The Road to Productivity

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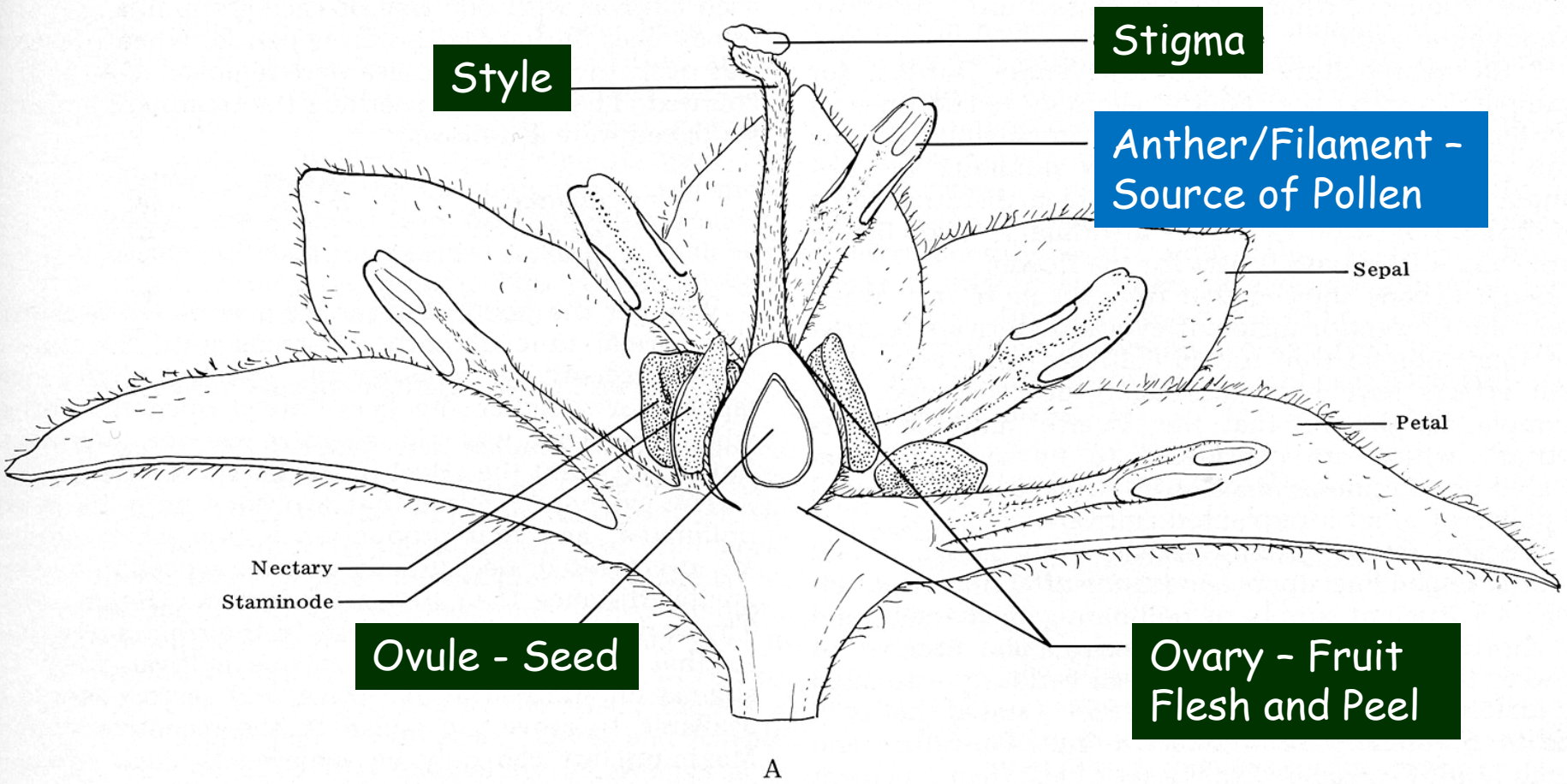
The ultimate crop that one harvests is dependent upon many factors:

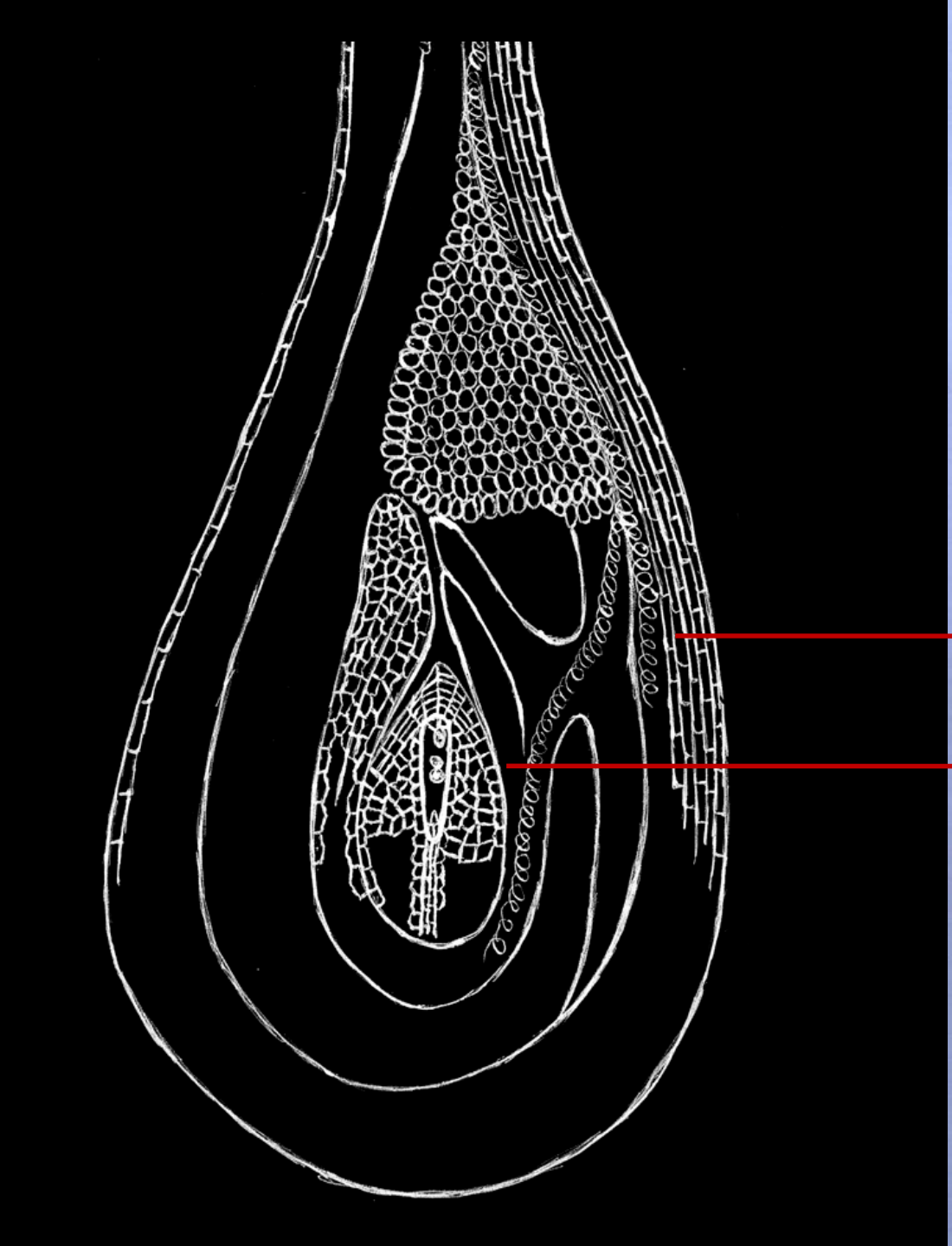
- On/Off status
- Overall tree health
- Conditions during flowering and fruit set
- Conditions during subsequent fruit development

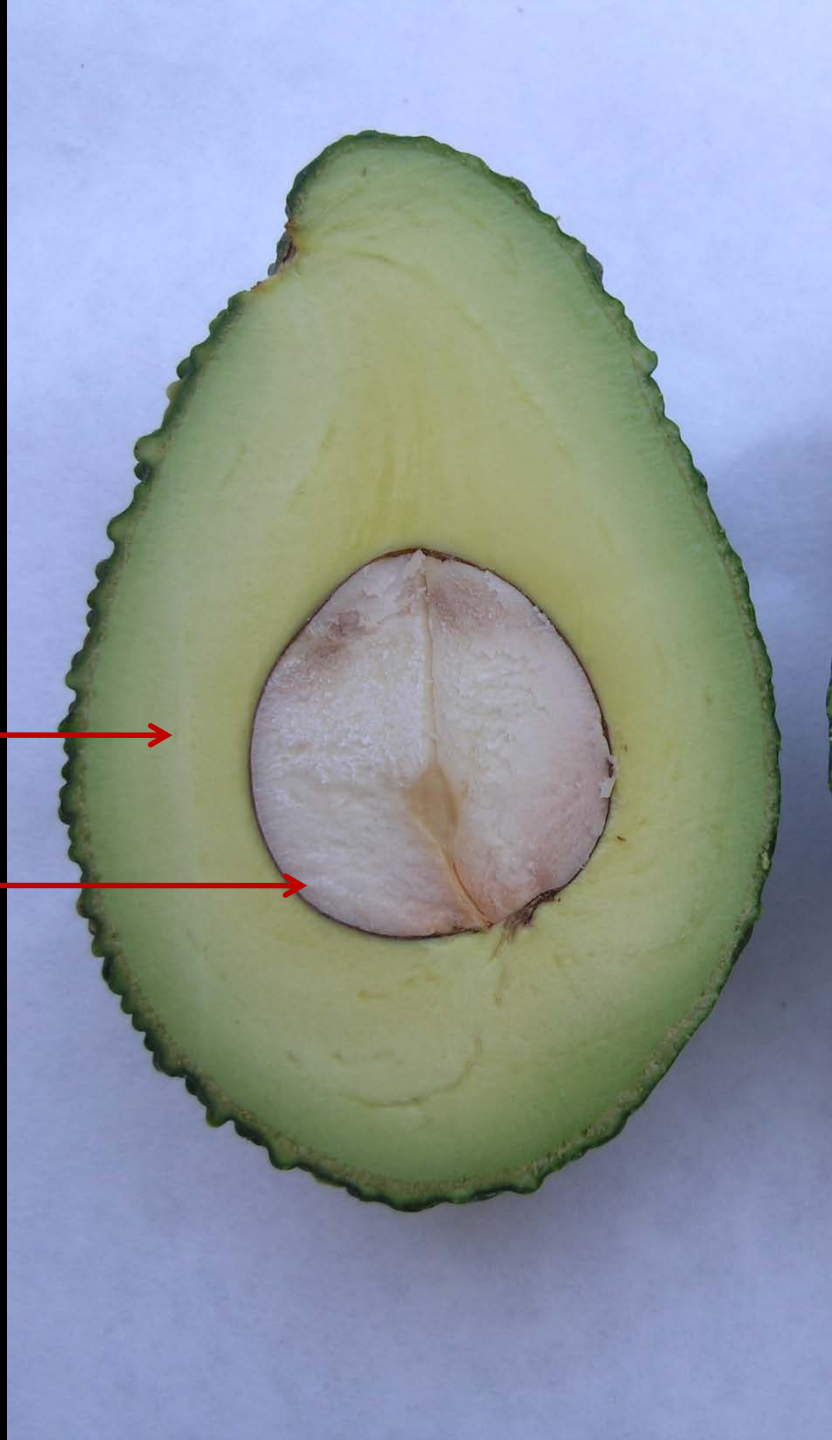
This presentation will focus on one small aspect of productivity - Pollination

Terminology



The avocado flower





Pollination Terms:

Pollination – the transfer of pollen from the anther to the stigma.

