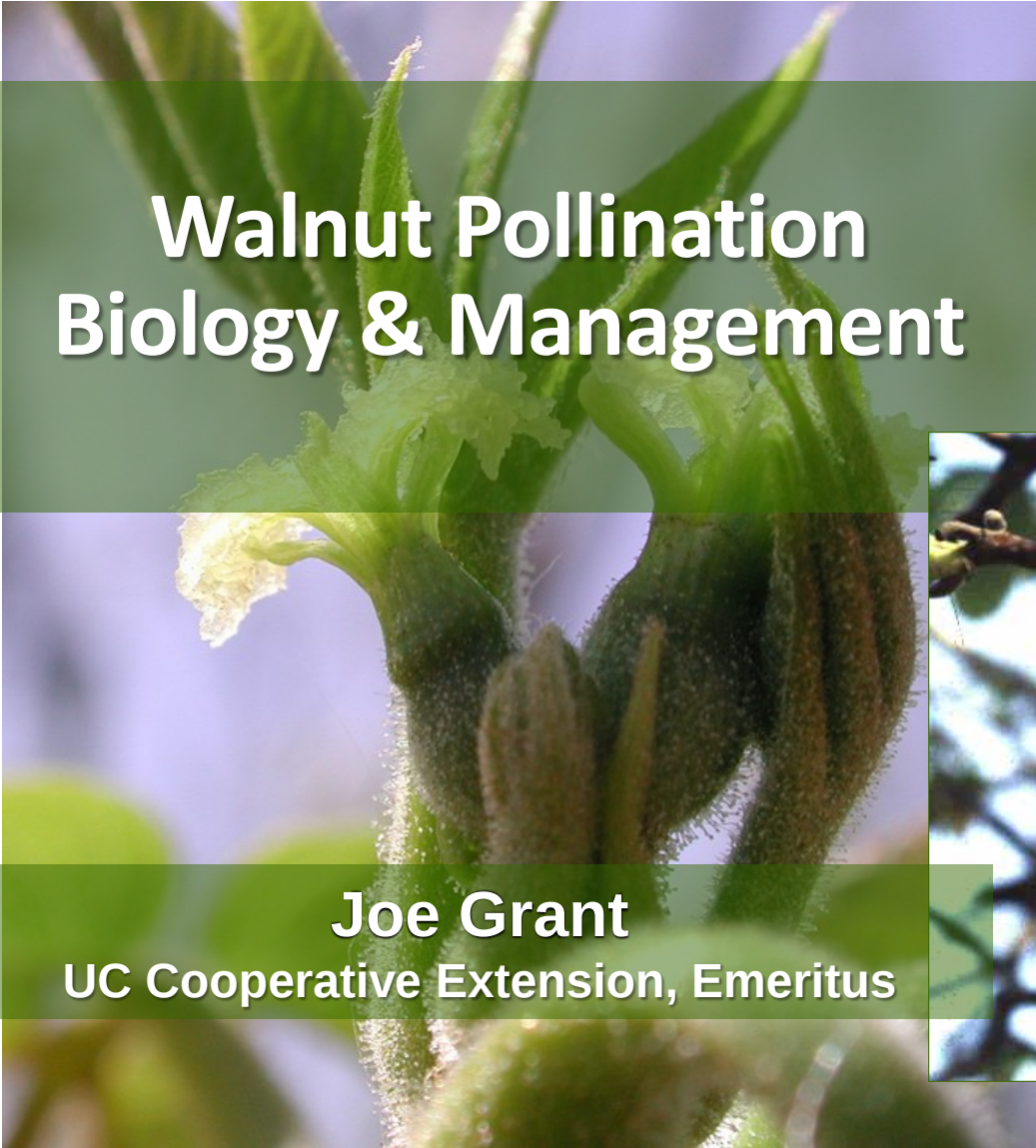


A large, detailed close-up photograph of a green walnut flower bud on a stem, with some yellowish petals visible. It serves as the background for the title and speaker information.

Walnut Pollination Biology & Management

Joe Grant
UC Cooperative Extension, Emeritus



Reproductive Biology (*Juglans regia* L.)

Monoecious

Wind Pollinated

Heterodichogamous

Reproductive Biology (*Juglans regia* L.)

Heterodichogamy

Dichogamy: Outcrossing mechanism based on temporal separation of male and female bloom.

Protandry: Male precedes female.

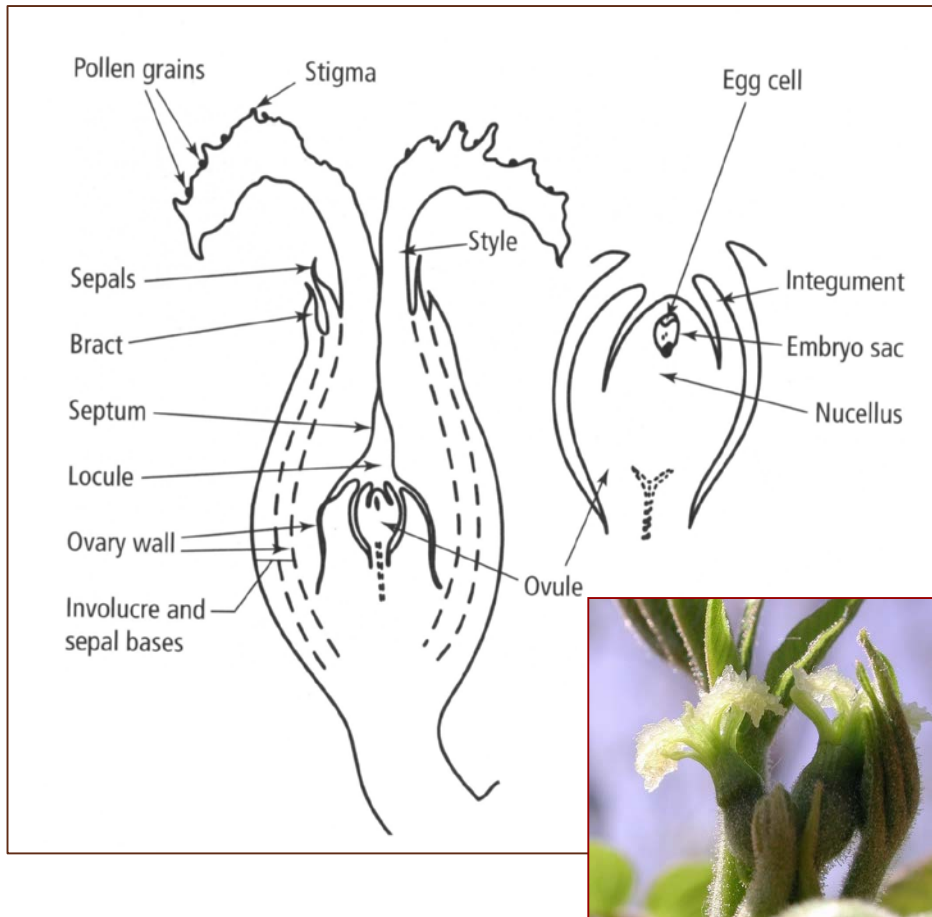
Protogyny: Female precedes male.

Heterodichogamy: Protandrous and protogynous individuals in the same species.

In walnut, the extent of dichogamy varies from year to year.

Reproductive Biology (*Juglans regia* L.)

