Pollination and Fruit Set

Sacramento Valley Olive Day
April 12, 2011

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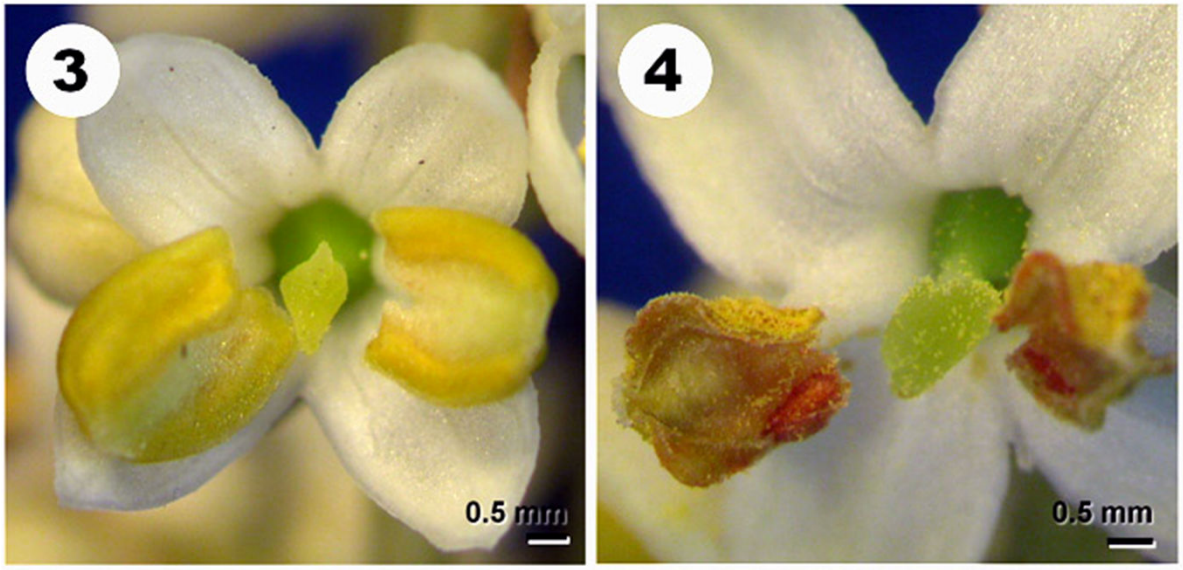
UC Davis Olive Center

Pollen and Pollination

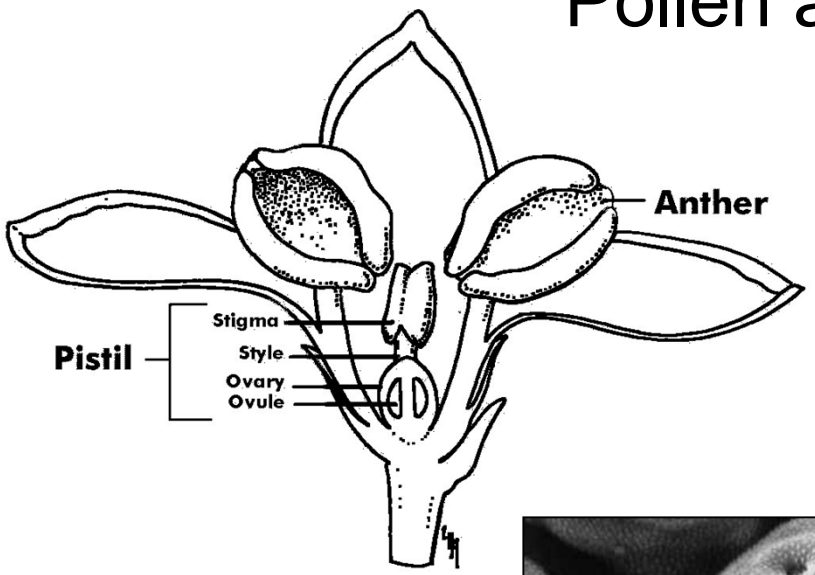


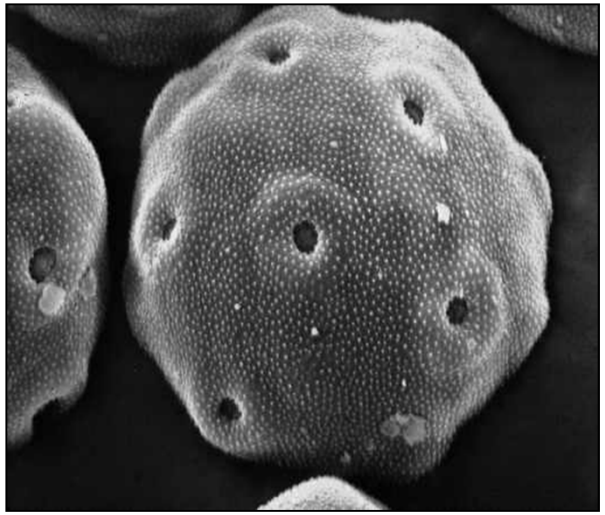
Zafra *et al.* 2010. *BMC Plant Biology* 10

Pollen grains form in the stamens of the flowers.

When the pollen is released it is carried to the stigmas.

Pollen and Pollination





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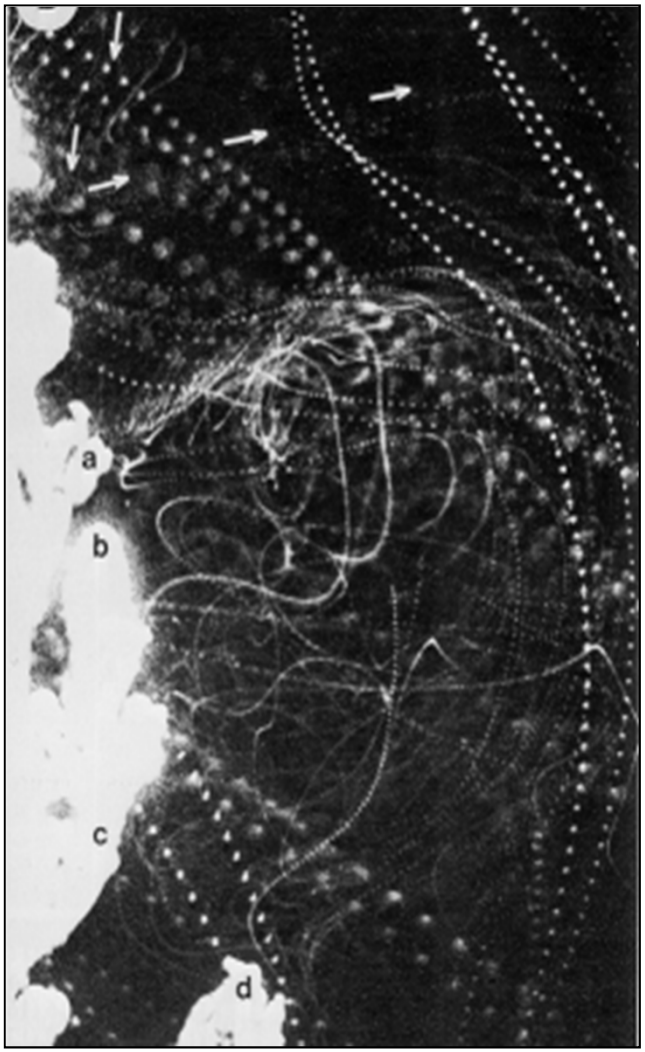
When the pollen is released it is carried to the stigmas.

