year 1.5 to 2 million hives needed in California almonds

Almond pollen are first nutrition sources for bees after winter

Orchard Design- Pollination

- 1- Main variety and pollinizer must have overlapping periods
- 2- Adequate spacing/location of pollinizers
- 4- Bees or other insects provided at right time and active
- 5- Weeds which are blooming need suppression



Orchards with self-pollinated varieties are deigned differently

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Bees and almonds

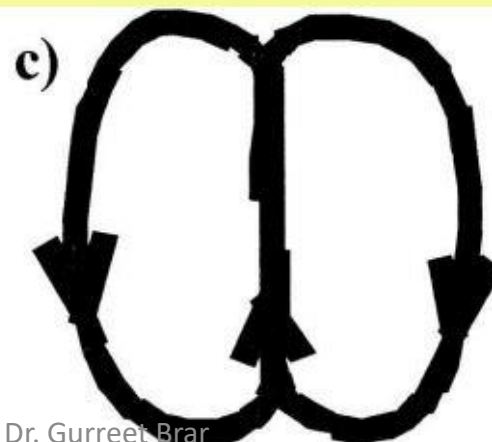
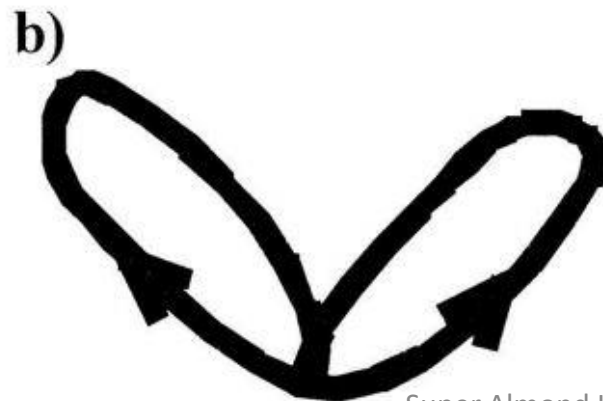
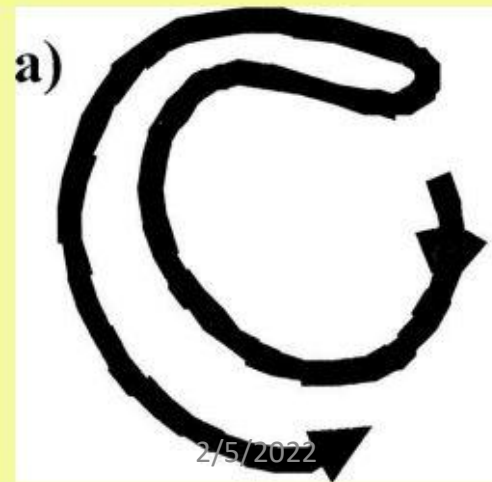
- Warm temperature, lack of rain, low wind speed > maximum bee activity
- Maximum activity within 300 m of a hive



Outside the hive

50 to 150 Meters

> 150 Meters



Orchard Design- Cross pollinated varieties

Orchard Goal: **uniformity**

- In almonds- single rows (every other row), maximizes exposure to pollinizer:
- 50 % primary variety: 50% pollinizer for maximal yields
- Some cases: 50:25:25 ratio, for more bloom overlap
 - Two pollinizers: One to cover start of bloom for main variety, second to cover end portion of bloom
 - For example: Non-pareil (50%), Monterey (50%), Carmel (50%)
- Need to consider harvest timings for all varieties also

Factors which Affect Pollination

Concept of the Effective Pollination Period (EPP): time lag between pollination and fertilization