- *Cross pollination* – the pollen deposited on the stigma is from another cultivar.
- *Close pollination* – the pollen deposited on the stigma is from another flower of the same tree or cultivar.
- *Self pollination* – the pollen deposited on the stigma is from the same flower.

Pollination Terms:

Pollinator: The agent which transfers pollen from the male to the female floral organ.

Pollinated Tree: A cultivar that receives the pollen *(i.e. Hass).*

Pollinizer: A cultivar that donates pollen to another cultivar.
Common Hass pollinizers: Bacon, Zutano, Ettinger, Edranol, Walter Hole.

Pollination Terms:

Fertilization – the fusion of the male gamete with the female gamete forming the zygote.

Effective Pollination – pollination which leads to fertilization.

Non effective pollination – pollination which does NOT lead to fertilization.

Avocado Flower Behavior

Avocado flowering characteristics

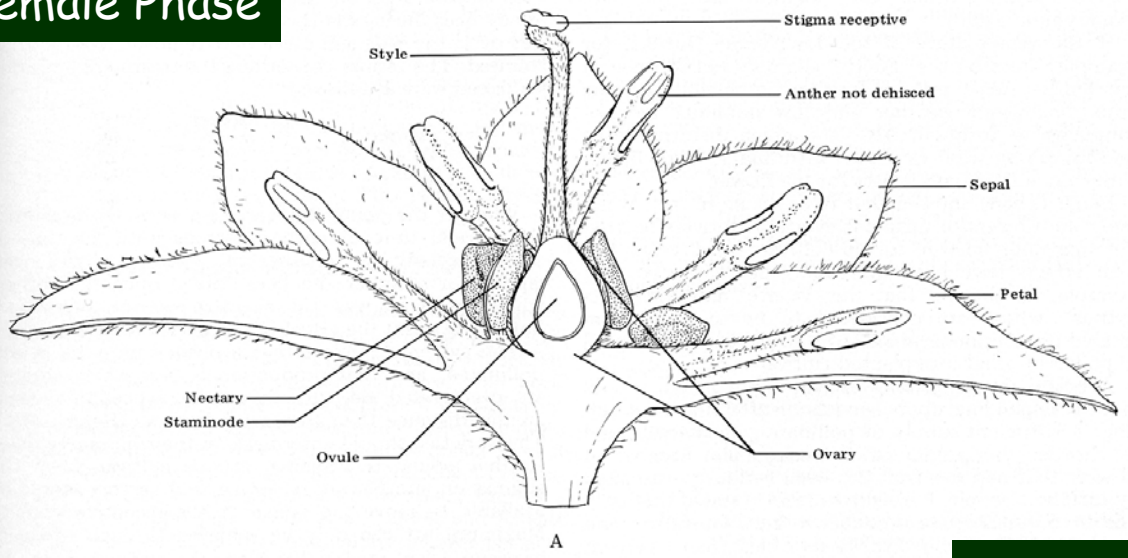
- Attraction: the whole tree acts like a giant inflorescence with many small flowers.
- Small fertilization percent: thus most flowers do not set fruit.
- Competition: between fruits and growth, as well as among the fruits, which leads to high rate of primary-fruit abscission.