Wind Pollination

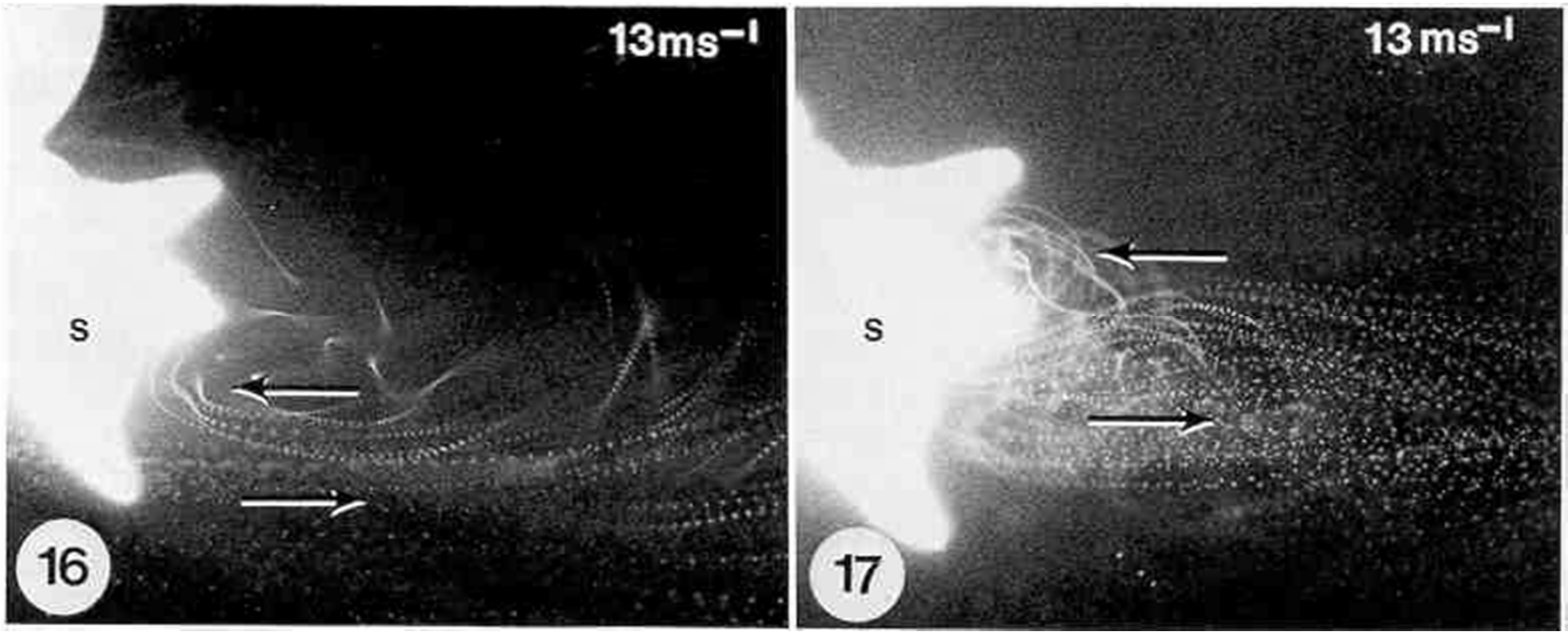
Olive flowers are wind pollinated.

Experiments using microscale wind tunnels show that pollen capture in wind-pollinated species is not simply chance capture of pollen moving in the air.

The shape and form of the flower structures create air flow patterns that direct the pollen to the stigma surfaces.