Once a flower opens the embryo has only a limited time when it is receptive

EPP's can range from 3-12 days depending on variety and climatic conditions

Environmental Regulators

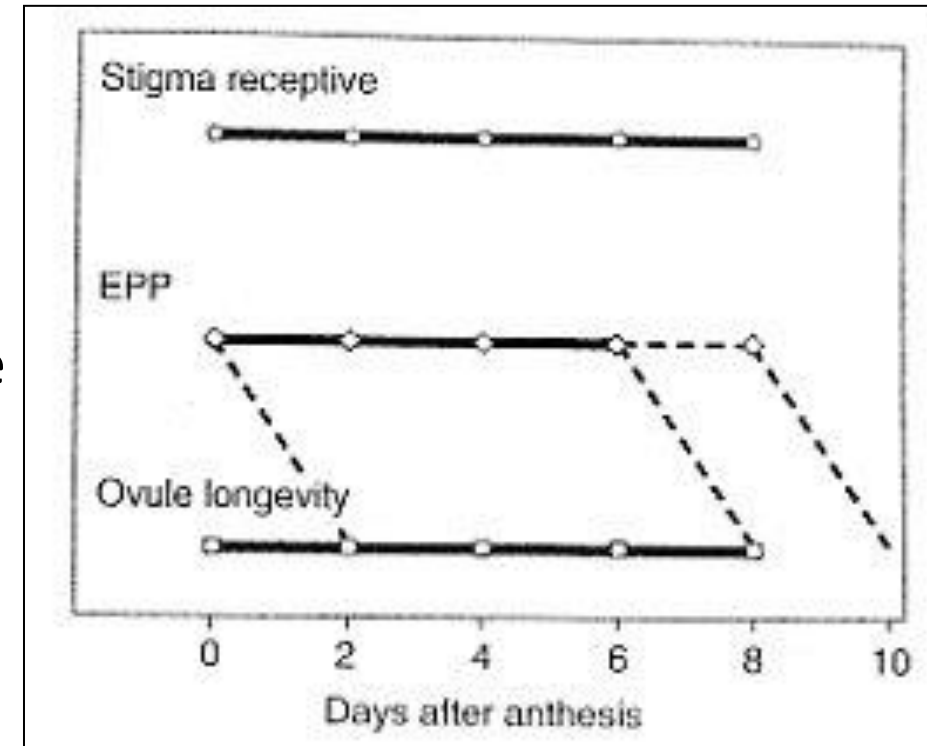
Temperature

→ Pears @ 5C pollen tube growth required 12 days

@ 15C pollen tube growth required 2 days

Pear ovules were viable for 11 days, therefore EPP @ 5 and 15C was?

This was growth cabinet work, temperature variations are more realistic...



Williams, 1964, in Dennis, 2003

Self fertile varieties

- Although self fertile varieties can set fruit without bees, however, research shows that they benefit from bees
- Yield of 'Independence' variety was 60% higher when bees were present (Saez et al, 2020; Nature)
- Bottomline: Use reduced number of hives per acre to save cost while still benefitting from bees

Management Strategy

- Self fertile varieties don't need bees but in California experts recommend $\frac{1}{4}^{\text{th}}$ to $\frac{1}{3}^{\text{rd}}$ the amount of bee-hives in compared with conventional
- This means 2 hives for every 3 or 4 acres. (University recommendation for conventional varieties is 2 hives per acre)
- Don't provide bees in 3rd year > we do not want to set a heavy crop in 3rd year in conventional density planting (Super High Density is different)
- During the third year, the young trees are still putting out a lot of vegetative growth to make proper structure.
- Therefore, heavy crop set disturbs that balance the tree needs for good structure development
- Plus, we don't know the expected yield so nutrition and watering is difficult to adjust.

Management Strategy

- In the cross-pollinated varieties, two bee hives per acre benefits for crop set
- In California new plantings are ar 50:50 Non-pareil: Monterey.
- 50:25:25 ratio with 2 pollinizer varieties creates difficulty for harvesting, due to separate harvest timings
- Hard-shell varieties like Butte: Padre go with 50:50 ratio in alternating row.
- Experimenting with alternating trees within a row have created issues in many orchards.

Management Strategy

- Reproductive buds are formed in late summer.
- Keep good water and nutrient program during the time of differentiation of flower buds in summer
- In California varieties, time of bud differentiation is about 2 weeks after Non-pareil harvest.
- Stress during this period can lead to loss of buds for next year,
- And next year set and yield will be low.