There are 2 phases to avocado flowering

This is called *Synchronous Dichogamy*

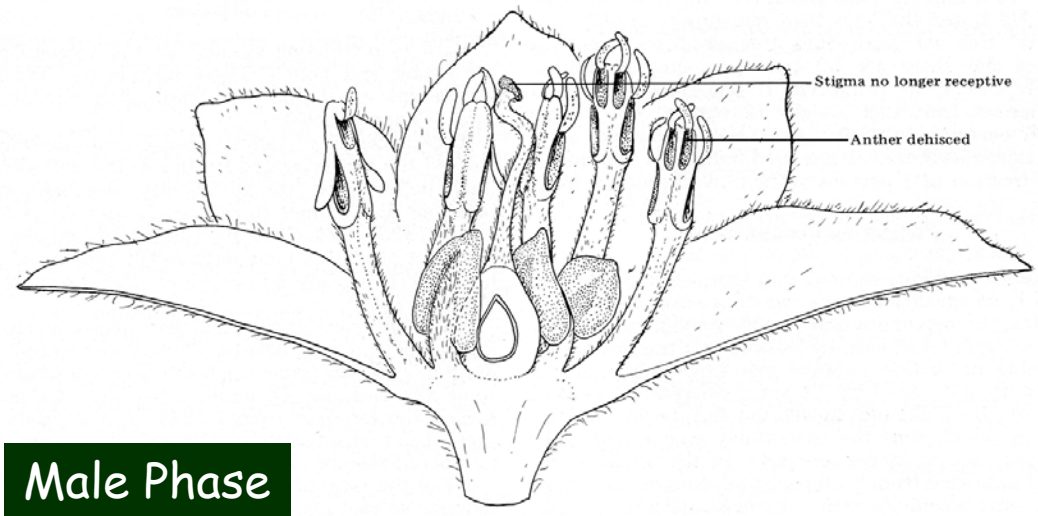
Source: I. Hormaza

Female Phase



A

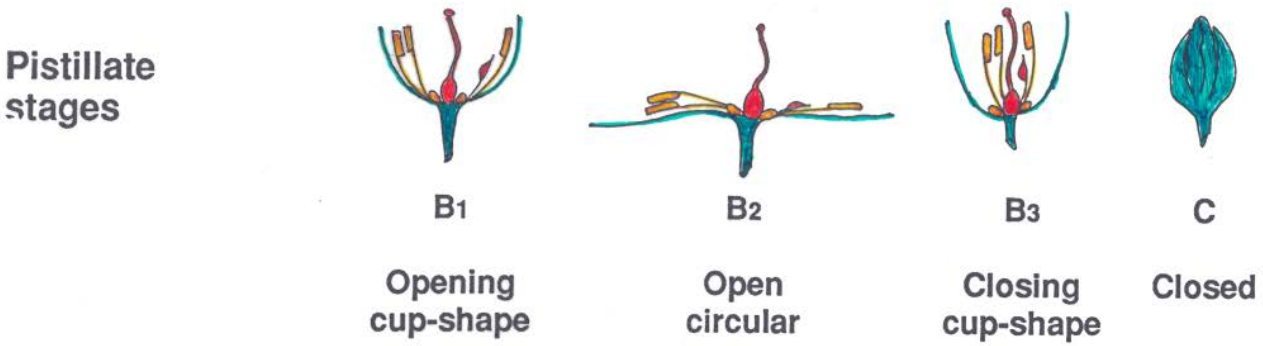
The avocado flower



B

Male Phase

FEMALE PHASE



MALE PHASE

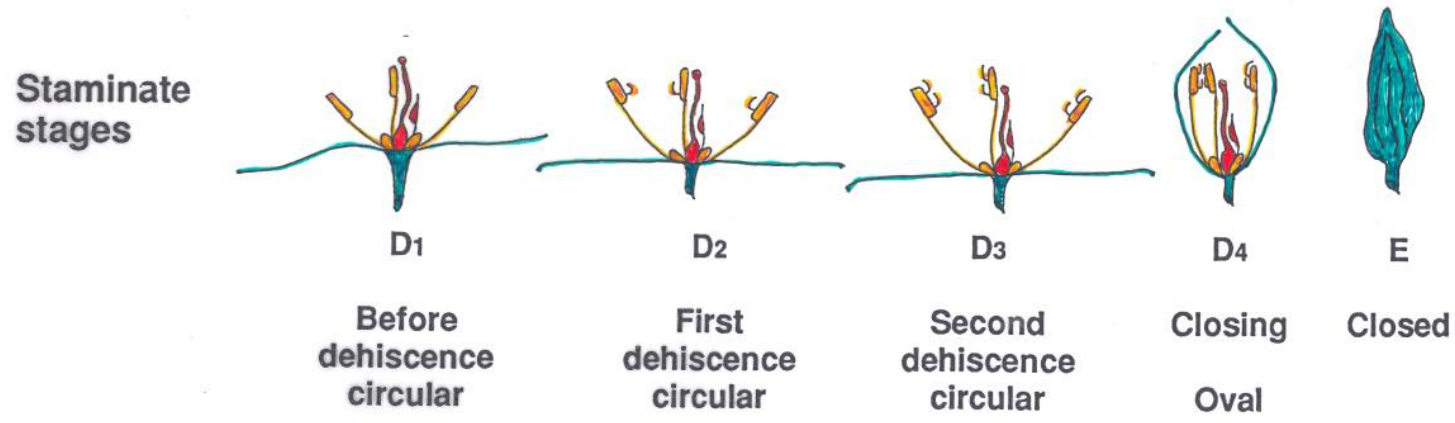
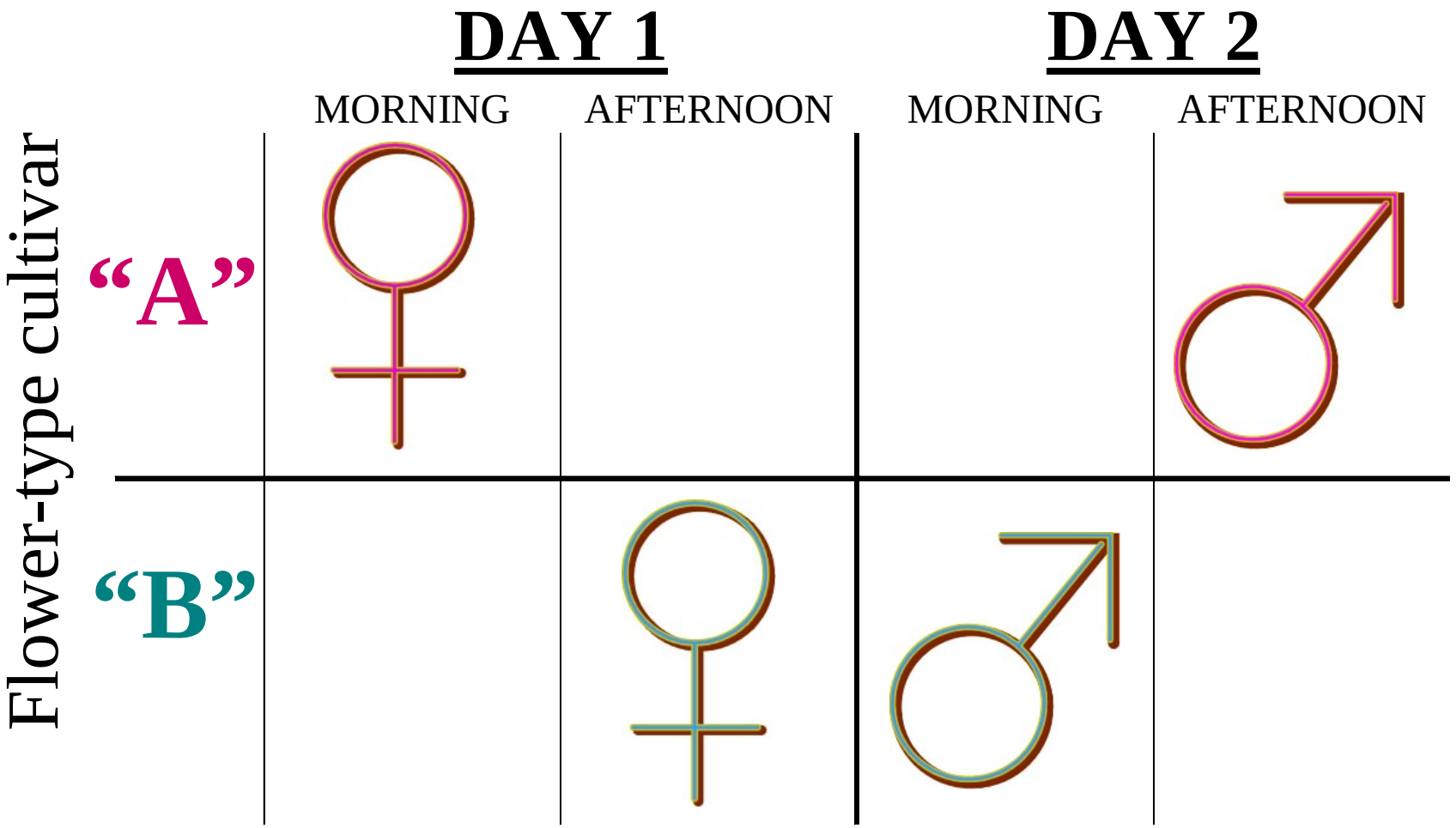


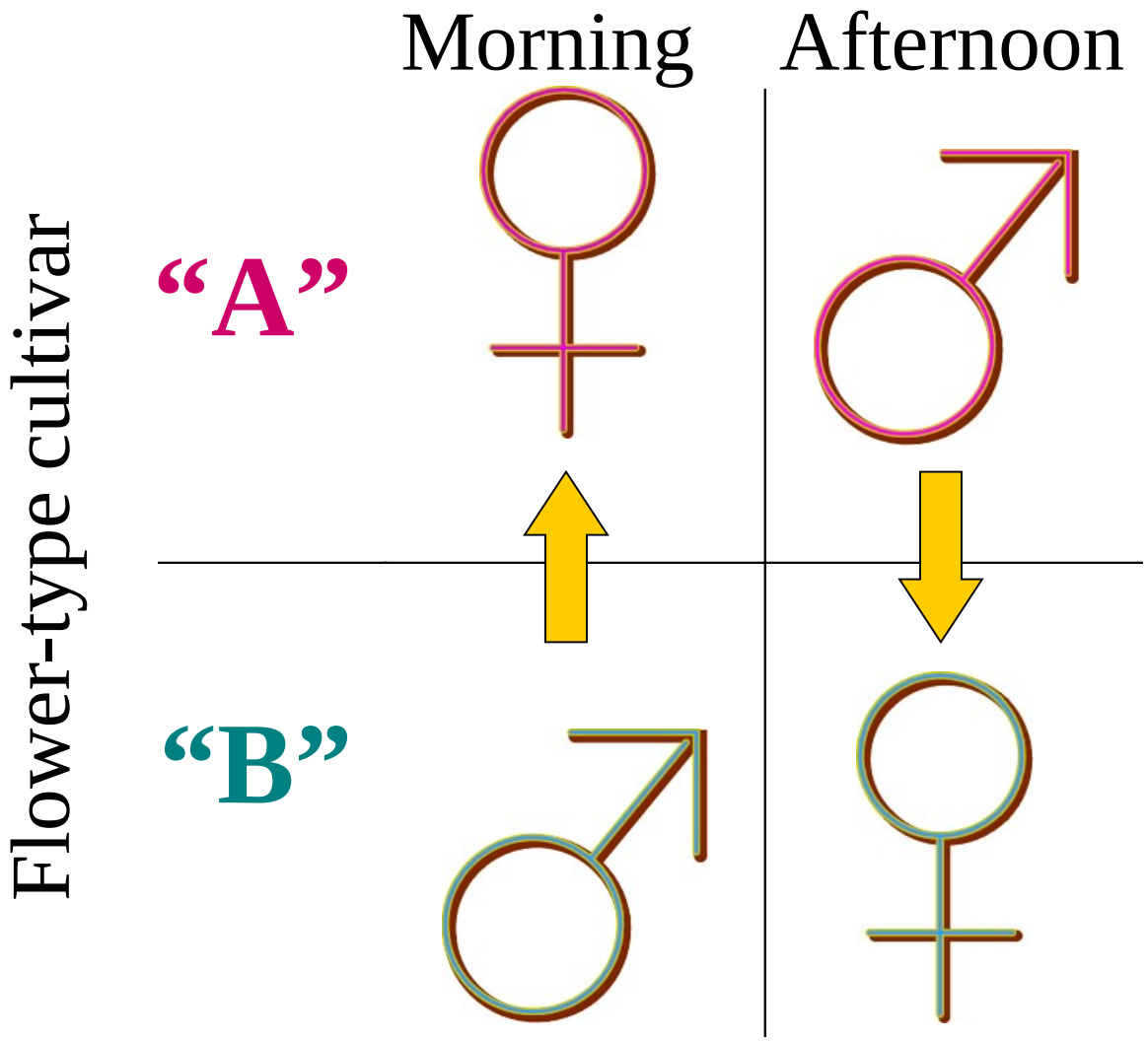
Fig. 1– Morphological stages of the flower

Ish Am, PhD. Thesis

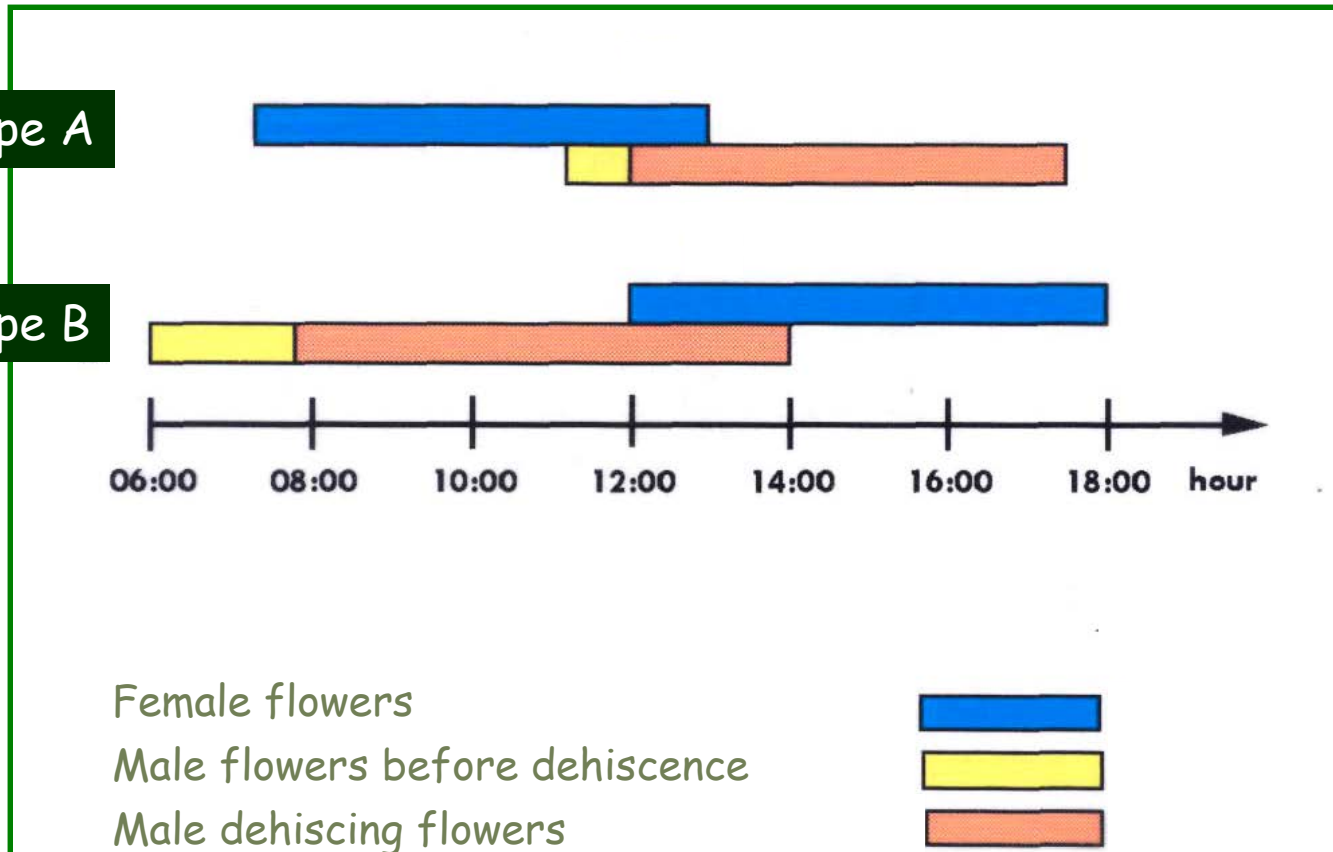
Timing of flowering for “A” and “B” flower types.