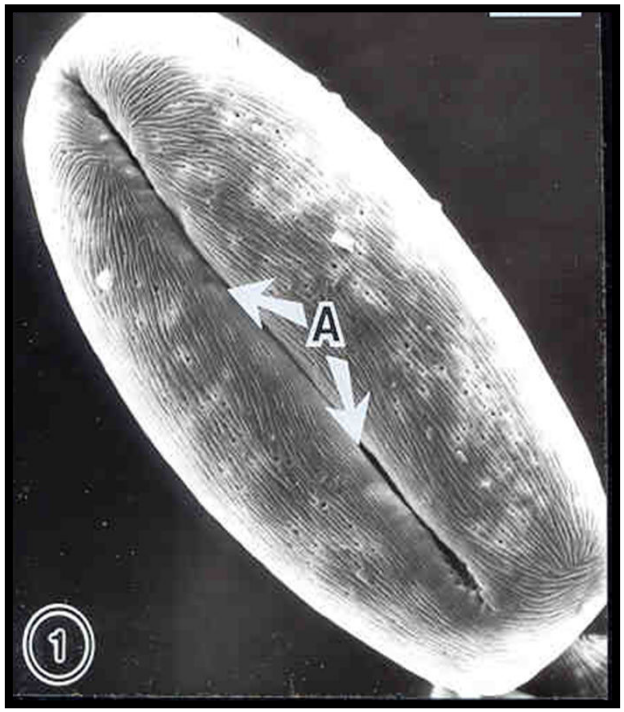


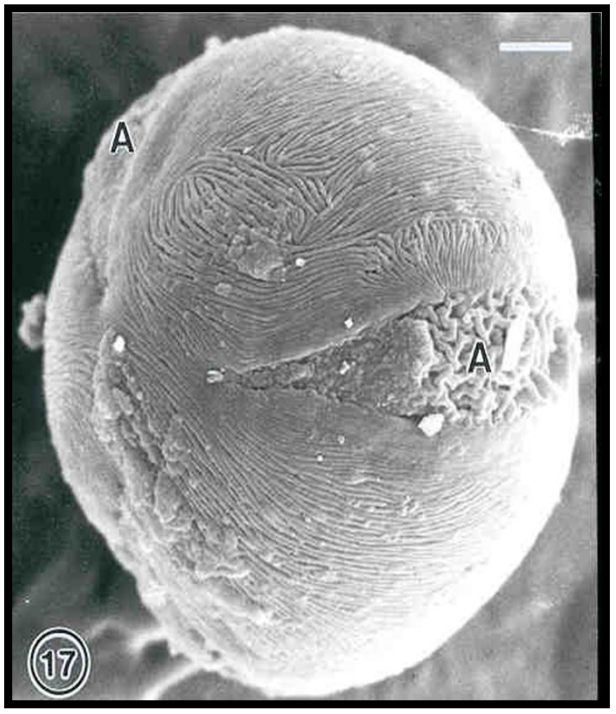
Wind Pollination



Niklas and Buchmann. Amer. J. Bot. 72:530

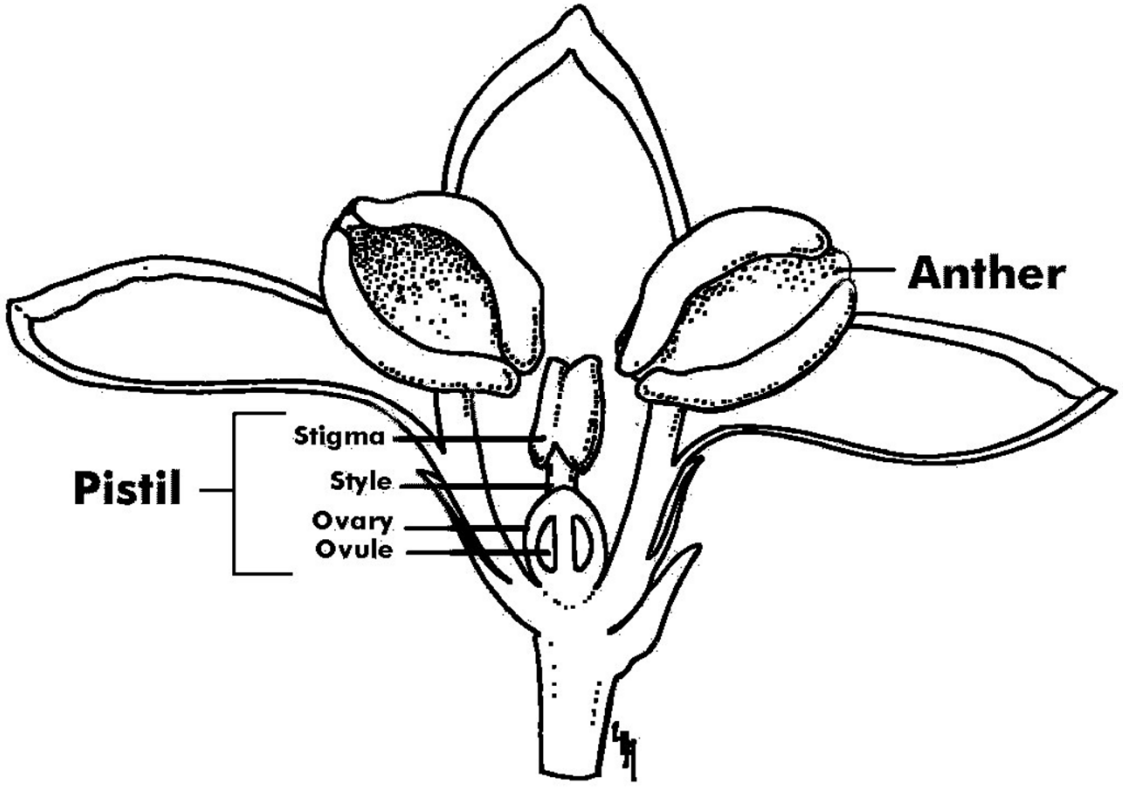
Pollination





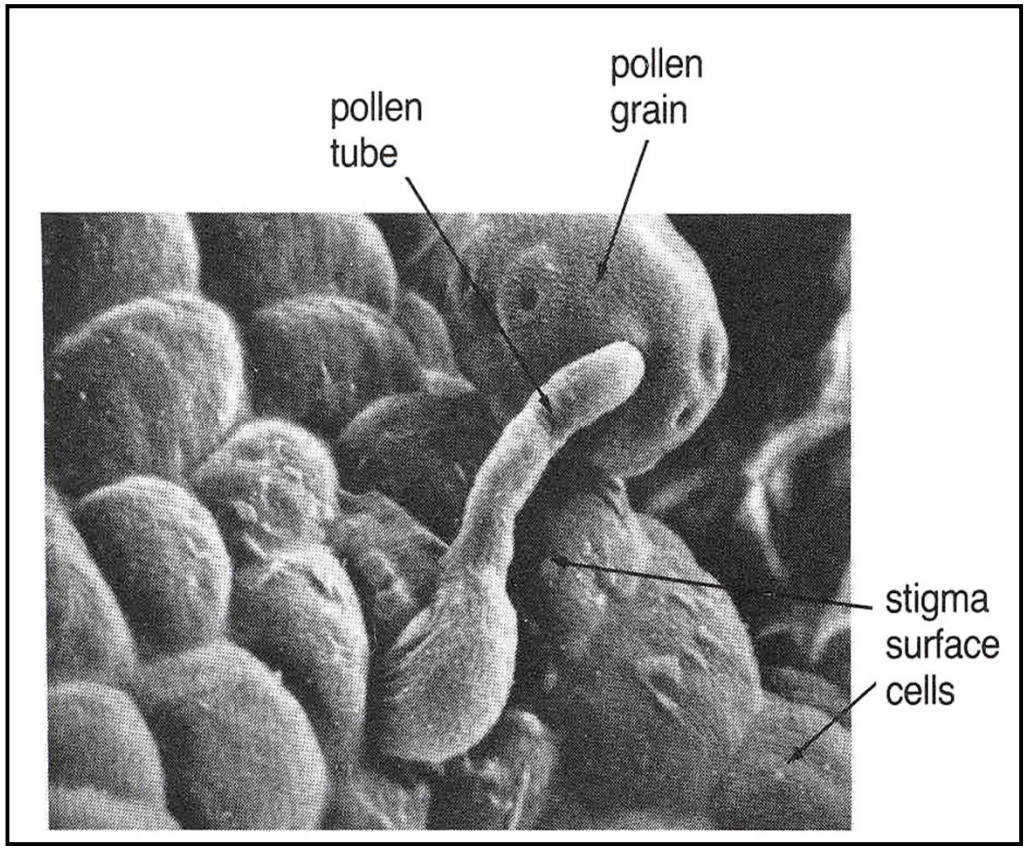
Pollen is released as a dehydrated cell. When it lands on the stigma it rapidly hydrates in the fluid that is secreted by the stigma surface cells.

Stigma Receptivity



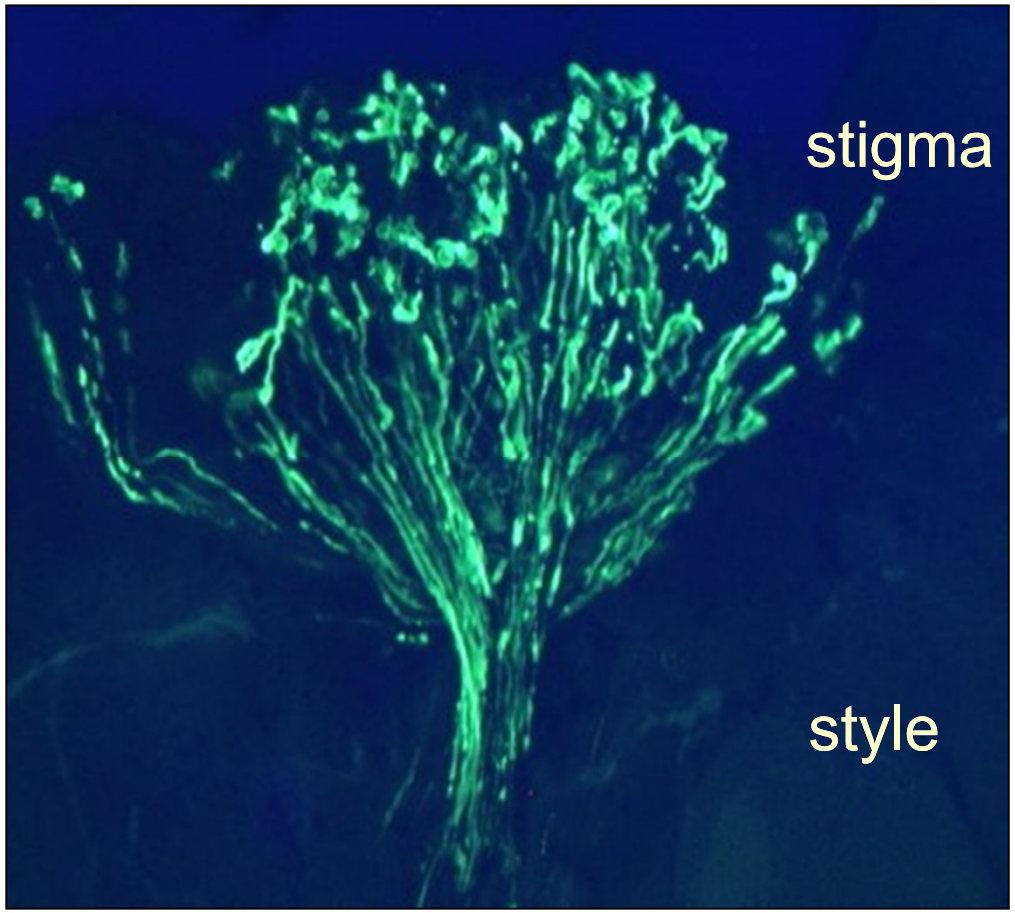
Stigma will support pollen hydration and germination for a limited period of receptivity. As receptivity passes, the stigma dries and turns brown.

Pollen Germination



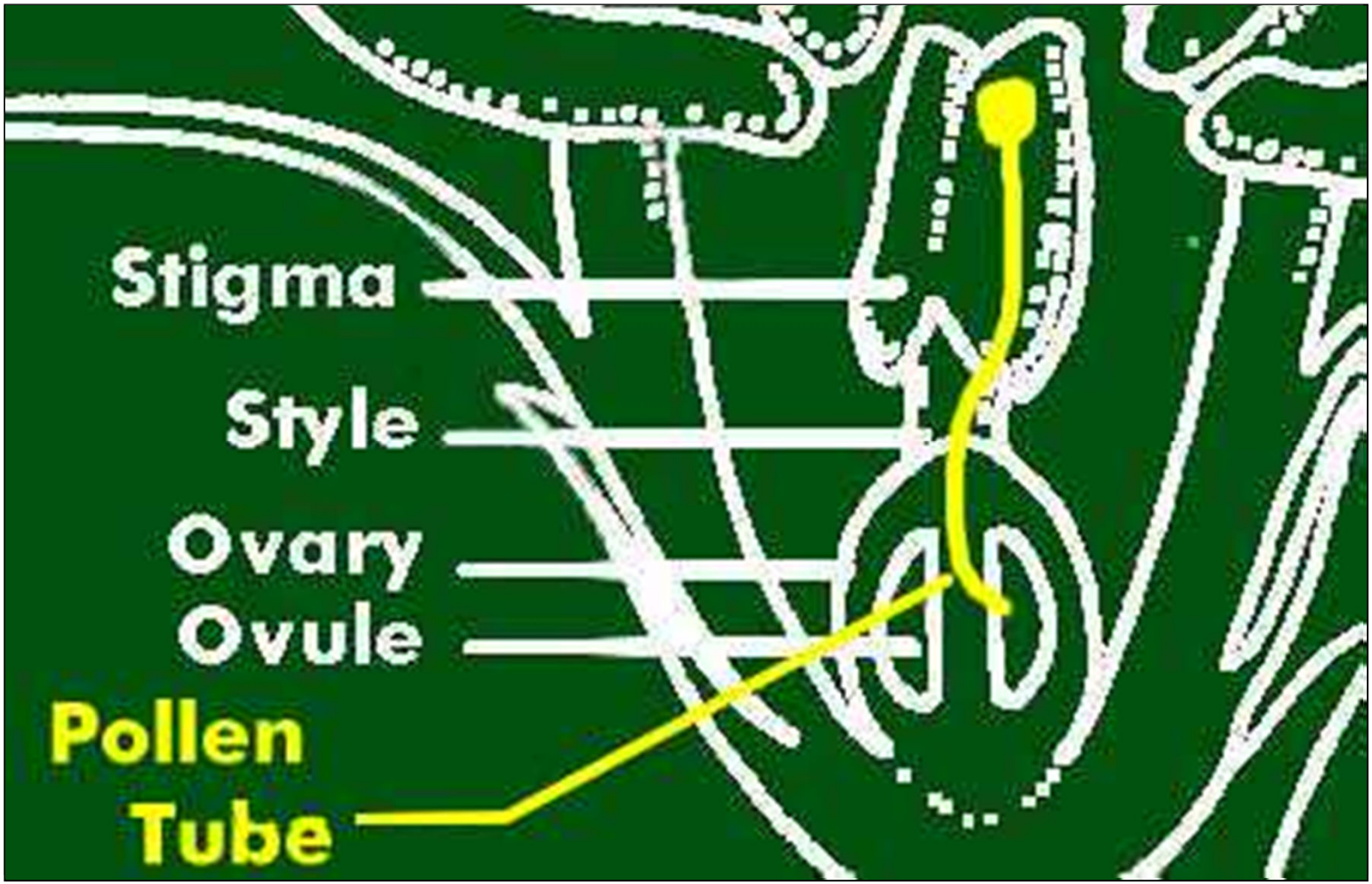
When pollen becomes hydrated on the stigma it germinates to form a tube that penetrates between stigma cells.