Pistillate Flowers Borne Terminally on Shoots

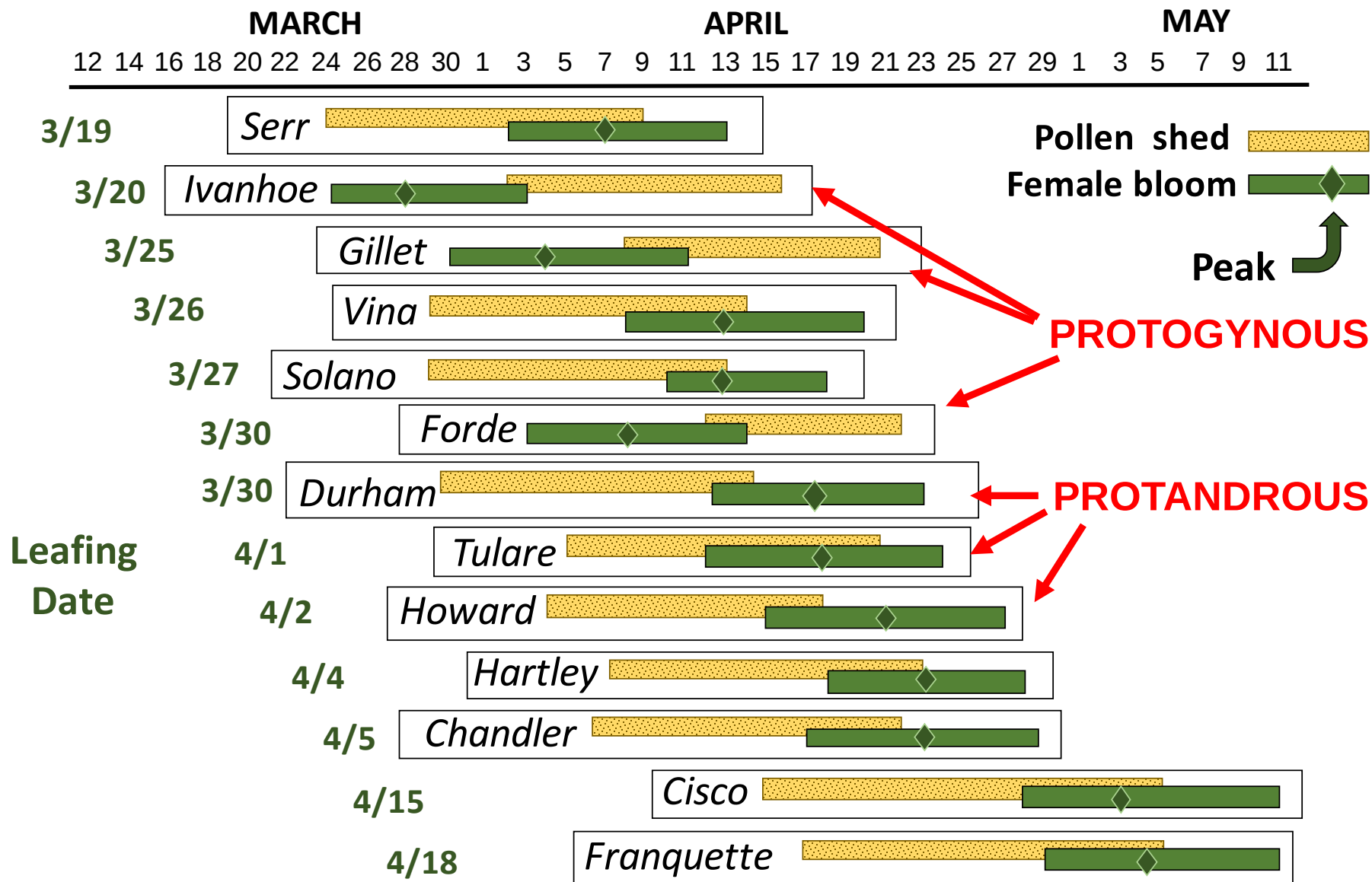


Staminate Flowers Borne in Catkins



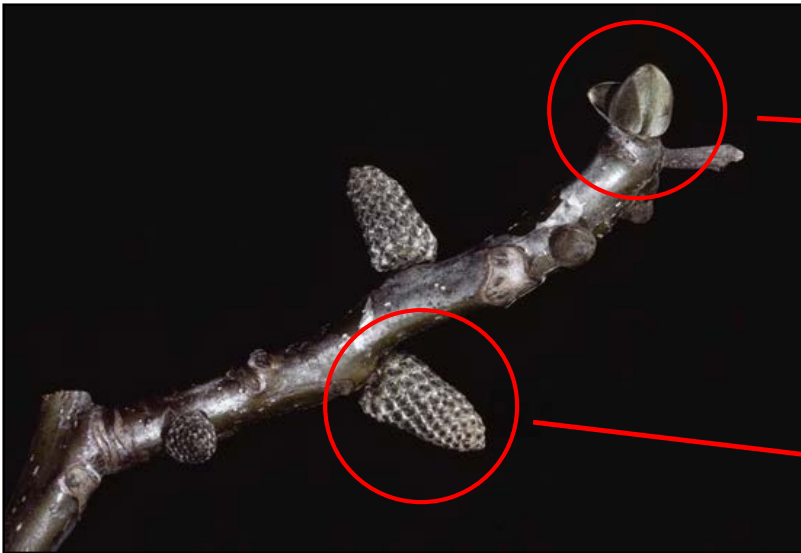
Heterodichogamy in Walnut



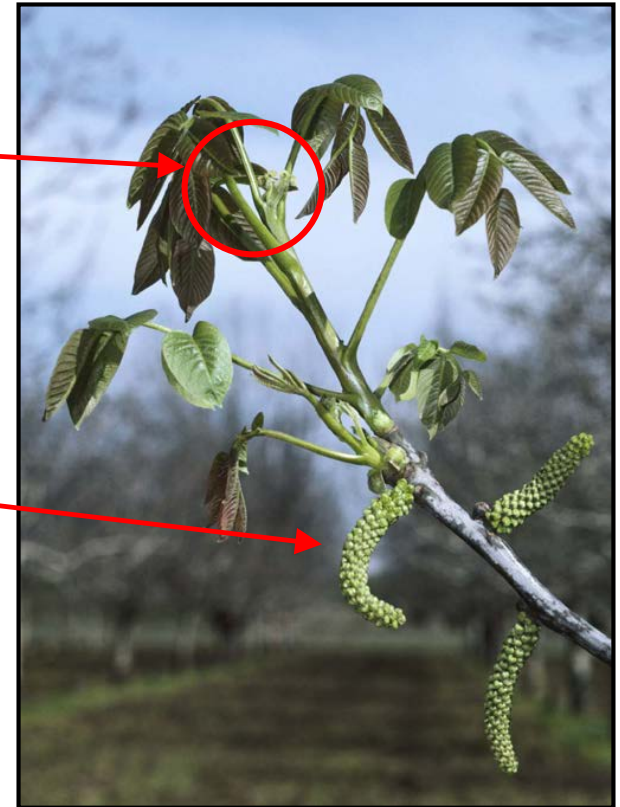


Walnut bloom and pollination

Dormant shoot



Leaf out

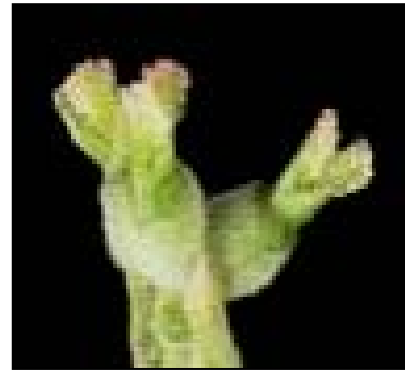
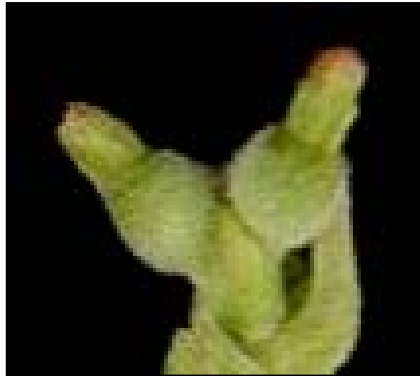