The sequence of timing for “A” and “B” flower types under field conditions.



Avocado Flowering Sequence

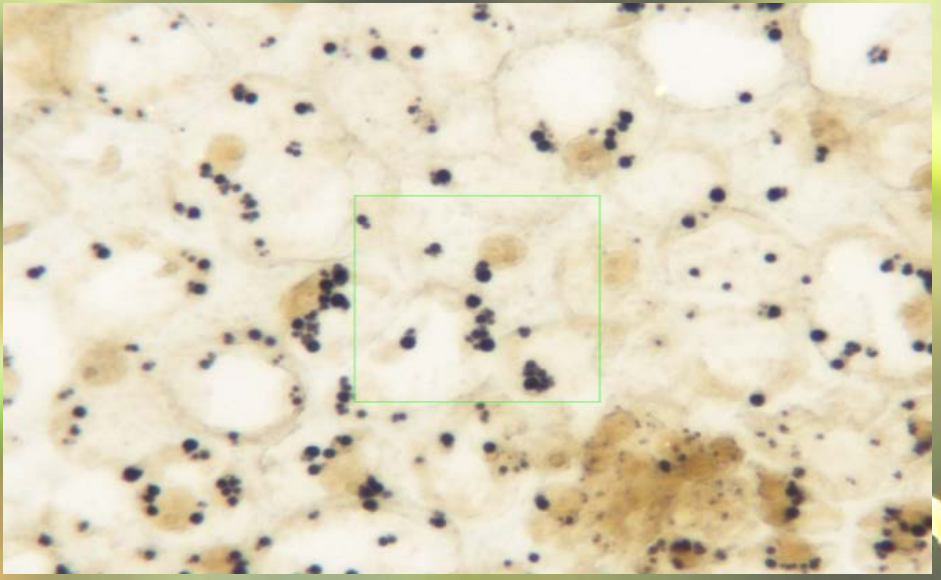


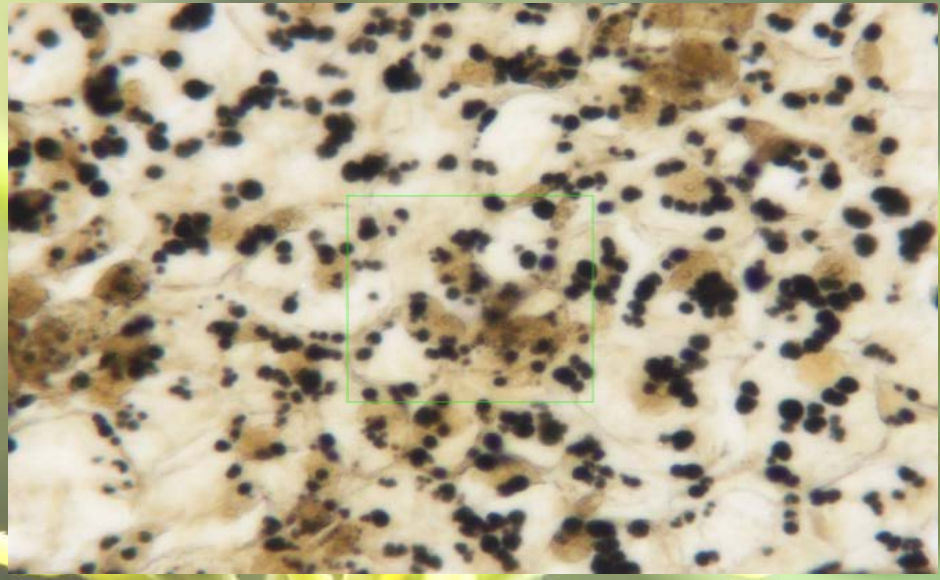
Source: I. Hormaza

Fruit Set

- Millions of flowers during bloom
- Long flower duration

Are all flowers created equal?