Pollen Tube Growth



The pollen tubes grow through the stigma, the style and into the ovary.

The pollen tubes carry male germ cells (sperms) to the ovary.



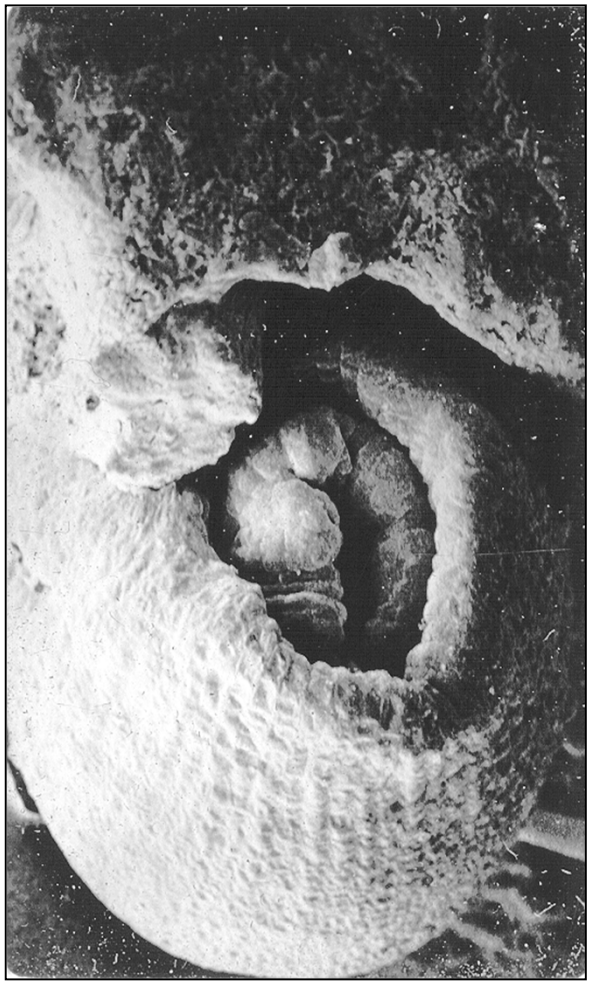
Pollen grains germinate on the stigma forming a pollen tube that grows through the style to the ovary where a pollen tube enters an ovule.

Ovules

Within the flowers' ovaries are ovules.

Stone fruits have two ovules.

Apples and pears have ten, two in each of the five ovaries.



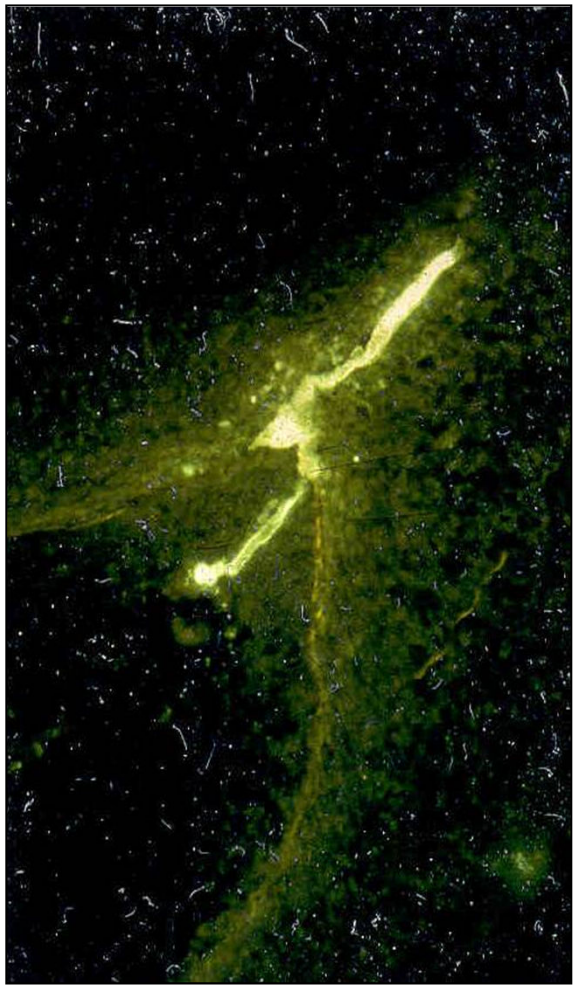
Female Germ Cell

The ovules are potential seeds.

They contain the female germ cells, eggs.

There is one egg cell in each ovule.

Fertilization



The first pollen tube to arrive enters the ovule and releases it contents.

One sperm cell fuses with the egg.

Fertilization triggers fruit set.

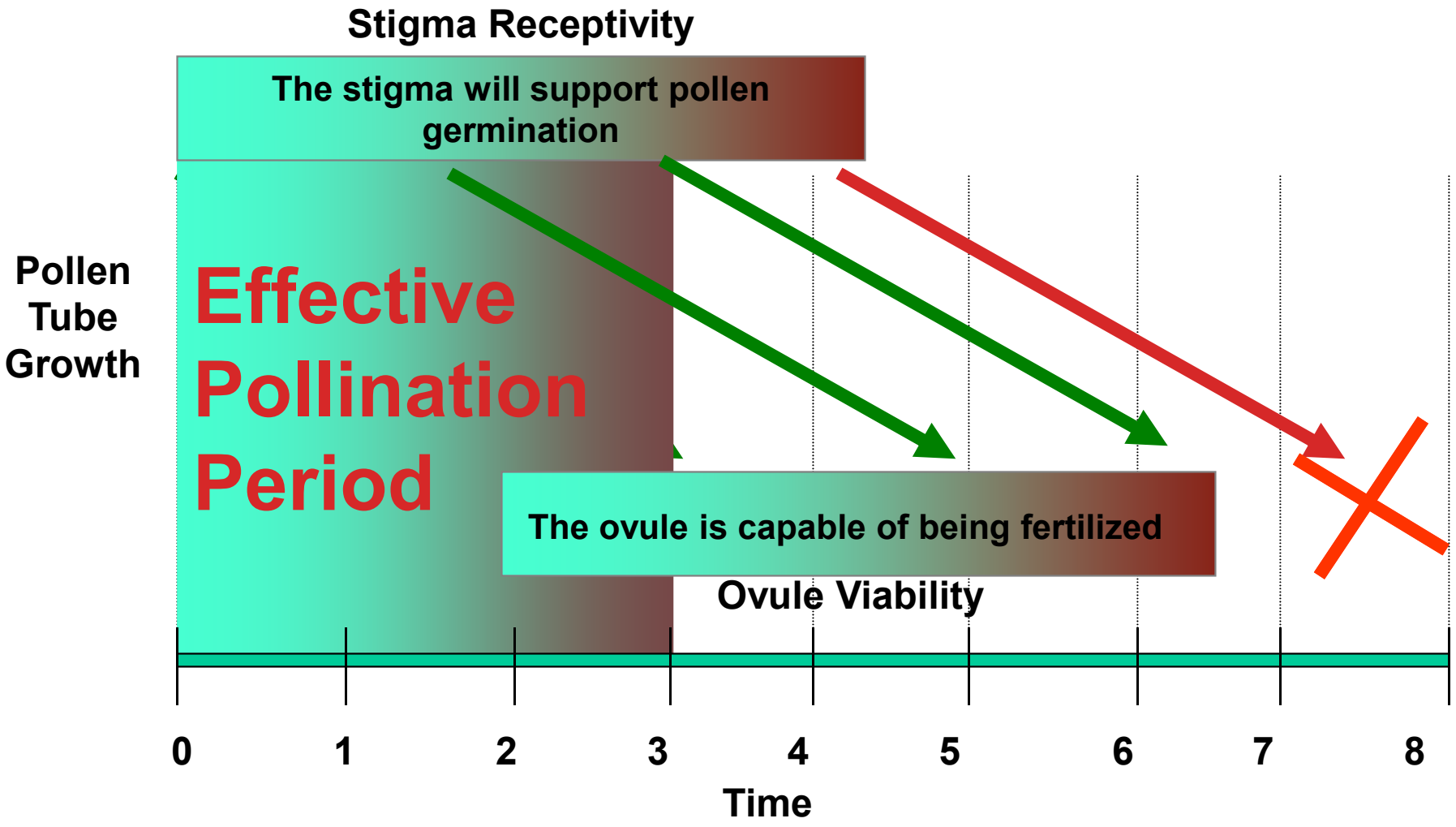
Effective Pollination Period (EPP)

EPP integrates three factors.