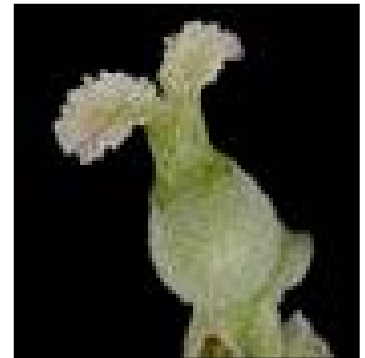
Pistillate (female) flower receptivity



Early flower
development
Not receptive

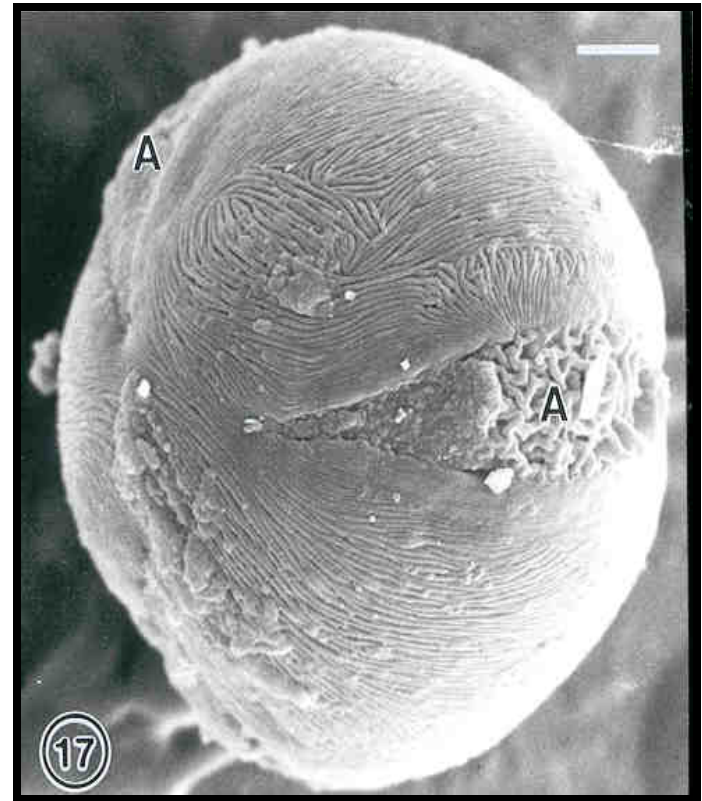
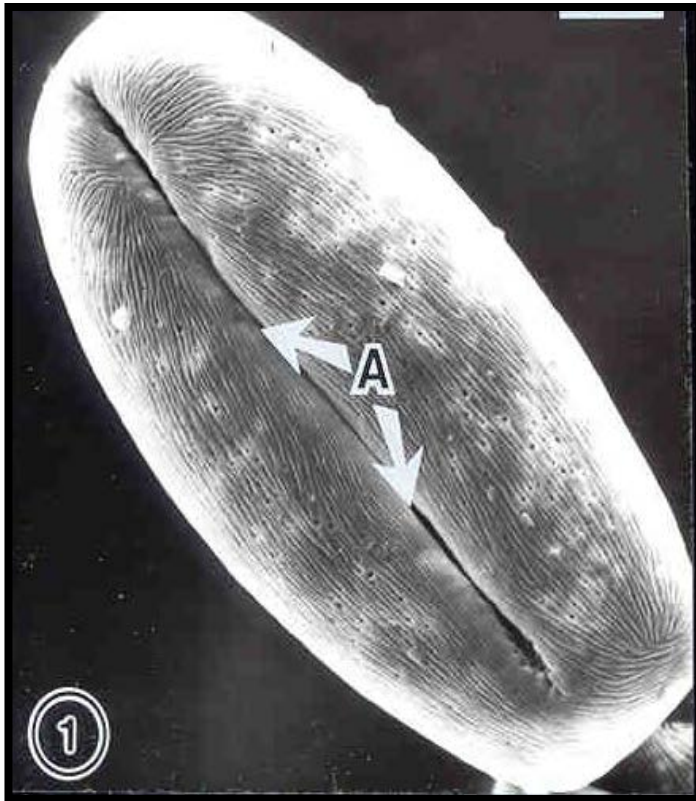


Peak Receptivity



Late flower
development
Not receptive

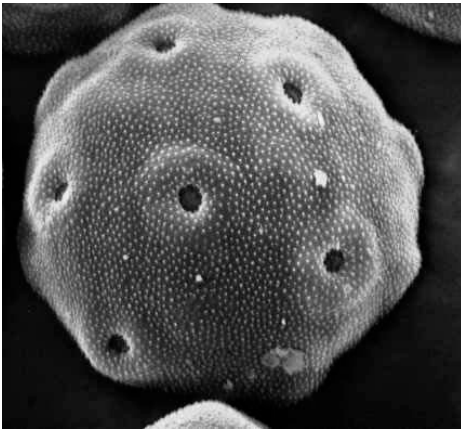
Pollen and pollination



Pollen is released from the anther as a dehydrated cell.

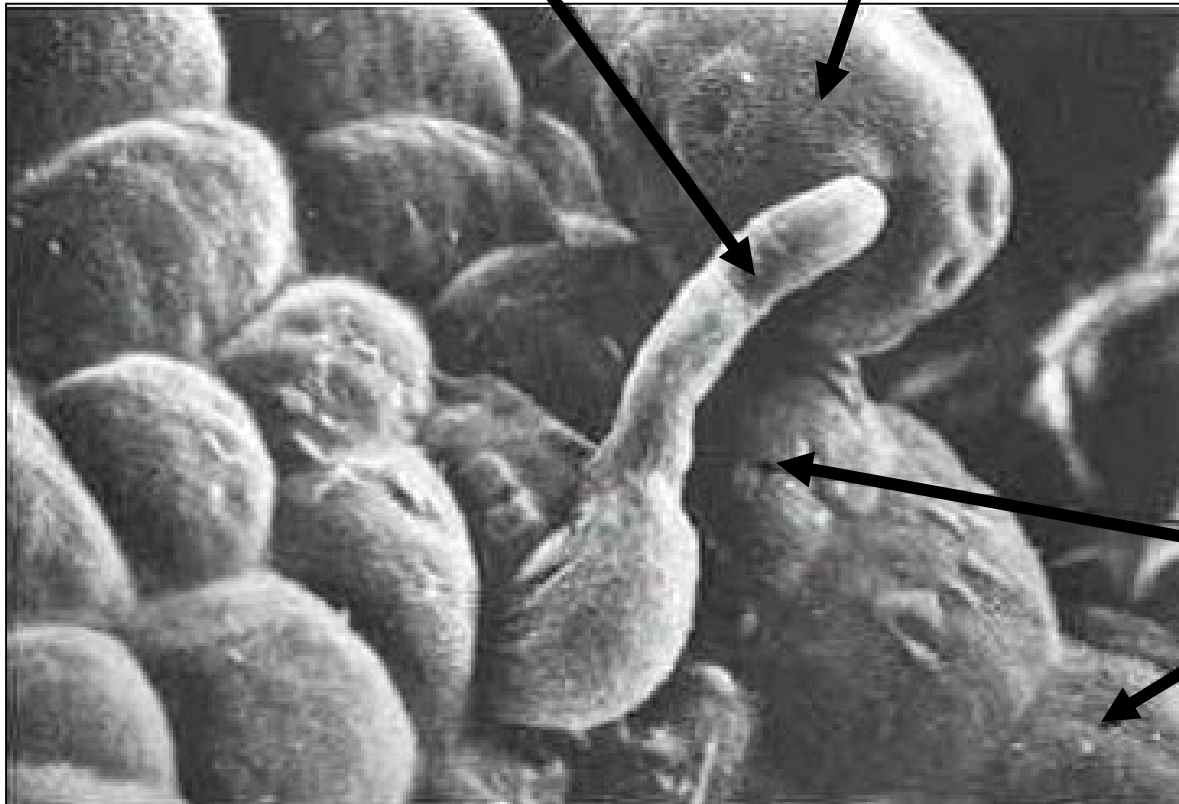
When pollen lands on a stigma it rapidly hydrates in the fluid present on the stigma surface.