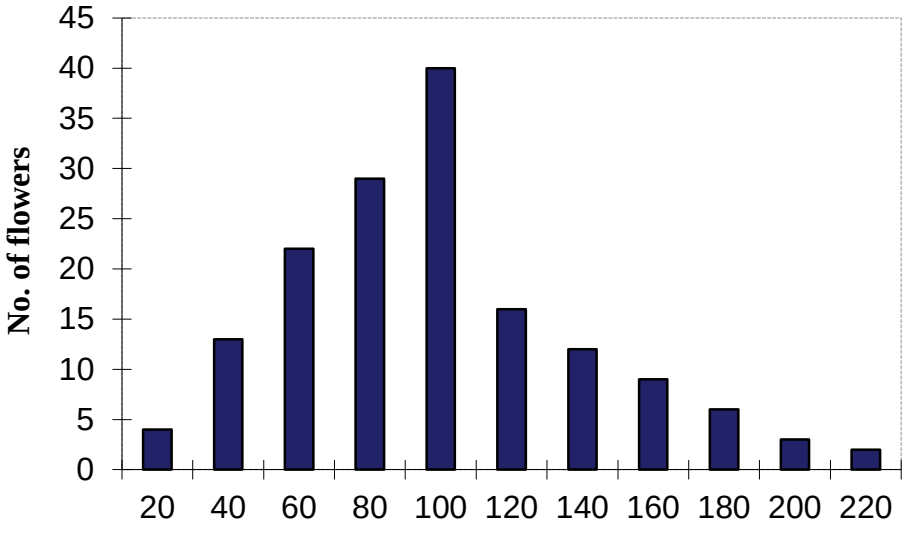




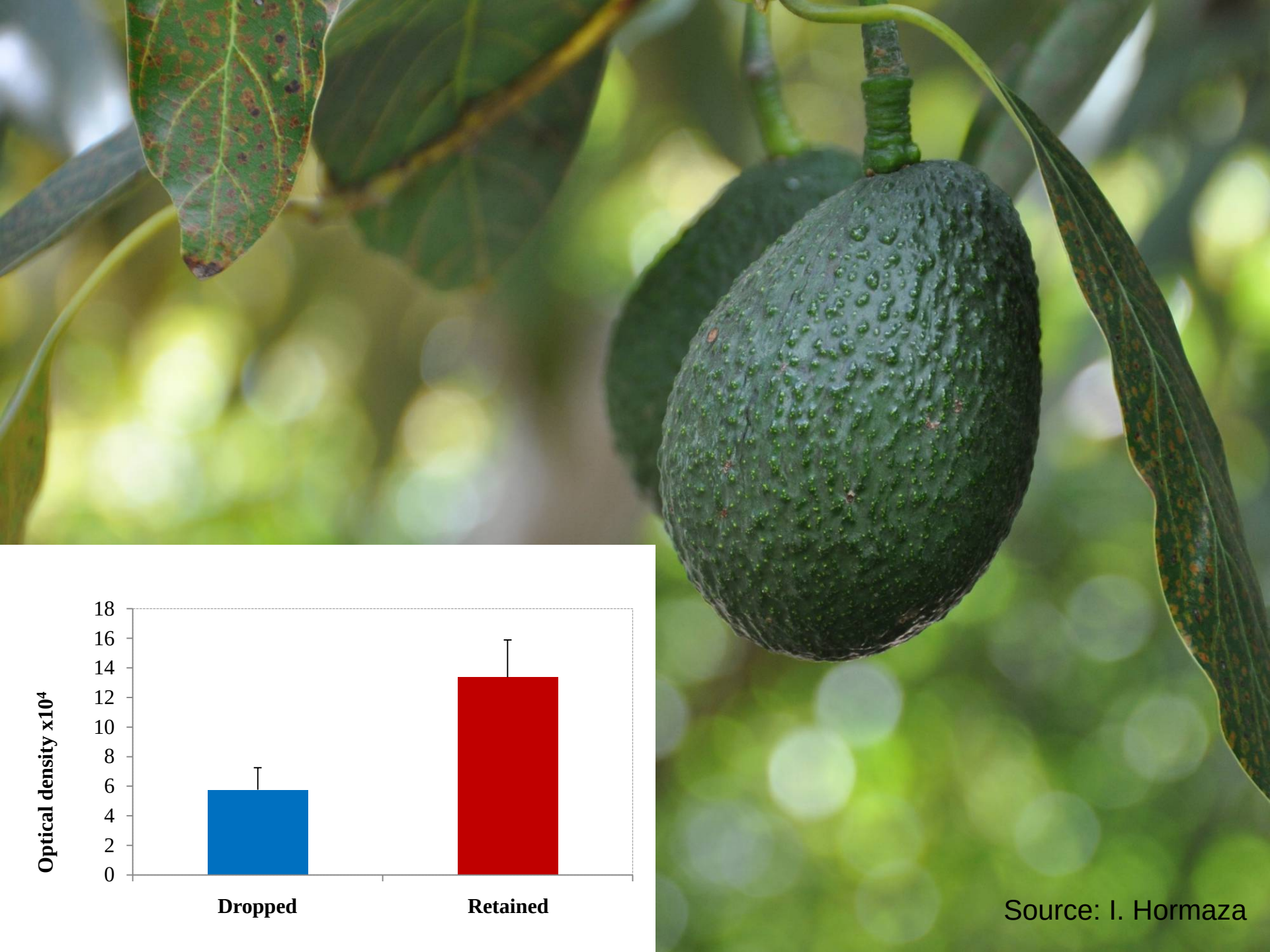
I_2KI

- NO EXTERNAL DIFFERENCES AMONG FLOWERS

- GREAT DIFFERENCES IN STARCH CONTENT

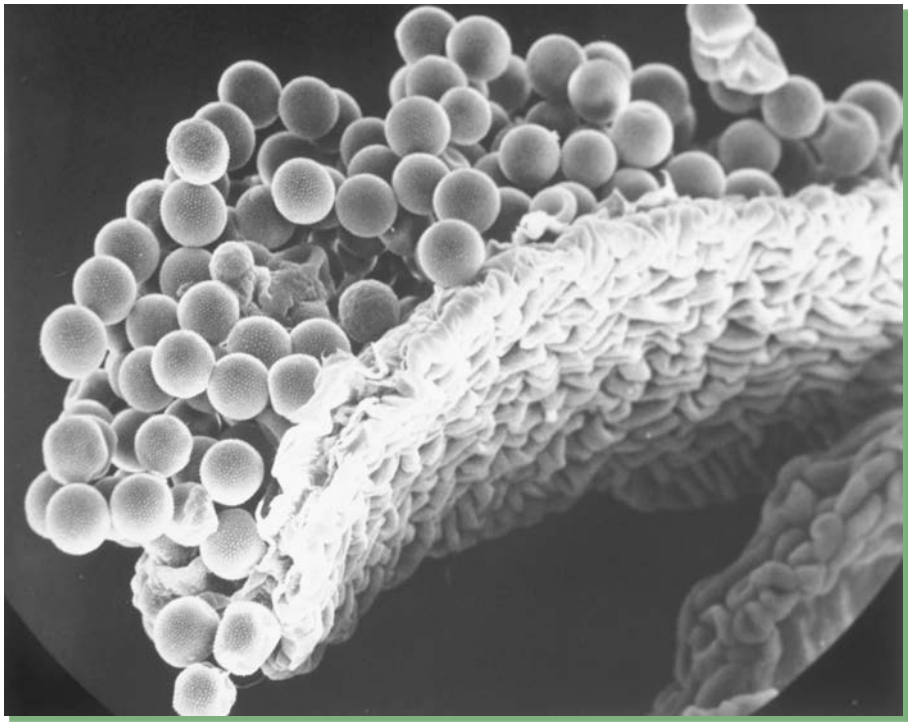


Source: I. Hormaza



Source: I. Hormaza

The avocado pollen grain

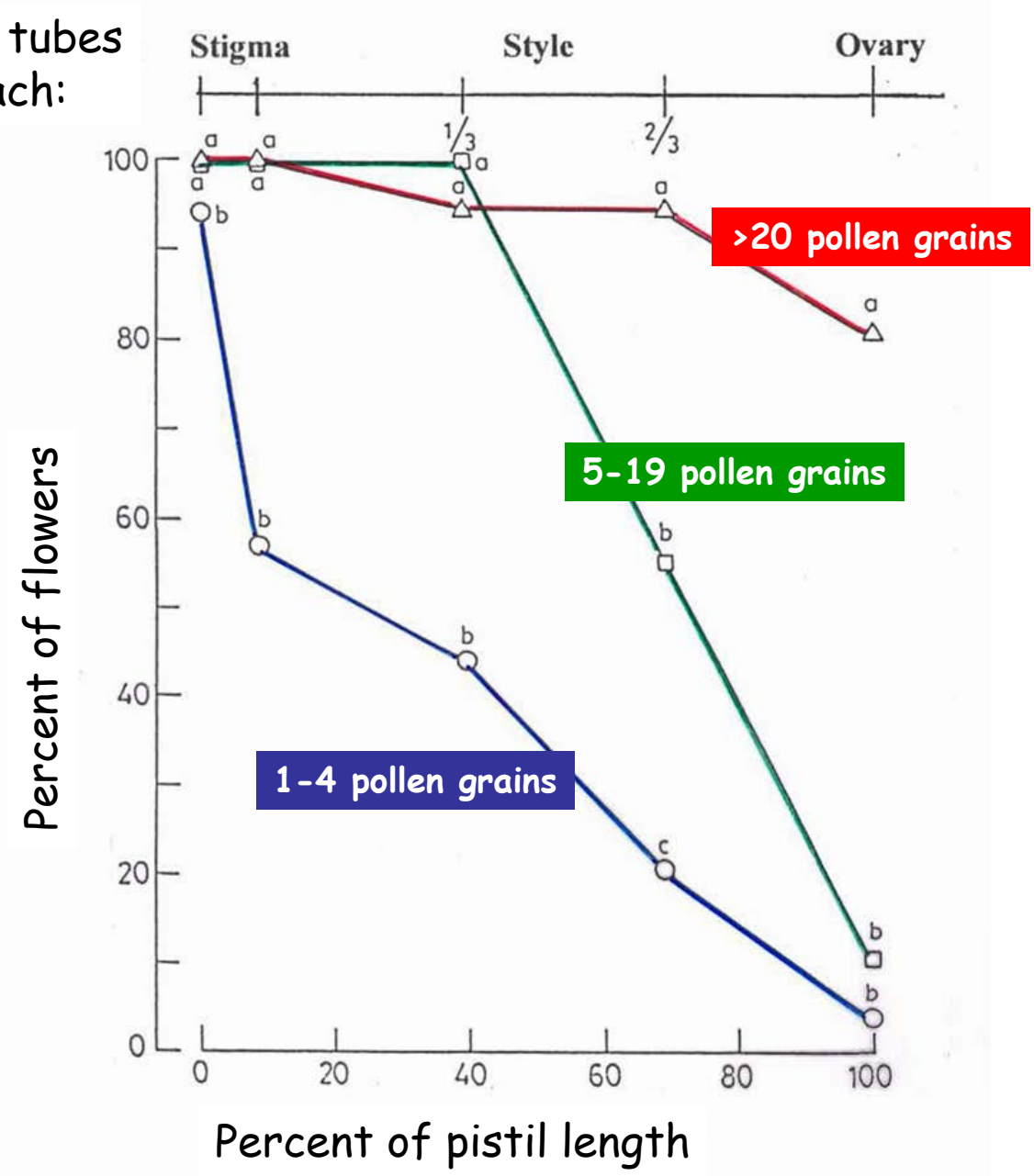


'Fuerte' pollen on anther flap

'Hass' pollen grain
(SEM x2000)

From: G. Ish Am

Avocado Pollen Germination Rate



Hand pollinated 'Hass' stigmas by 'Ettinger' pollen.
Four hrs of germination.

Shoval, 1987

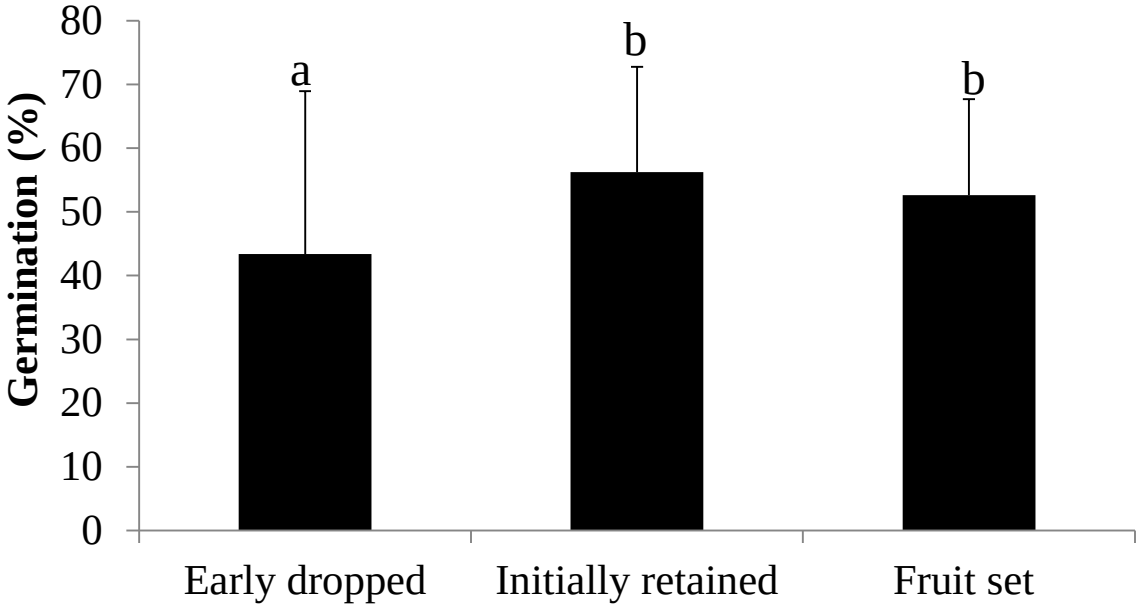
Effect of competition between and cooperation among the pollen grains