1. Stigma receptivity: the ability of the stigma to support pollen germination.
2. Pollen tube growth rate: the time required for the pollen tubes to grow through the style to the ovule.
3. Ovule viability: the time that the ovule is capable of being fertilized.

Each of these is temperature dependent.

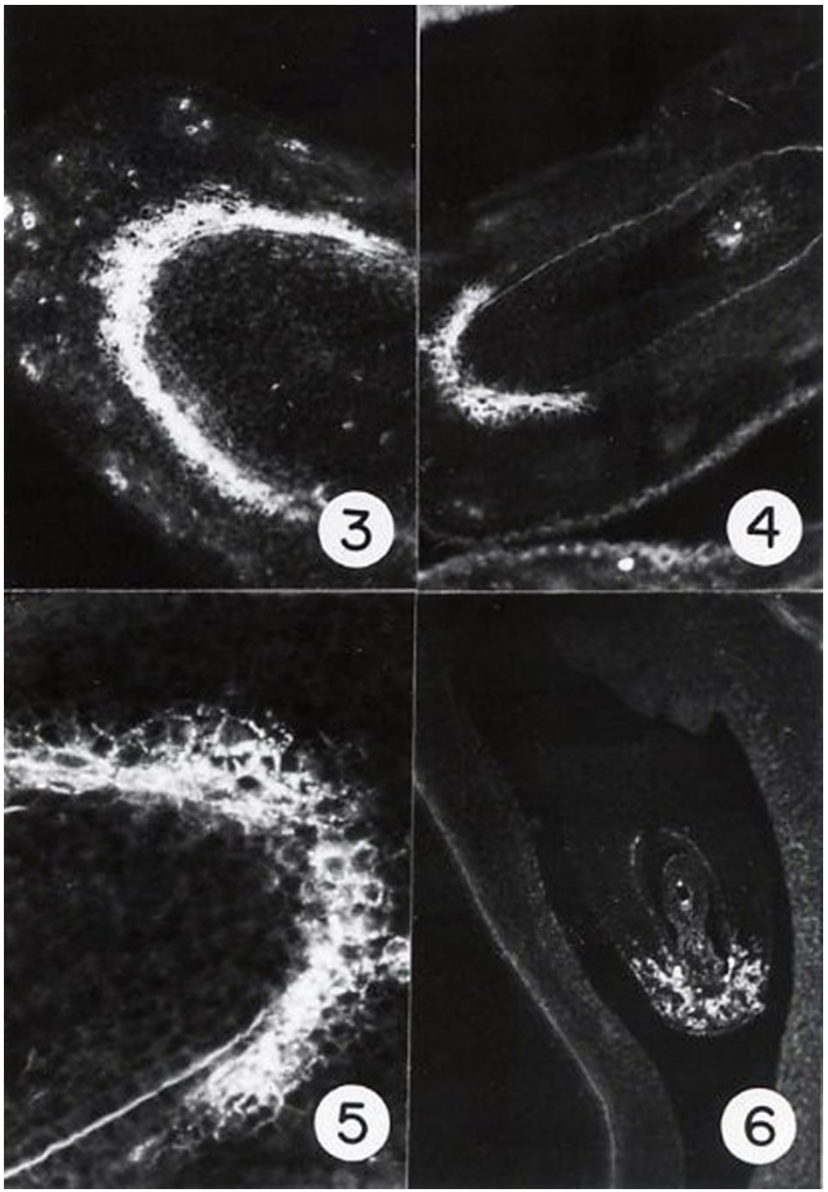
Effective Pollination Period



Ovule Viability

- Often the key factor in EPP.
- Most difficult to determine
- Little available temperature data for any species

Fluorescence Indicator of Ovule Viability



Aniline blue induced fluorescence in senescent almond ovules.

(Pimenta & Polito, 1982)

Determinants of EPP in Olive

‘Manzanillo’ in Davis, CA (1994-1995)

1994 mean daily temp: 20.7C (69.3F)

1995 mean daily temp: 18.6C (65.5F)

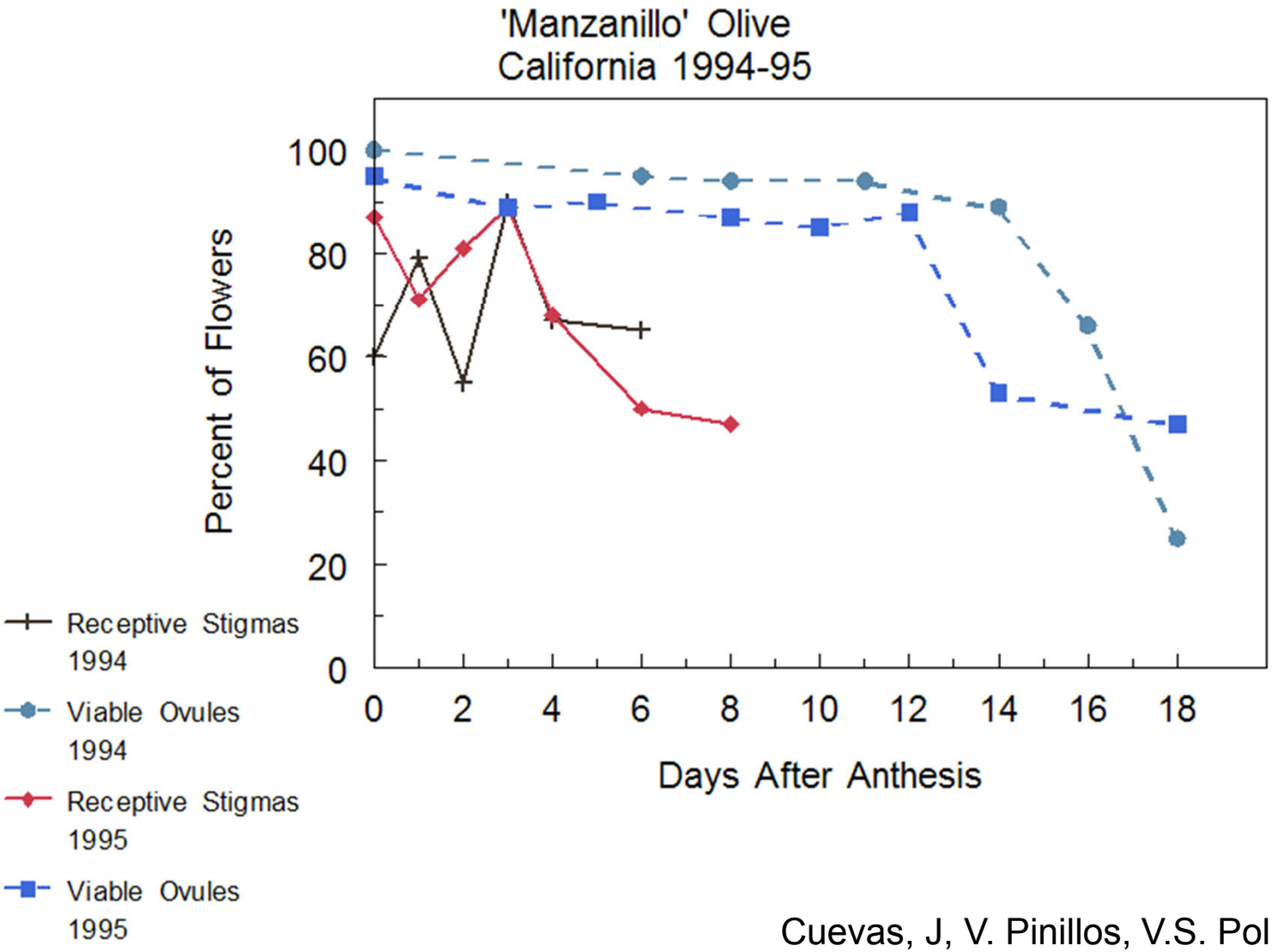
‘Picual’ in Cordoba, Spain (2000-2001)

2000 mean daily temp: 20.3C (68.5F)

2001 mean daily temp: 15.5C (59.9F)

Cuevas, J, V. Pinillos, V.S. Polito. 2009. Effective pollination period for 'Manzanillo' and 'Picual' olive trees. J. Hortic. Sci. Biotech. 84: 370-374

Determinants of EPP
(‘Manzanillo’ Olive - Davis, 1994, 1995)