Walnut pollen



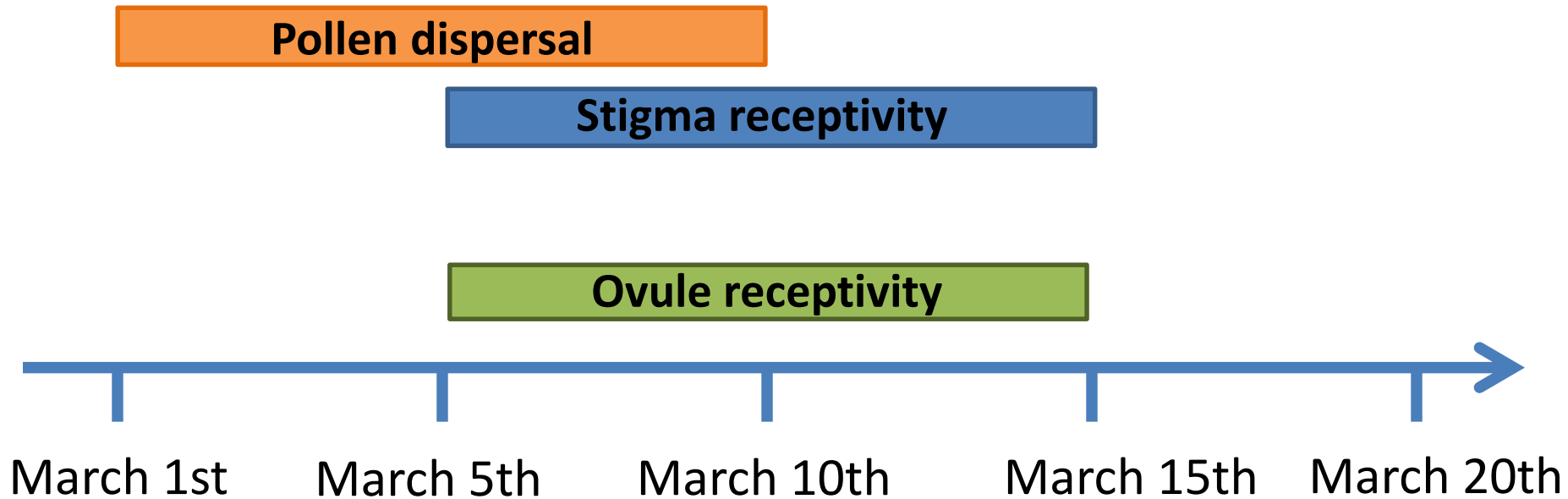
Pollen tube

Pollen grain



Stigma
surface
cells

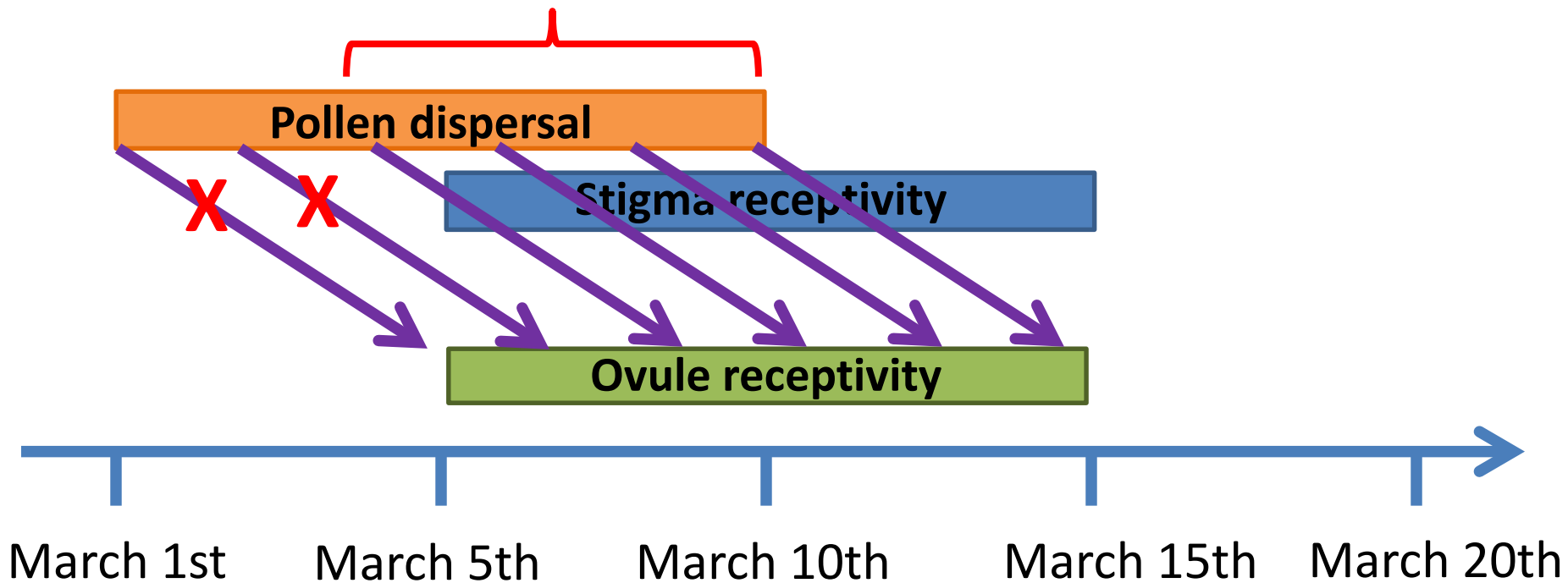
Effective Pollination Period (EPP)



Pollen tube growth from stigma to ovule = ~5 days

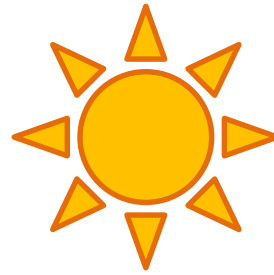
Effective Pollination Period (EPP)

EPP = 6 days



Pollen tube growth from stigma to ovule = ~5 days

Effective Pollination Period (EPP)



High temperatures
can reduce stigma and
ovule receptivity

Pollen dispersal

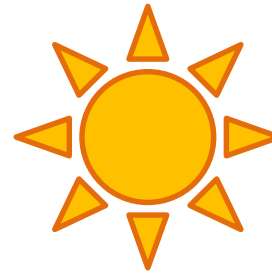
Stigma receptivity

Ovule receptivity



Pollen tube growth from stigma to ovule = ~5 days

Effective Pollination Period (EPP)