Early dropped

Initially retained

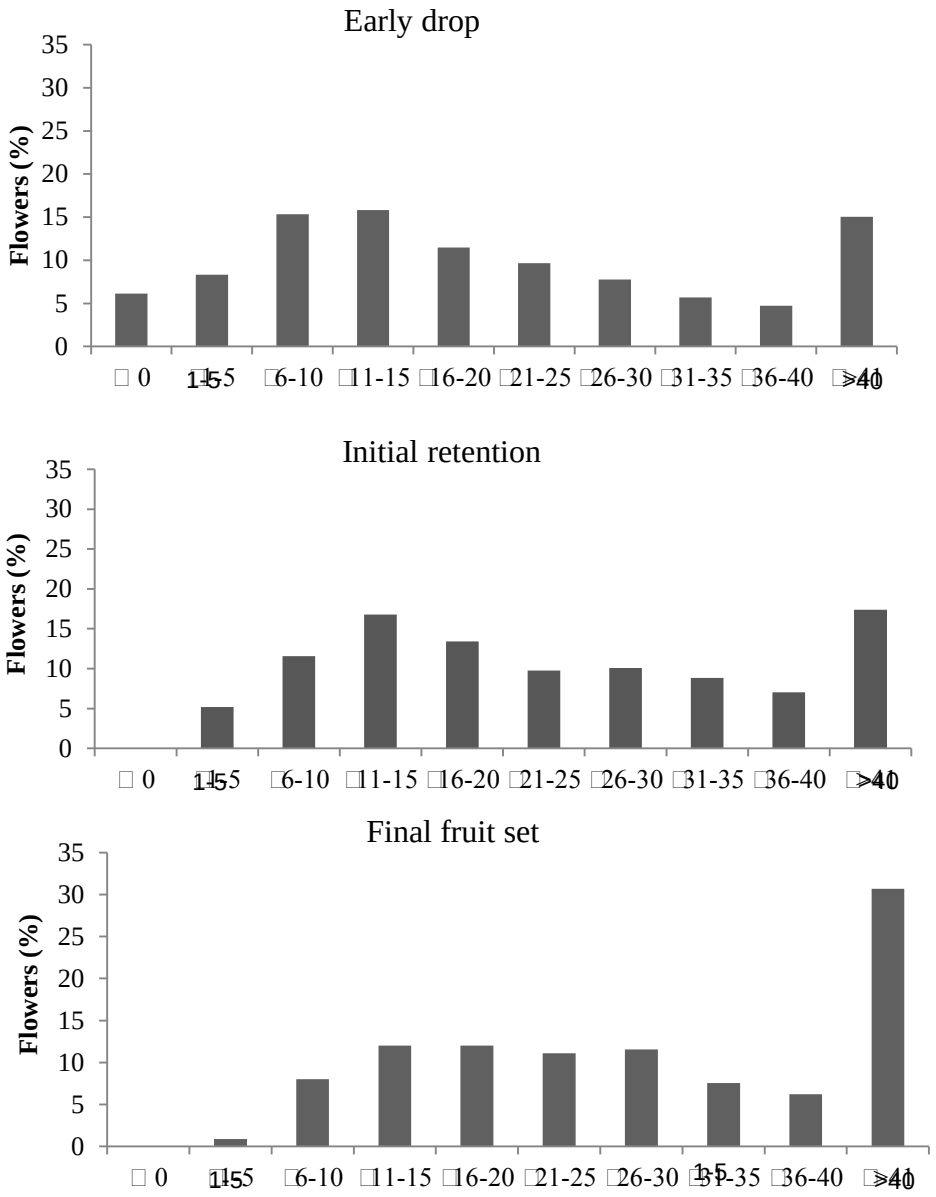
Fruit set

Hass Flowers/
Fuerte Pollen



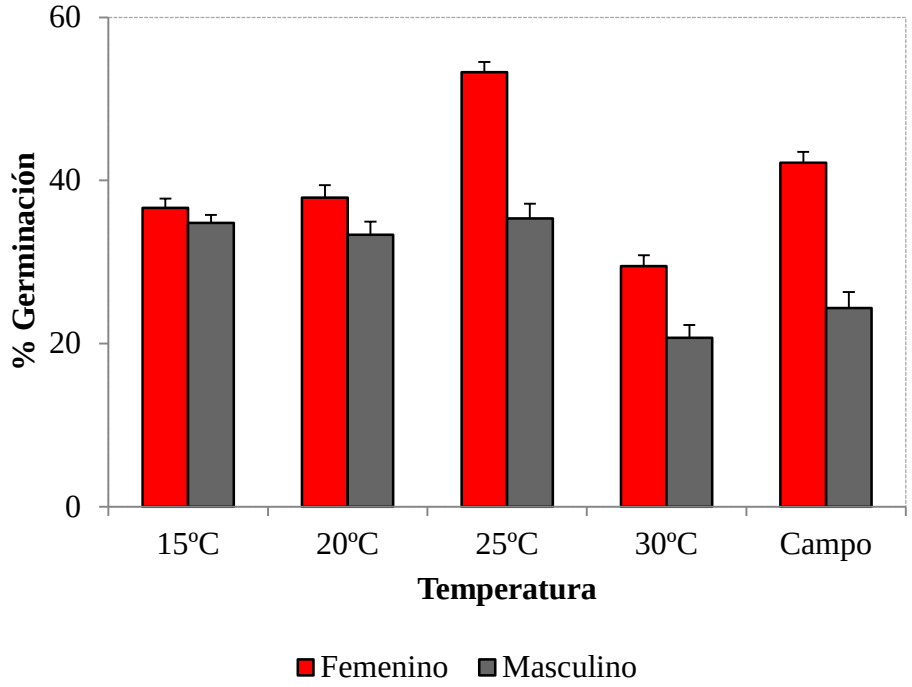
Pollen germination does not appear to be limiting

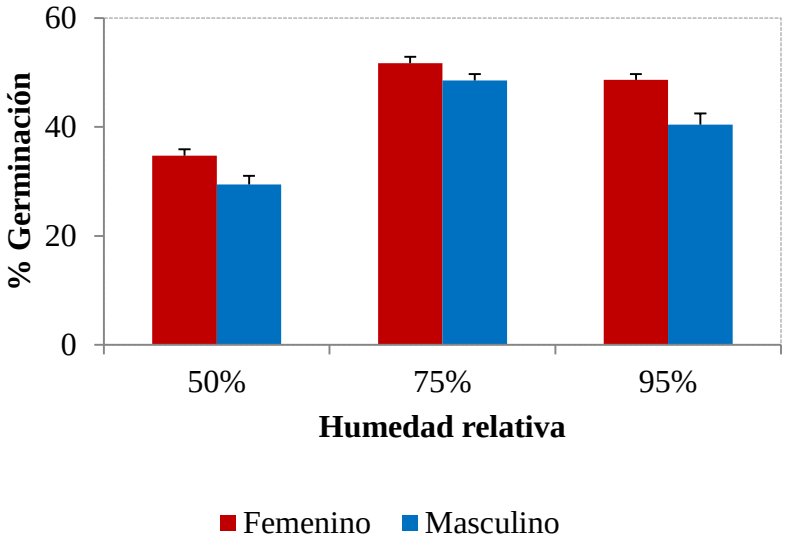
NUMBER OF POLLEN GRAINS ON STIGMA AND FLOWER FATE



Temperature and Humidity

Temperature and Relative Humidity Impacts Pollen Germination





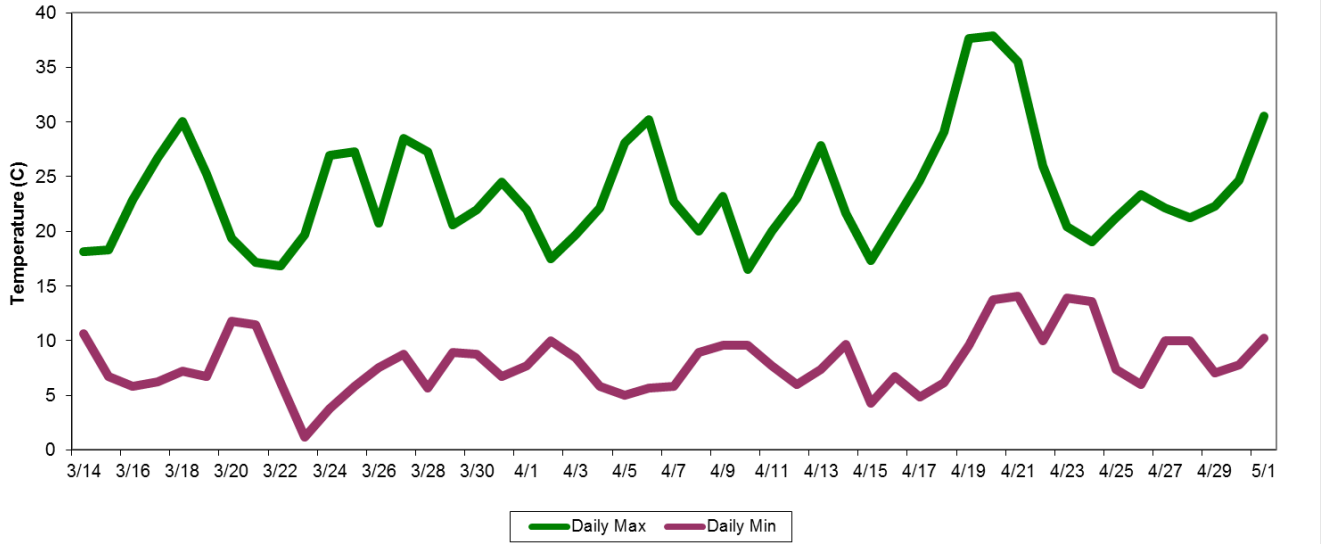
Source: I. Hormaza

Sedgley and Annells, 1981

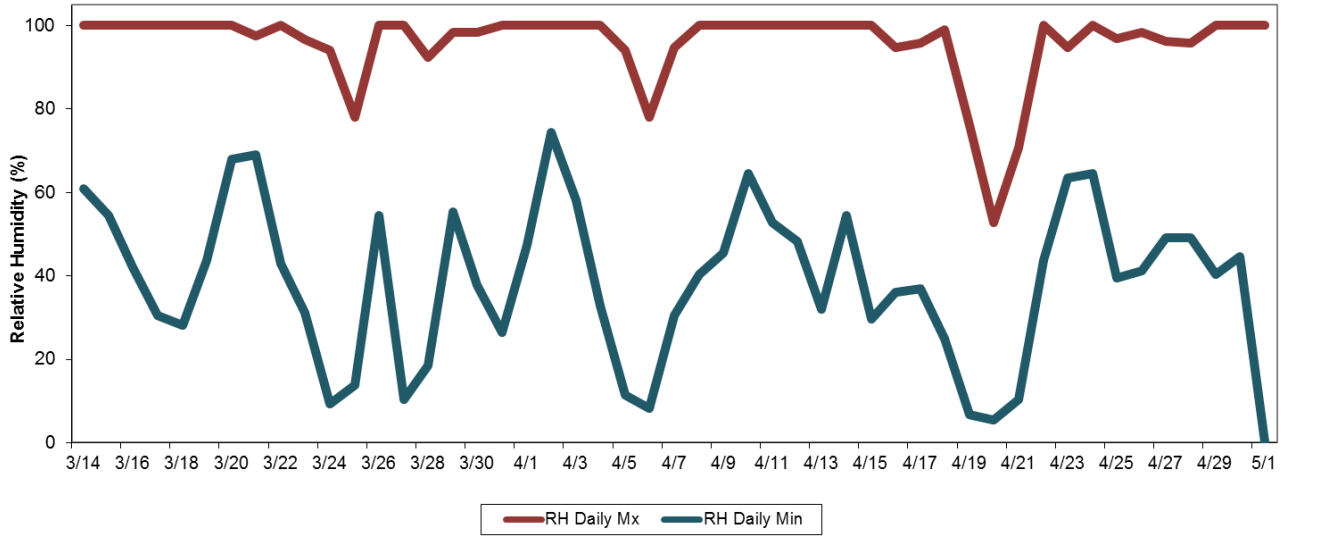
- Kept trees at 3 temperature regimes (Day/Night): 91/82; 77/68; 63/54
- Flowering cycle: At 63/54 prolonged from 36 hr to 72 hr
- Overlap: most overlap occurred at 77/68
- Fertilization: occurred at all temps but lowest at 63/54
- Embryo development: occurred at all temperatures but fruitlets abscised at high temps and growth very slow at low temp