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Determinants of EPP
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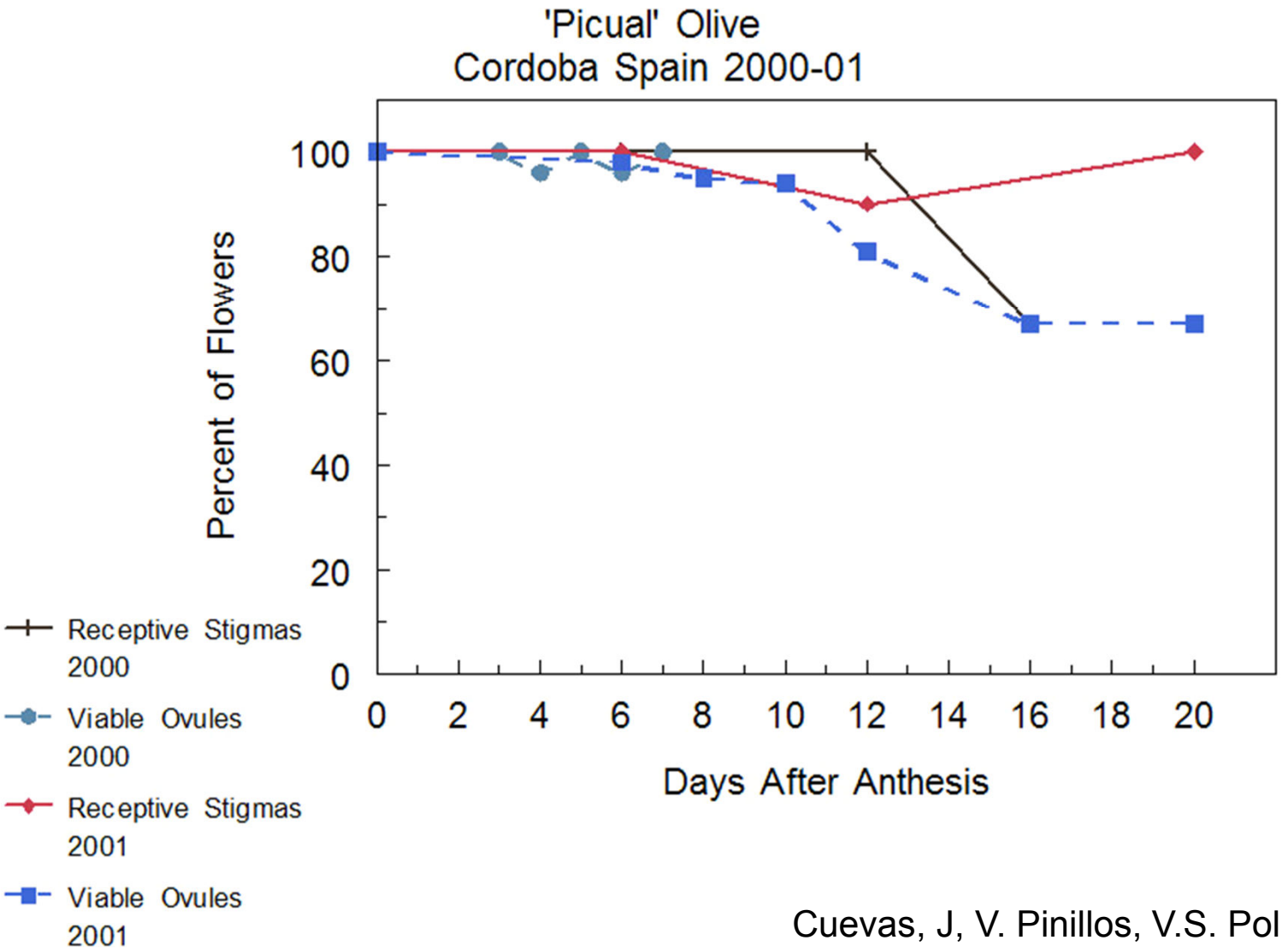

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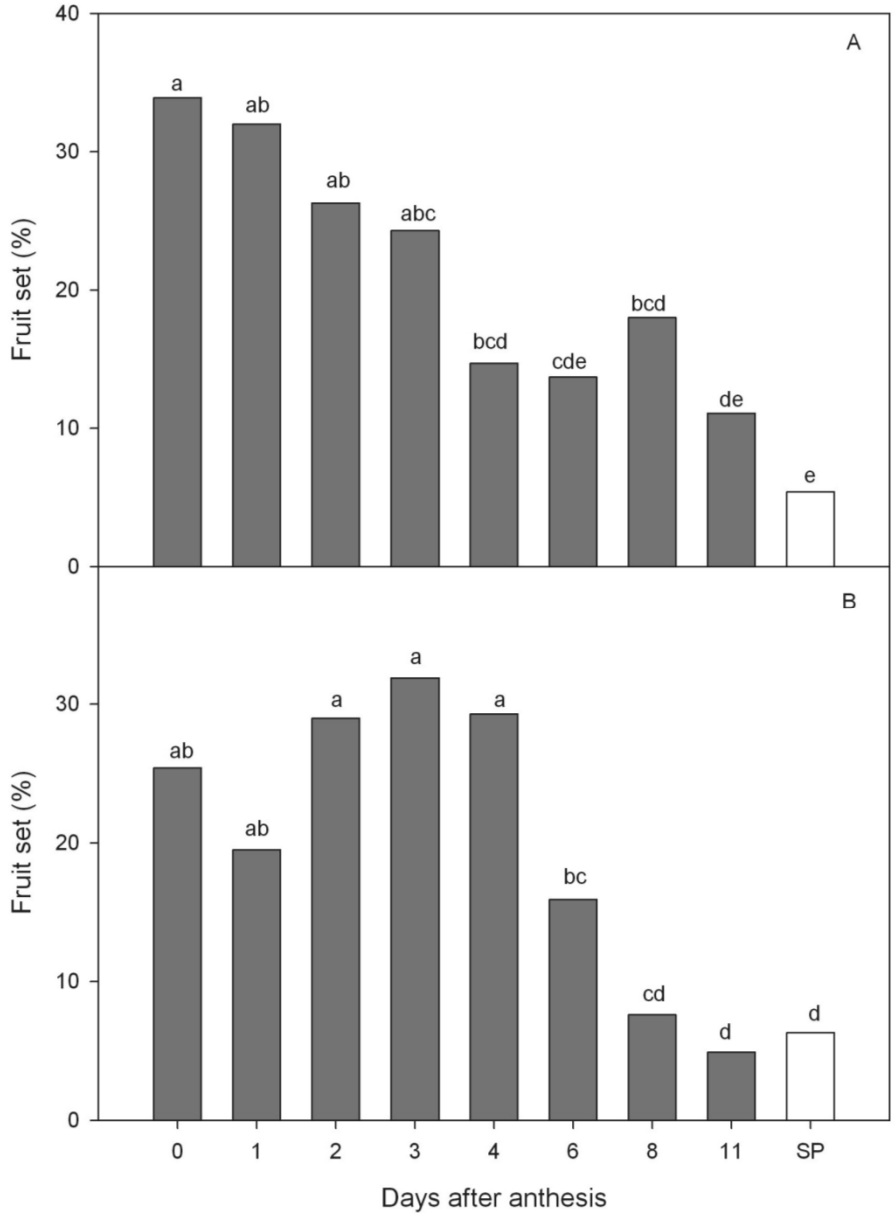
Initial Fruit Set
(Manzanillo - Davis, 1994, 1995)



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Initial Fruit Set
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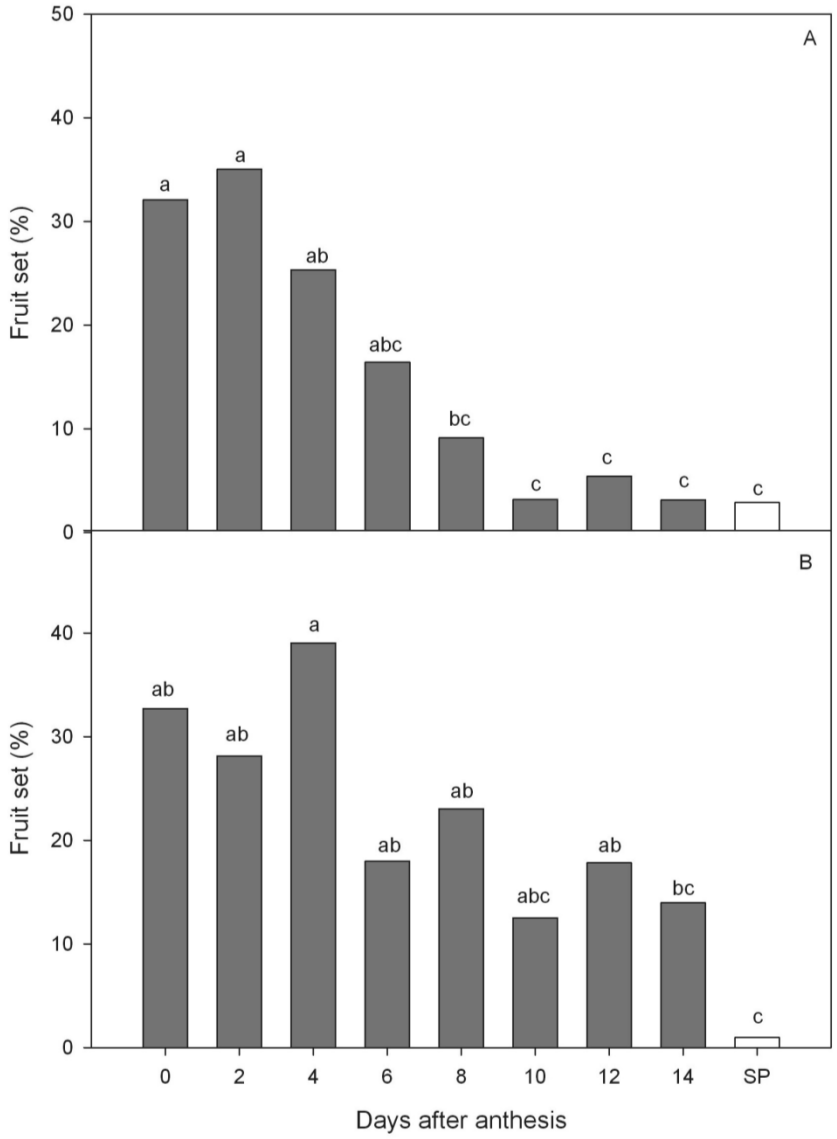