High temperatures
can reduce stigma and
ovule receptivity

EPP = 3 days



Pollen dispersal

X

X

Stigma receptivity
receptivity

Ovule receptivity

X

X

March 1st

March 5th

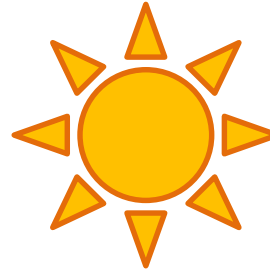
March 10th

March 15th

March 20th

Pollen tube growth from stigma to ovule = ~5 days

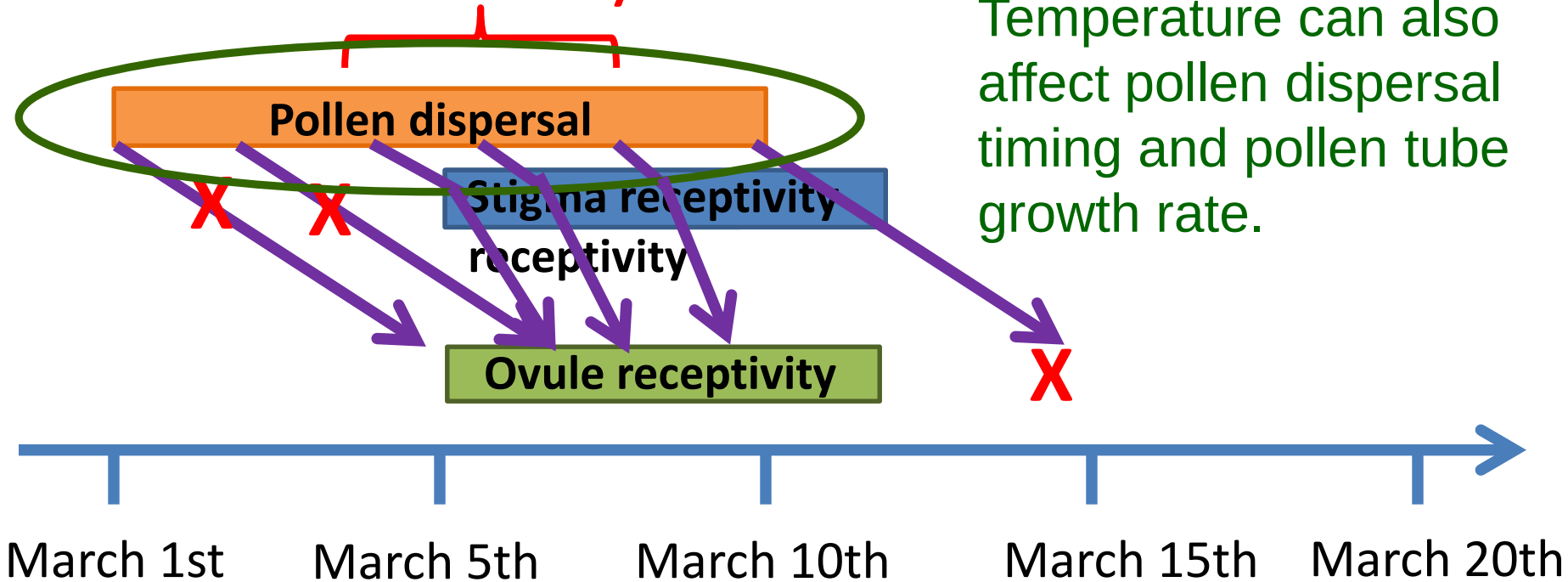
Effective Pollination Period (EPP)



High temperatures can reduce stigma and ovule receptivity

Temperature can also affect pollen dispersal timing and pollen tube growth rate.

EPP = 4 days



Pollen tube growth from stigma to ovule = ~3 days

Causes of flower and early fruit drop



Pollinated and unpollinated
flowers 5 weeks after bloom

PFA



Serr pistillate flowers 12 days
after bloom

Pistillate Flower Abortion (PFA)

Flowers stop growing at 2-3mm diameter stage and abscise about 10 days after bloom.

Was first noted as a problem in 'Serr'.

PFA is most severe in this variety where 90% of flowers can be lost.



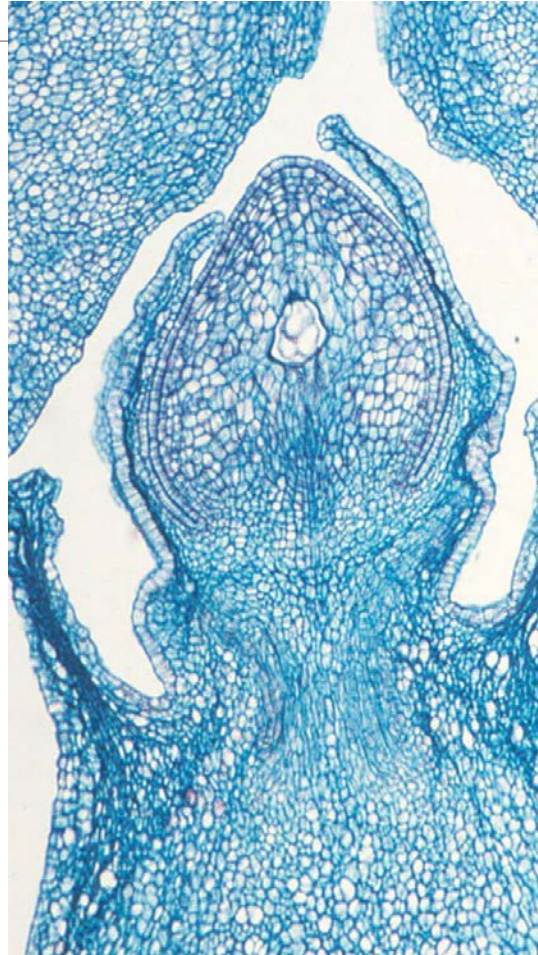
Prof. Polito

PFA - Ovule Tissue Necrotic and Collapsed

Day 6



Day 8



Day 10



What Causes PFA?

Many early theories were tested and disproved:

- *Inadequate pollination*
- *Nutritional deficiencies*
- *Light exposure*
- *Within-tree resource competition*
- *Pathogens*
- *Water stress*

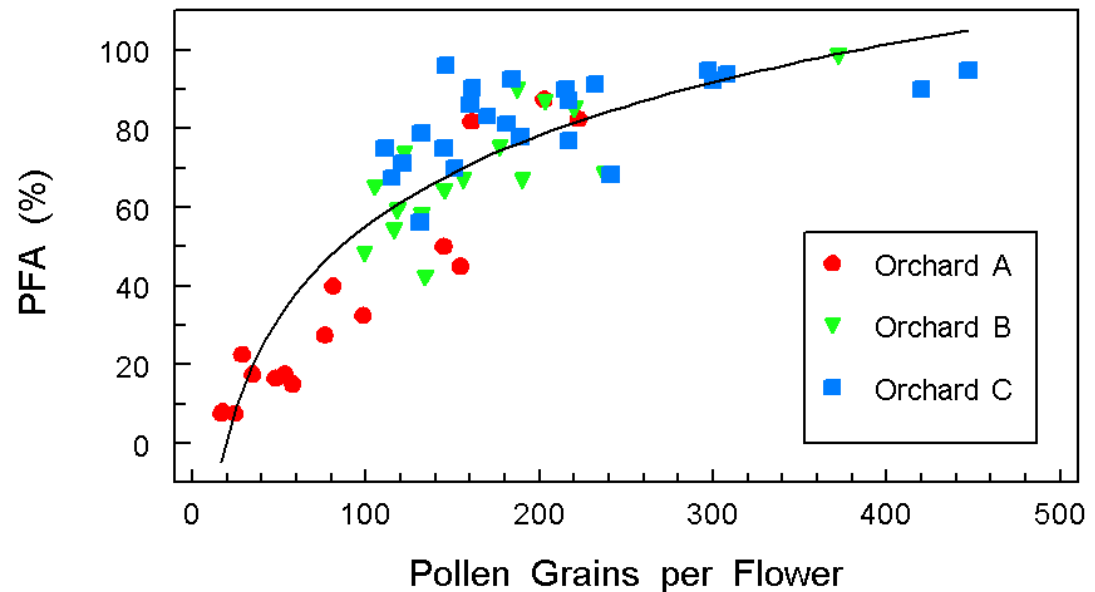
....and, several others, all of which proved negative.