Temperature fluctuations during flowering
Irvine, CA

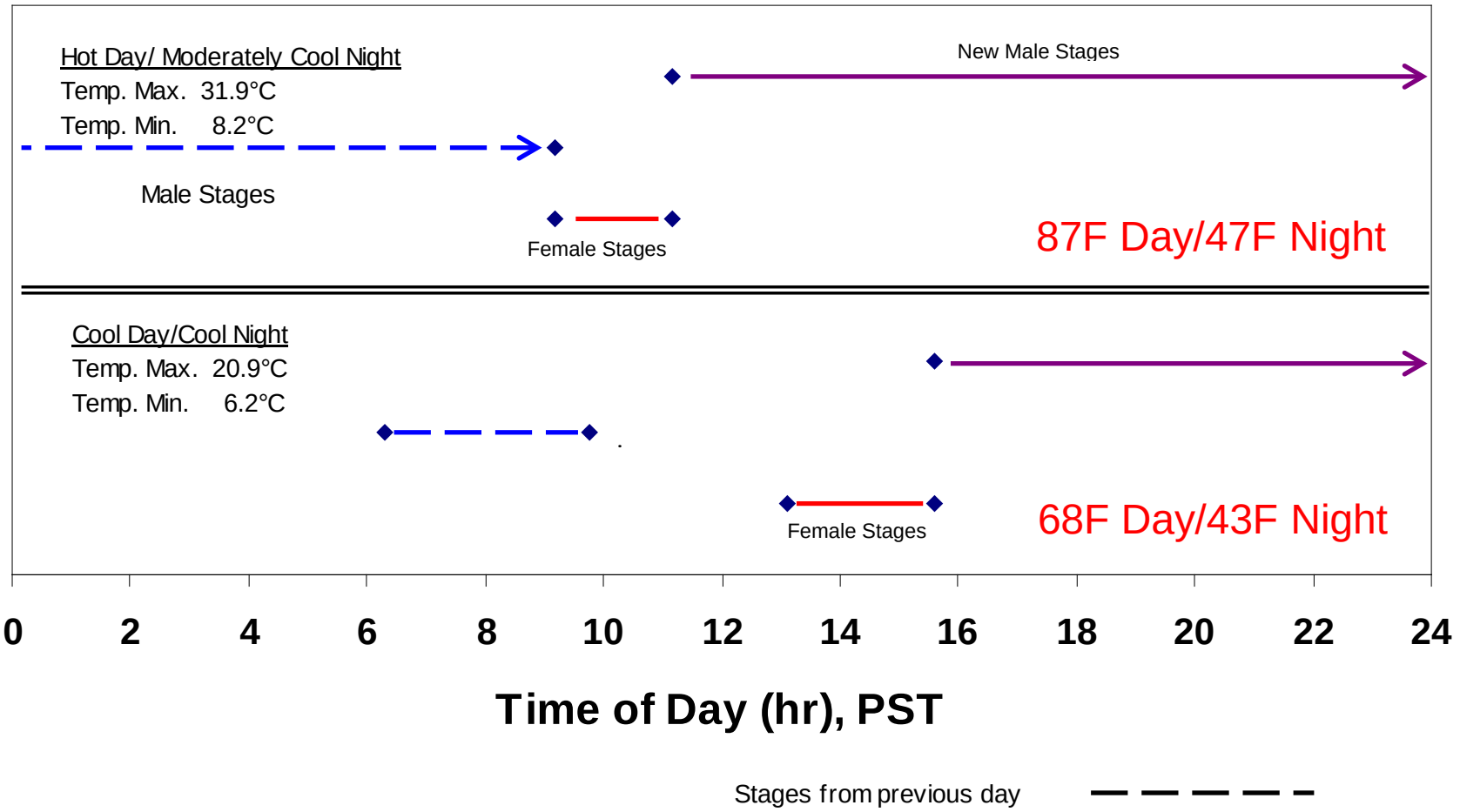
TEMP



RH

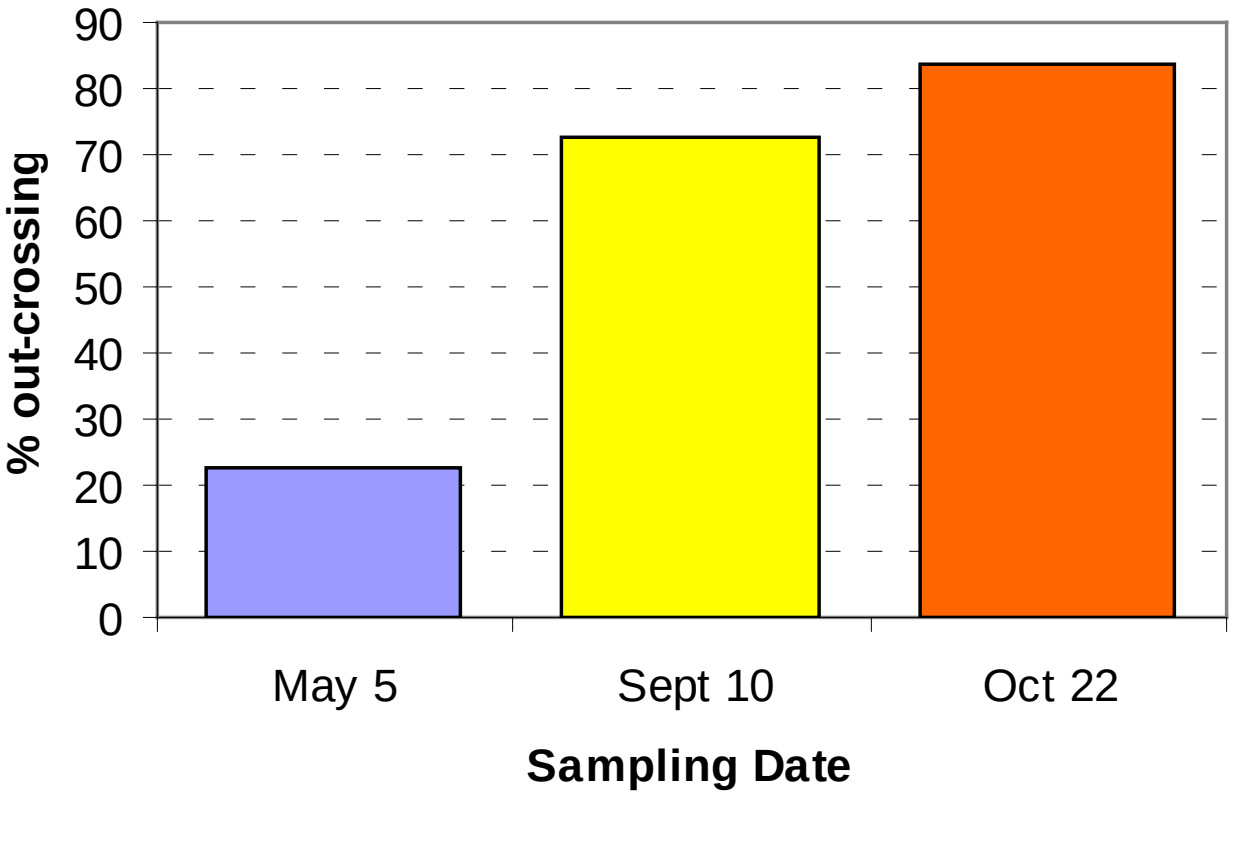


Temperature influences the timing of the female and male stages



Do You Need Pollinizers?

Survival of cross vs. self progenies



Percent of crossed 'Hass' fruits by both 'Ettinger' or 'Fuerte' according to time after fruit set.

Source: Degani, Goldring and Gazit. 1989. J. Amer. Soc. Hort. Sci. 114:106-111
Via www.avocadosource.com

MATERIALES Y MÉTODOS

TMTO	Descripción
0	Control, No Net House, 5,5% Edranol
1	Net House, 12 Hass + 0 Edranol
2	Net House, 11 Hass + 1 Edranol
3	Net House, 10 Hass + 2 Edranol