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Compatibility Relationships in Olive Cultivars

Self Incompatibility

Self-incompatibility (or self-unfruitfulness) refers to the inability of a flower to support growth of pollen from the same tree or cultivar.

Self-incompatible species set little or no fruit without being pollinated by a compatible cultivar.

Incompatibility groups comprise cultivars that are incompatible with each other. The response to pollen of a cultivar from the same incompatibility group is the same as that to self pollen.

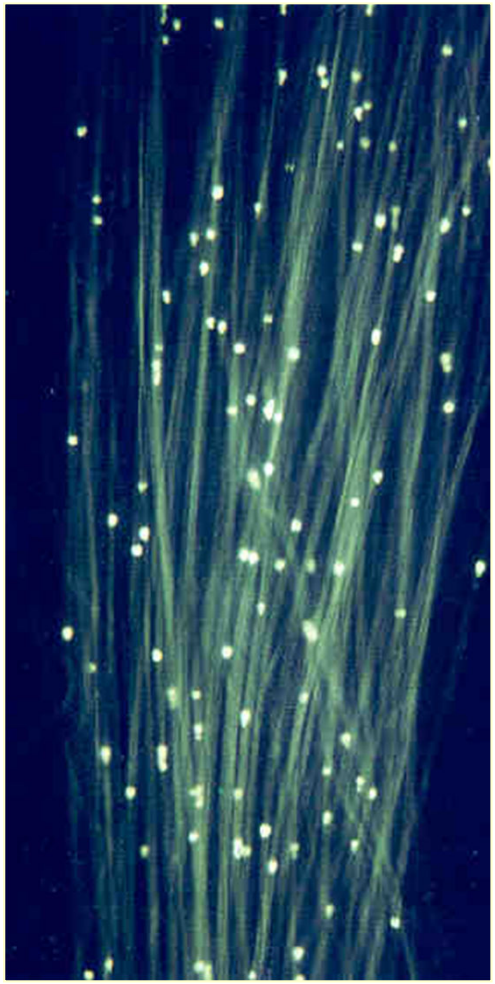
Self Incompatibility

Olives are at least partially self-incompatible.

Self-incompatibility in olive is temperature dependent.

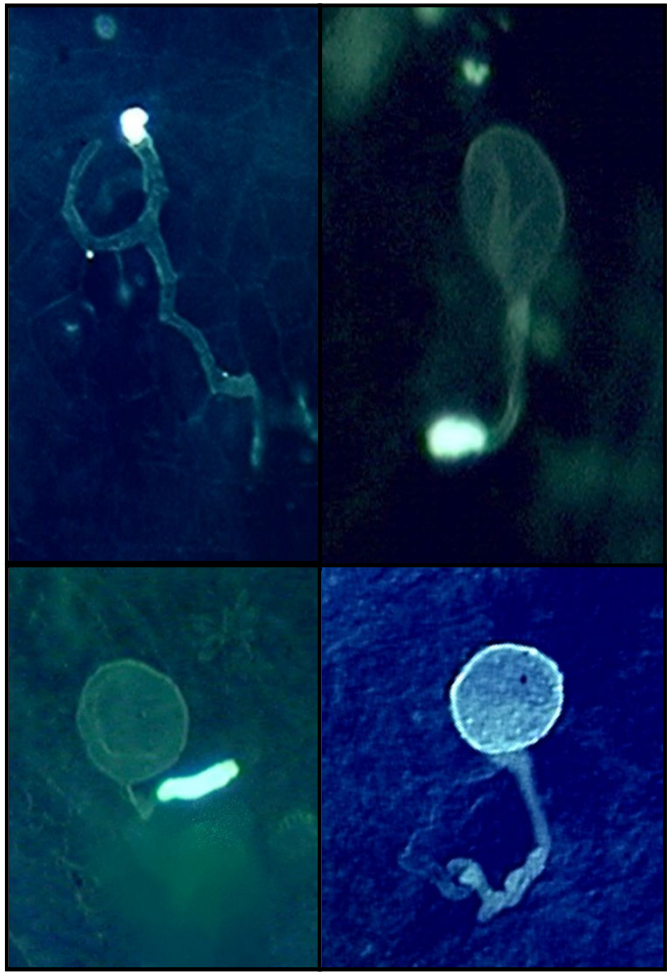
The relationship is not well understood, but self-incompatibility is greater under higher temperature conditions.

Gametophytic Self-Incompatibility (GSI)



Compatible pollen tubes grow straight down the style.

Incompatible pollen tubes branch, swell and grow irregularly, never reaching the ovary.



Pollen germination in reciprocal olive crosses.

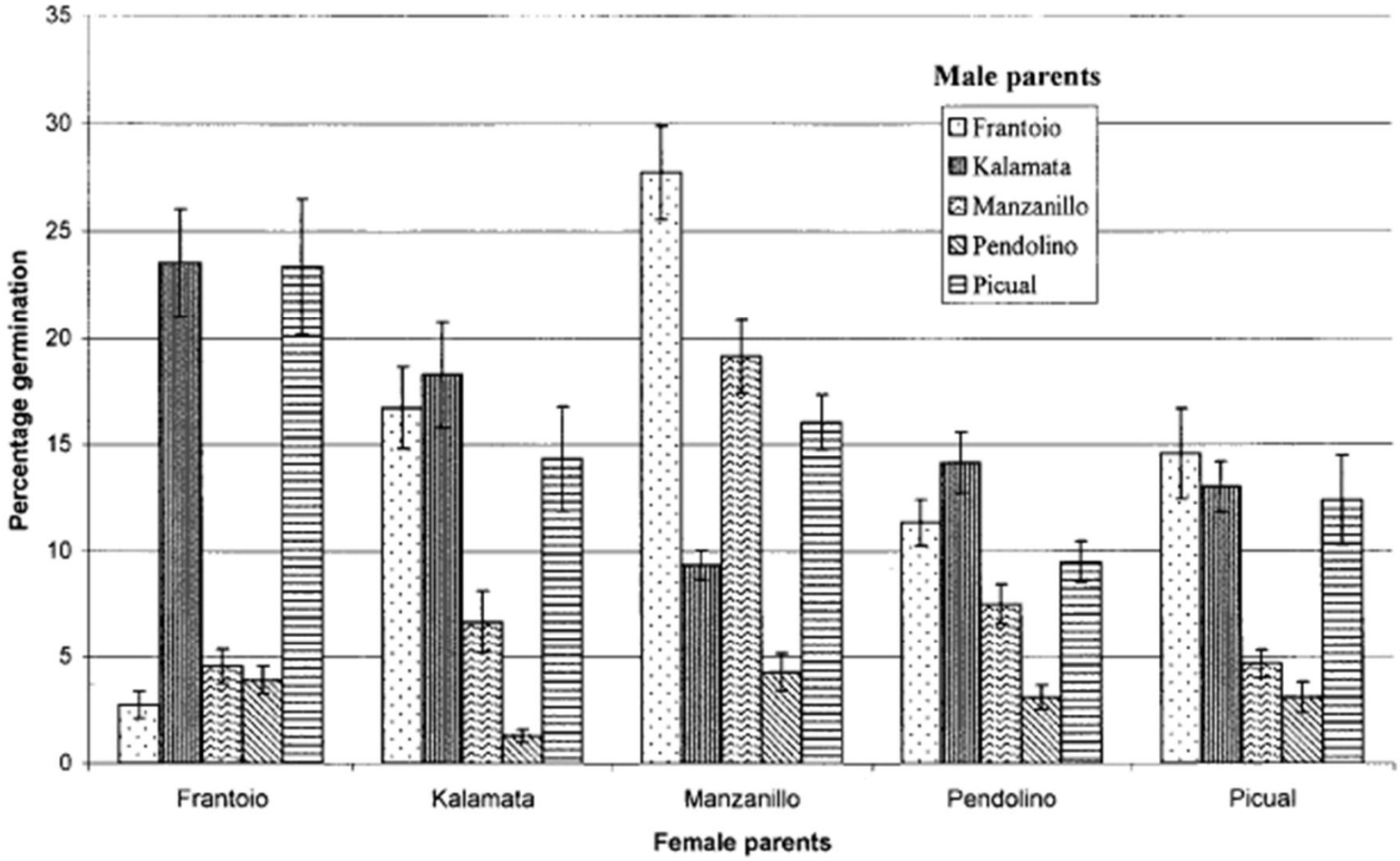


FIG. 5
Results of diallel cross between five olive cultivars showing pollen germination on the stigma. Bars represent 95% confidence intervals.