What Causes PFA?

Observation that 'Serr' trees adjacent to pollinizers (typically 'Tehama') had higher levels of PFA than trees more distant from pollinizer rows.

Is pollen load a factor in PFA?

- *PFA decreases with distance from pollinizers (Serr).*
- *Yield and PFA are inversely related with distance from pollinizer rows in Serr.*
- *PFA increases with pollen load.*



Excess pollen → PFA

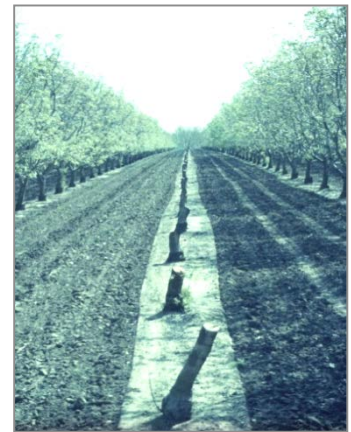
Four approaches to reducing pollen load:

Remove catkins from pollinizer trees

Remove pollinizers from the orchard

Remove catkins from pollinizers and main cultivar

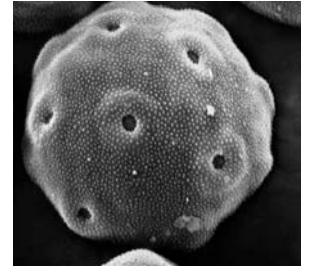
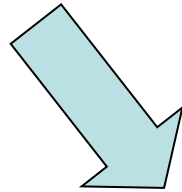
ReTain[®] plant growth regulator



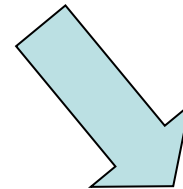
What Causes PFA?



Too much pollen



Ethylene



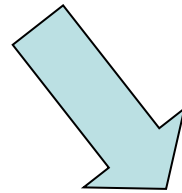
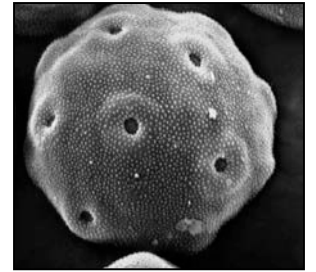
PFA



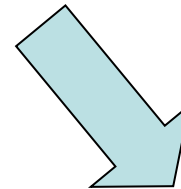
What Causes PFA?



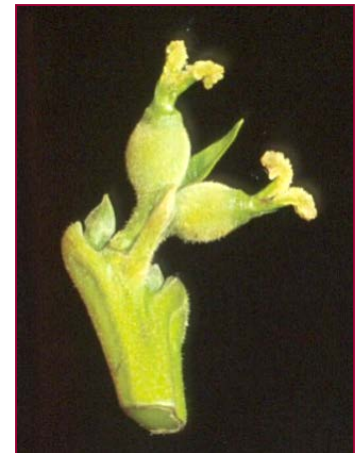
Too much pollen



~~Ethylene~~



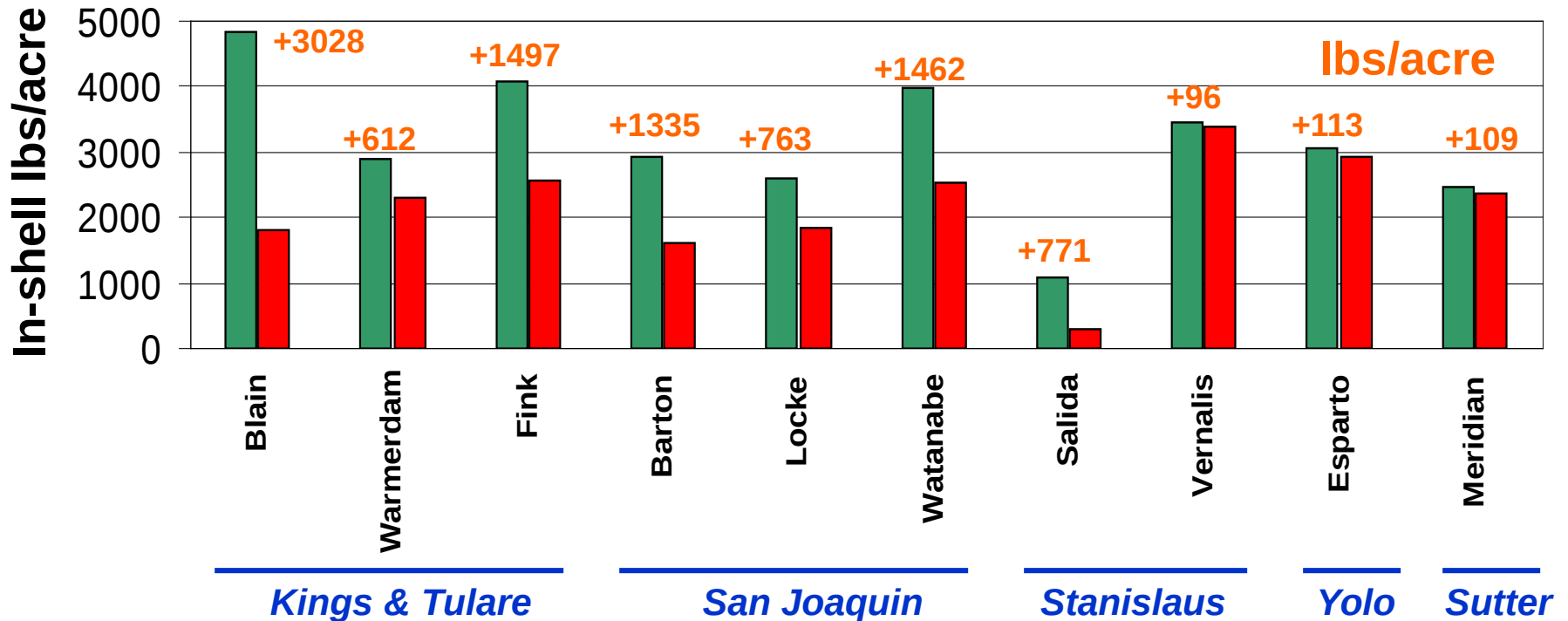
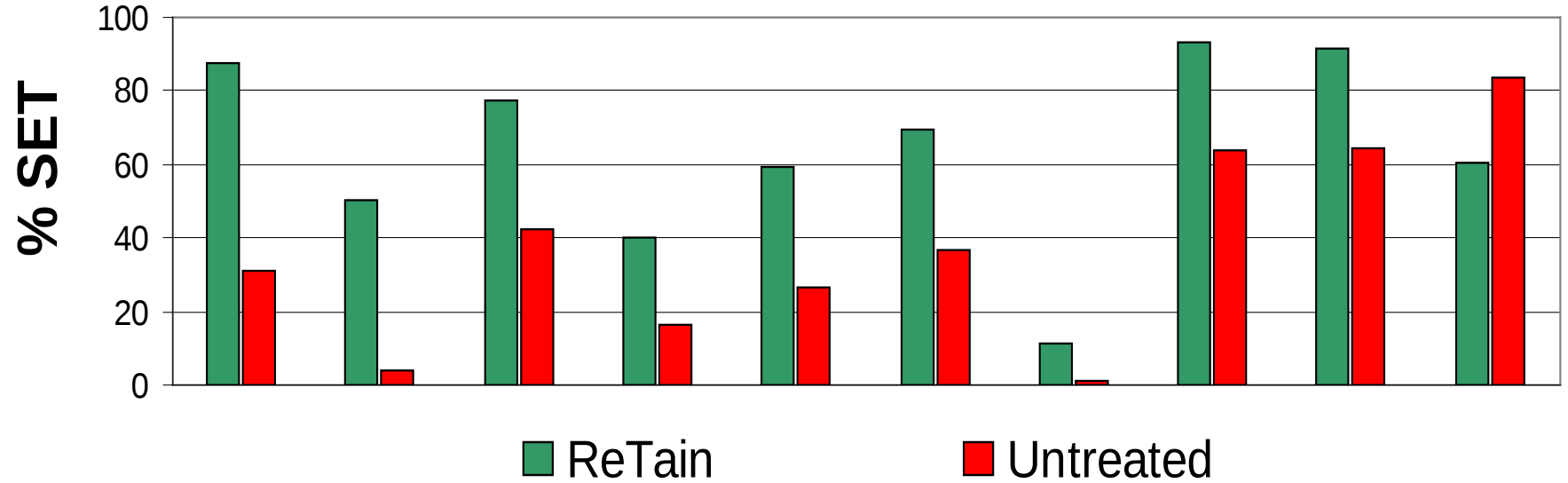
PFA





Active ingredient: *aminovinyglycine (AVG)*
an ethylene biosynthesis inhibitor

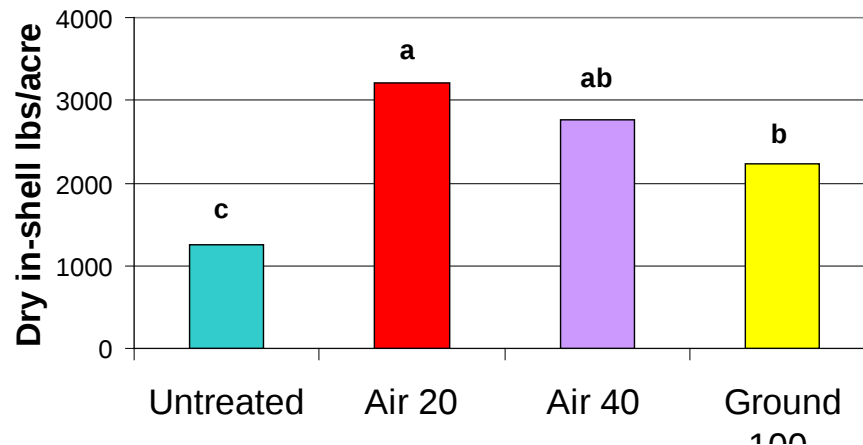
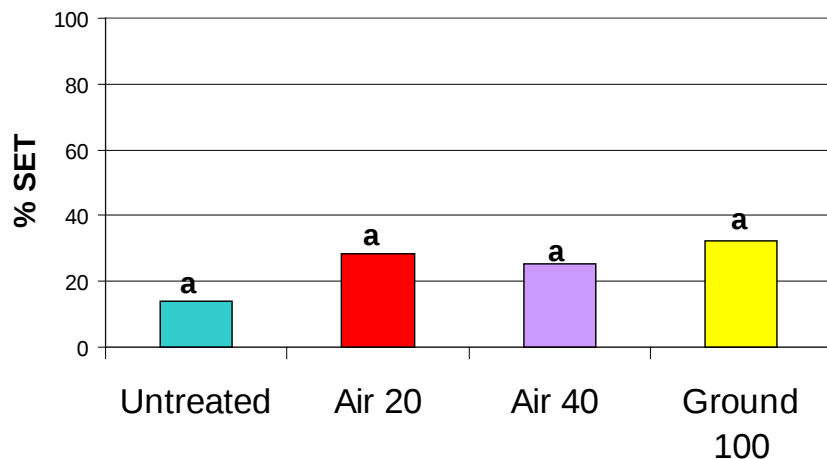
Regional Serr ReTain Trials, 2006



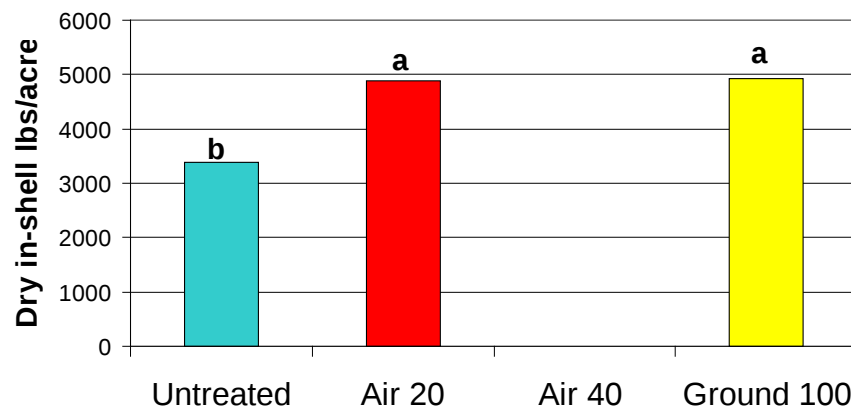
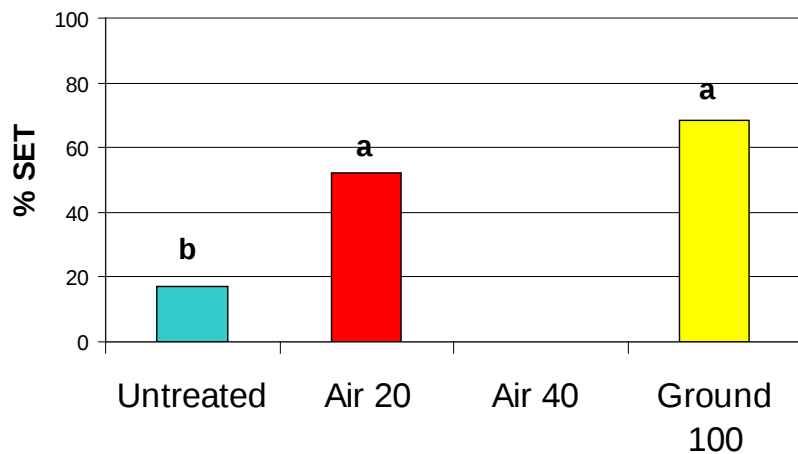
Air application of ReTain are an effective alternative to ground applications



DONDERO, San Joaquin County



BRAGG, Kings/Tulare



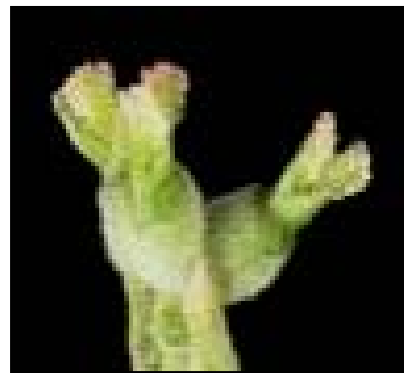
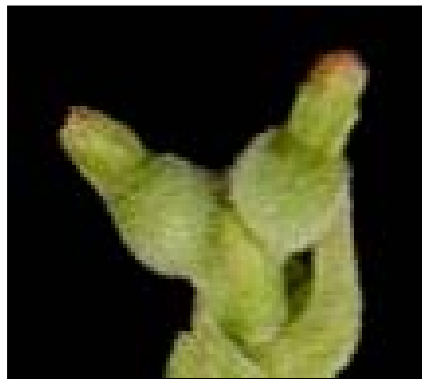


Application Timing

✓ 30% female bloom (peak receptivity)



Early flower
development -
Not receptive



Peak Pollen Receptivity



Late flower
development
Not receptive

45°

Using ReTain®

“Bad PFA years”

Heavy catkin load on main variety

Large overlap between catkin shedding of main variety and its female bloom

Large overlap between catkin shedding of pollinizers and female bloom of main variety

No rain during female bloom receptive period

Using ReTain®

Consider first:

Are low yields due to PFA?