Wu, Collins, Sedgley. 2002. Sexual compatibility within and between olive cultivars. J. Hortic Sci Biotech 77:665-673.

Almond Compatibility Groups

I	**($S_{c,d}$)**	**Nonpareil, IXL, Long IXL, Profuse, Tardy Nonpareil**
II	**($S_{a,b}$)**	**Mission, Languedoc, Ballico**
III	**($S_{a,c}$)**	**Thompson, Robson, Harvey, Mono, Sauret No. 2, Granada**
IV	**($S_{b,c}$)**	**Merced, Ne Plus Ultra, Ripon, Norman, Price Cluster, Rosetta**
V	**($S_{a,d}$)**	**Carmel, Carrion, Sauret No. 1, Livingston, Monarch**
VI	**($S_{b,d}$)**	**Monterey**
VII	**($S_{?,d}$)**	**Solano, Sonora, Vesta Kapareil**
	($S_{?,d}$)	**Butte, Grace**
	($S_{?,?}$)	**Aldrich, Dottie Won, Fritz, Pearl, Ruby, Padre, Tokyo**

Partial Self Incompatibility

Olives are partially self incompatible. Some fruit set occurs with self pollination, but it is reduced relative to compatible cross pollination.

Self incompatibility in olives is temperature dependent. The same cultivar is highly self-incompatible in the hot, southern San Joaquin Valley, but largely self compatible in the cooler growing areas of the northern Sacramento Valley.

Self-Incompatibility of Olive

Fruit Set of 'Manzanillo' after self and cross pollinations

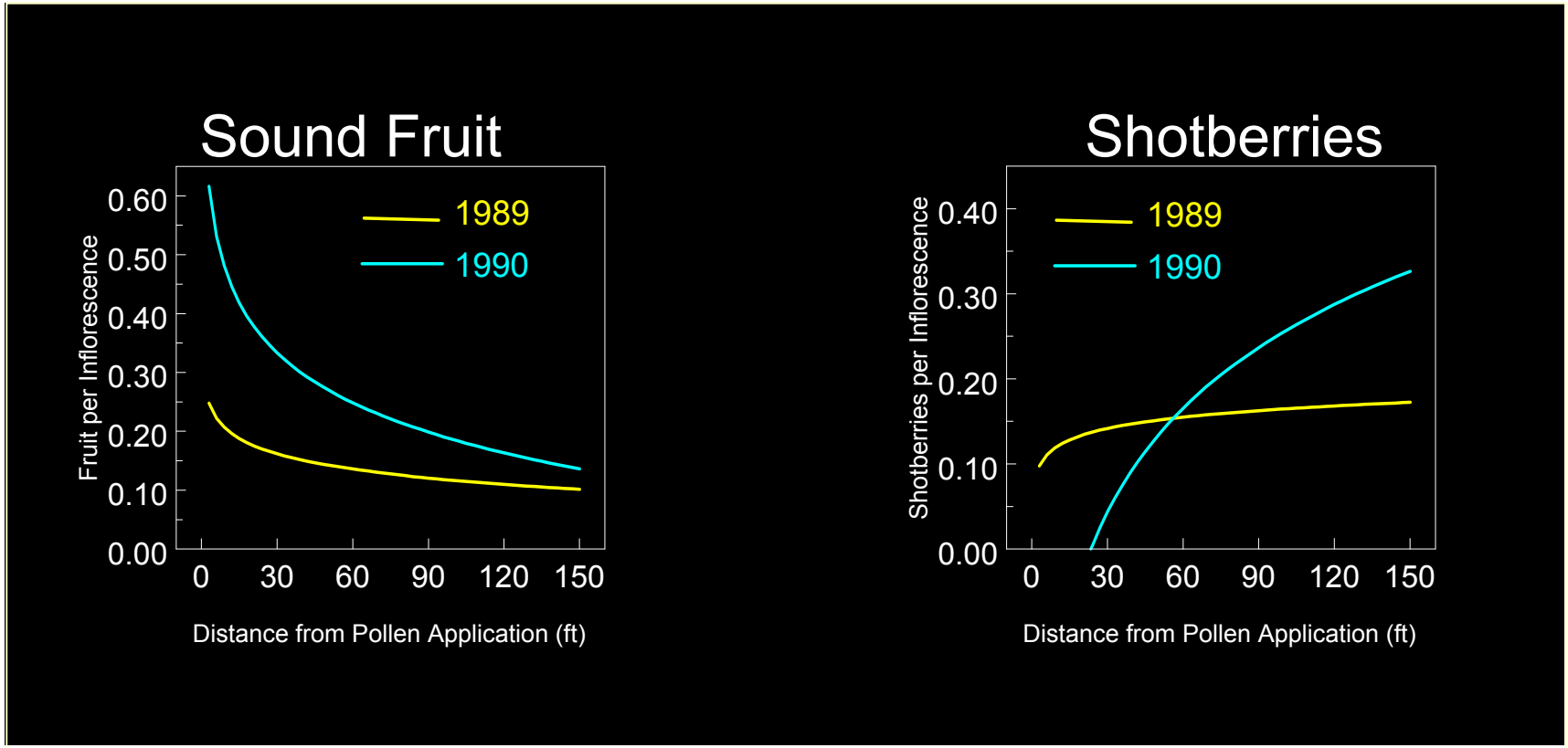
Pollen Source	**1994**	**1995**
Self	0.122 a	0.100 a
Mission	0.094 a	0.147 a
Ascolano	---	0.245 a
Sevillano	0.506 b	0.463 b
Sev:Mis Mixture	0.575 b	---

Cuevas, J. and V, S. Polito. 1997. HortScience 32(6):1056-1058.

Managing Self-Incompatibility: Supplemental Pollen Application

Shotberries

Managing Self-Incompatibility: Supplemental Pollen Application



Sound Fruit & Shotberries vs. Distance from Pollen Application

‘Manzanillo’ orchard (Madera county) with supplemental ‘Sevillano’ pollen

Sibbett, G. S., M. Freeman, L. Ferguson, and V. S. Polito. 1992. HortTechnology 2.

Compatibility Relationships in Oil Cultivars

Combinations of mother trees and pollen donors found likely to be compatible in Australia

Frantoio:	Kalamata, Mission, Coratina
Kalamata:	Frantoio, Koroneiki, Barnea
Koroneiki:	Mission, Hojiblanca
Mission:	Koroneiki, Arbequina
Barnea:	Kalamata, Mission

J.Guerin and M. Sedgley. 2007. Cross pollination in olive cultivars. RIRDC Publication No 07/169

Combinations of mother trees and pollen donors found to be incompatible in Australia.

Frantoio and Barnea

Kalamata and Mission

Mission and Kalamata

Kalamata and Manzanillo

Koroneiki and Frantoio

J.Guerin and M. Sedgley. 2007.
Cross pollination in olive cultivars.
RIRDC Publication No 07/169

Spanish researchers, working in ‘Picual’ and ‘Arbequina’ orchards found:

1. In monocultivar fields, trees from the center of the orchard produced fruits with few or no seeds from self pollen.
2. Outcrossing rates from DNA analysis of progeny showed:

   100% outcrossing for ‘Arbequina’ in SHD orchards

   91-95% outcrossing for ‘Picual’ in monocultivar orchards

   Strong evidence for self incompatibility in both cvs.

Diaz et al. 2006. JASHS 131:250.

Summary

- Evidence is strong for self-incompatibility of olive.
- Some indication that high temperatures increase self-incompatibility response.
- ‘Mission’ and ‘Manzanillo’ are self- and cross-incompatible. Both are compatible with ‘Sevillano’.
- Compatibility relationships among common oil cultivars is less clear although self-incompatibility is evident in all cultivars examined.