Can I return more than the \$300/acre?

Will this be a bad PFA year?

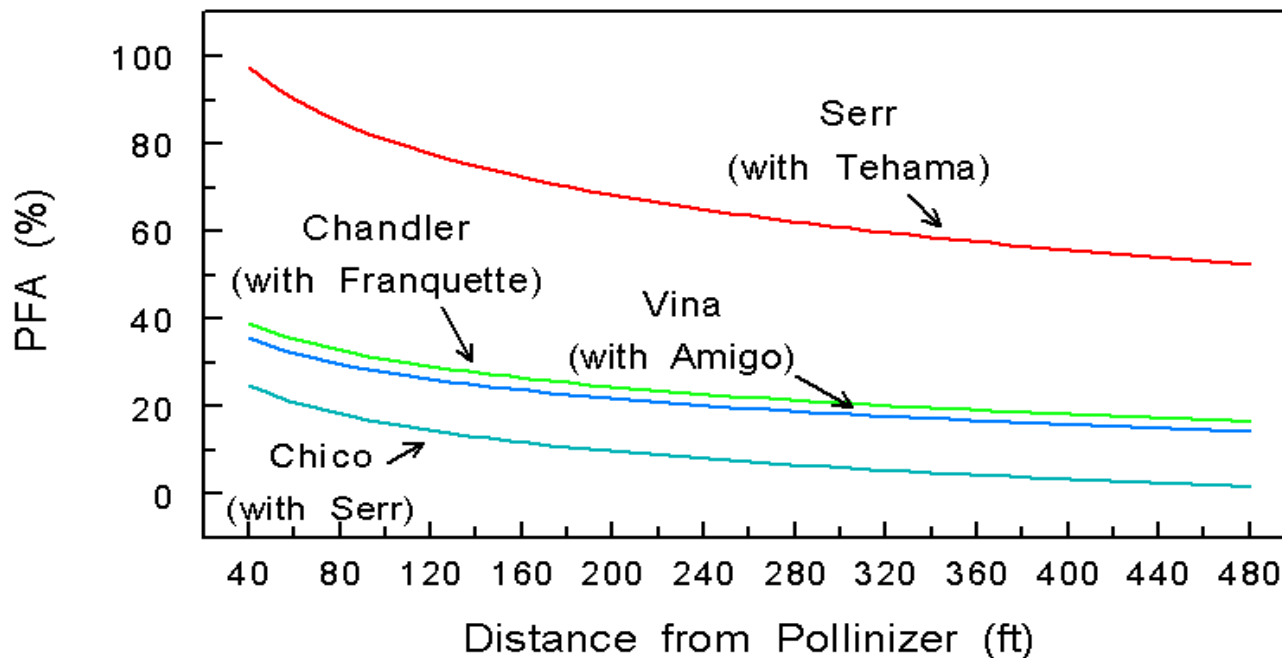
If YES to all . . .

- ✓ Apply at “5-30%” female bloom
- ✓ 100-200 gallons per acre
- ✓ GOOD COVERAGE
- ✓ 1 pouch per acre (50 grams a.i.)
- ✓ Apply at least 2 days before or after COPPER
- ✓ Split applications (at half-dose) not consistently better than single applications
- ✓ Double applications better may not be not cost effective

OTHER ReTain® FINDINGS

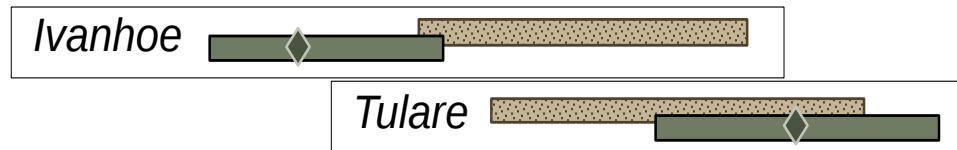
Other varieties?

- TULARE most thoroughly tested: Large benefits sometimes; other times little or no effect
- CHANDLER: Not enough PFA to justify expense
- OTHERS: When considering, first be sure low yields are due to PFA and not other causes

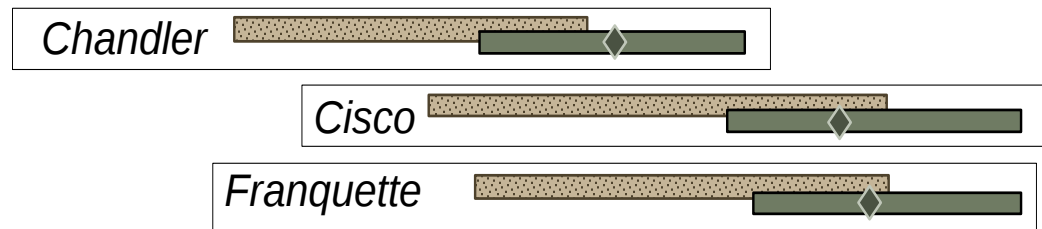


Pollinizer density & placement in walnut orchards

Dichogamy exists in all commercial varieties. In some, overlap between male and female bloom may be small.



Traditional recommendation: 10% pollinizers to cover the main variety's pistillate bloom not covered by itself.



PFA, understanding of pollen flow in orchards, and move to higher tree densities  Rethink 10% recommendation.

Pollinizer density & placement in walnut orchards

ARE POLLINIZERS EVEN NECESSARY?

- Varieties with good self-overlap and that seem to produce well without pollinizers, e.g.:

Tulare, Sexton, AND SERR

- Varieties with less overlap that generally benefit from pollinizers:

All others

- Especially: When young and catkin numbers are low, OR orchard is in isolated locations with no outside pollen sources
- UNLESS: Orchard is in walnut areas with other pollen sources nearby.

Pollinizer density & placement in walnut orchards

WHAT % POLLINIZERS?

Current thinking: 3-5% seems to be sufficient in many cases

- On UPWIND EDGES and the balance in ROWS PERPENDICULAR to prevailing winds
- Consider higher percentage in isolated locations with no sources of outside pollen
- Low catkin production in young orchards:
 - *Minimal pruning of pollinizers to promote early catkin production*
 - *Start with a higher percentage with some temporary trees to be removed later ?*

Pollinizer density & placement in walnut orchards

DISTANCE BETWEEN POLLINIZERS?

Pollen is wind-borne, and wind direction & speed varies by region and by day

Pollen remains viable around 24-48 hours, maybe longer, depending on conditions

Downwind “fall-out” from pollinizer trees in commercial orchards is thought to be around 120-150 feet, but

Pollen flow studies indicate significant contribution from outside orchards is possible.



Current thinking: 250-300 feet between pollinizer rows.

Suggested pollinizers

Serr	None
Chandler	Cisco, Franquette
Howard	Cisco, Franquette
Tulare	Chandler, Howard, Cisco, Franquette
Gillet	Payne, Serr, Solano, Vina
Forde	Ivanhoe, Solano, Serr, Payne, Vina
Ivanhoe	Serr, Payne
Solano	Chandler, Tulare, Howard, Ivanhoe
Durham	Chandler, Howard, Cisco

THANK YOU!