5 Replicated Blocks

Each Net House had Honey Bees

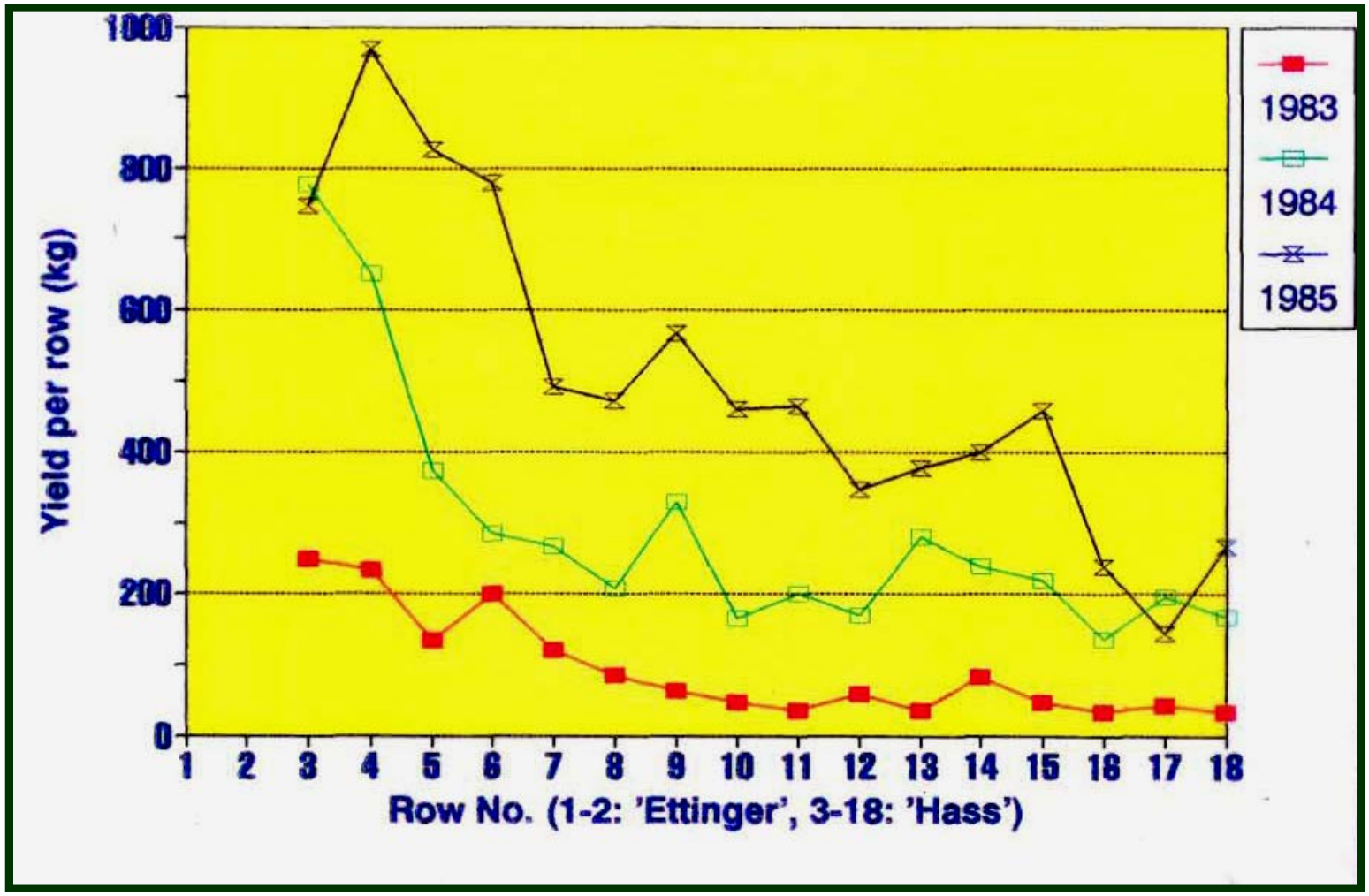
Resultados

Cuadro 1. Efecto de los distintos tratamientos en el promedio de número de frutos obtenidos en paltos var. Hass. Encón, Panquehue.

TMTO	Frutos 2012	Frutos 2013	Frutos 2014	∑ 2012-2014
0	50,51 ± 57,88 a	--	--	--
1	19,30 ± 43,97 c	138,90 ± 67,62 ab	49,25 ± 59,70 b	207,45 ± 85,58 b
2	22,89 ± 42,21 bc	151,98 ± 70,06 a	79,25 ± 62,82 a	254,13 ± 89,35 a
3	41,48 ± 50,30 ab	121,52 ± 67,28 b	74,70 ± 77,96 ab	237,70 ± 106,05 ab

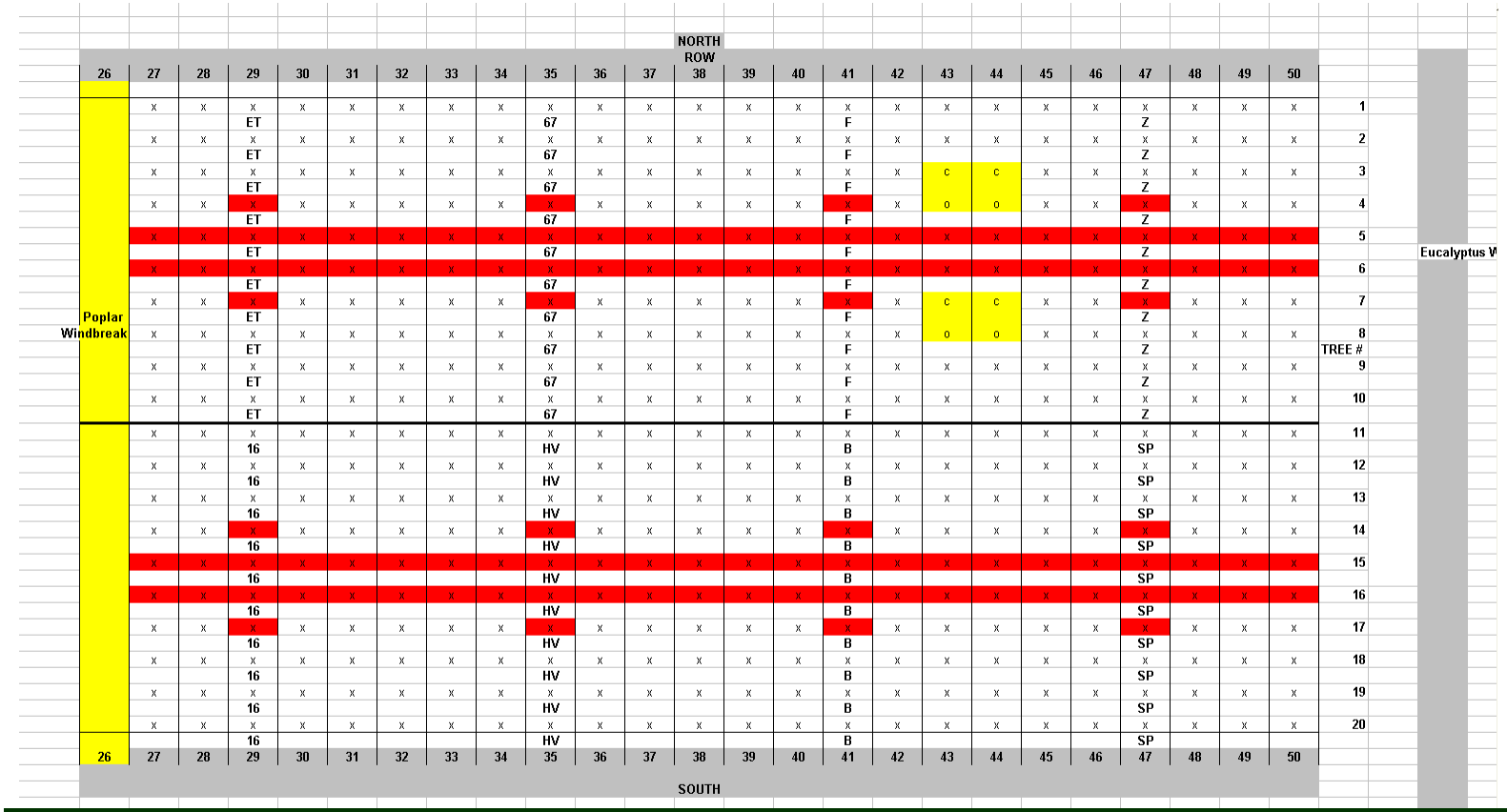
Letras distintas indican que existen diferencias significativas. (Test de Tukey, $P \leq 0,10$).

Hass yields decrease significantly
with increasing distance from 'Ettinger'



Source: Guil et al. 1986. Alon Hanotea 40:443-455

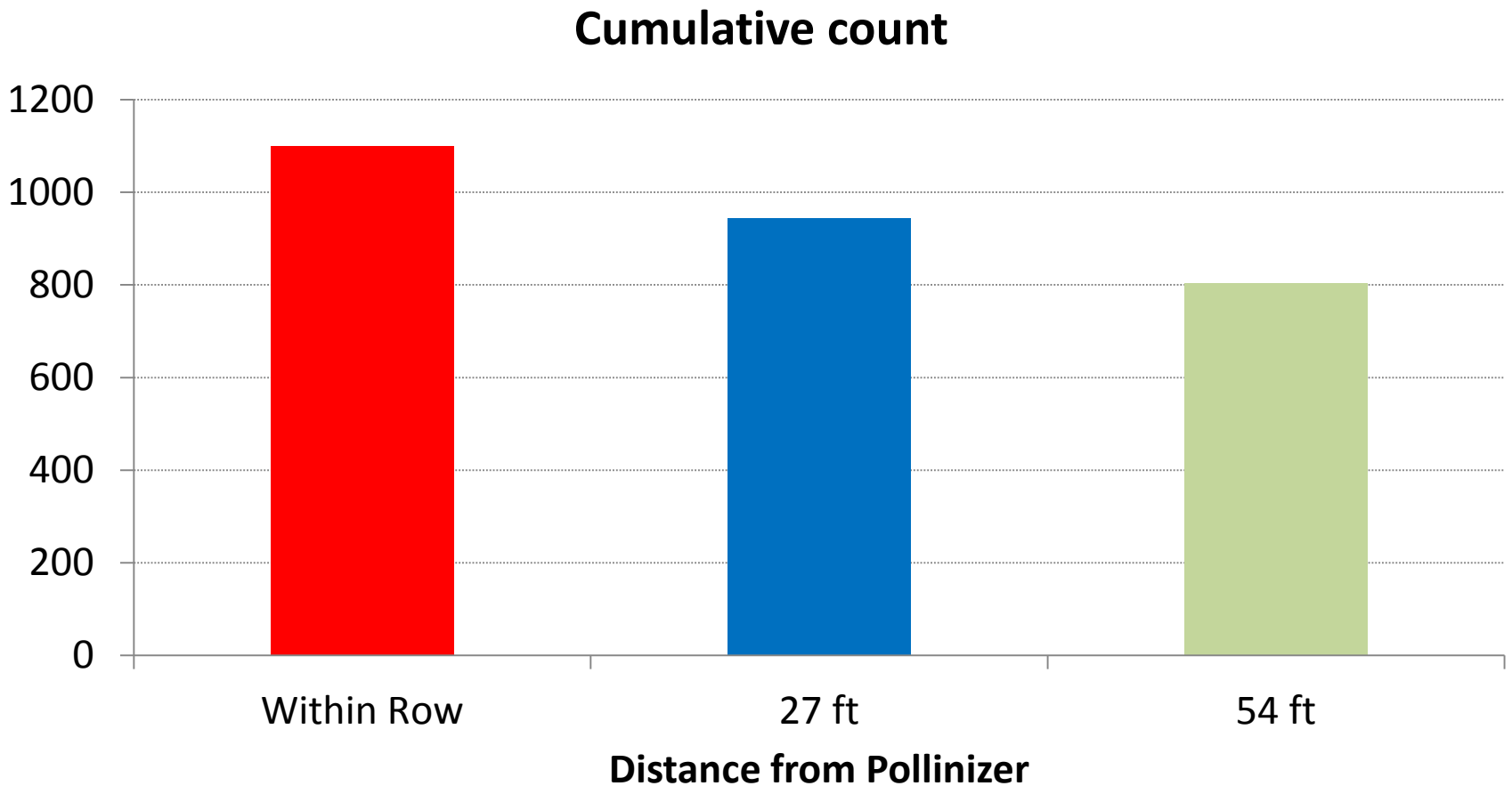
Does distance play a role?



DeBusschere Pollinizer Trial – Coastal Ventura County

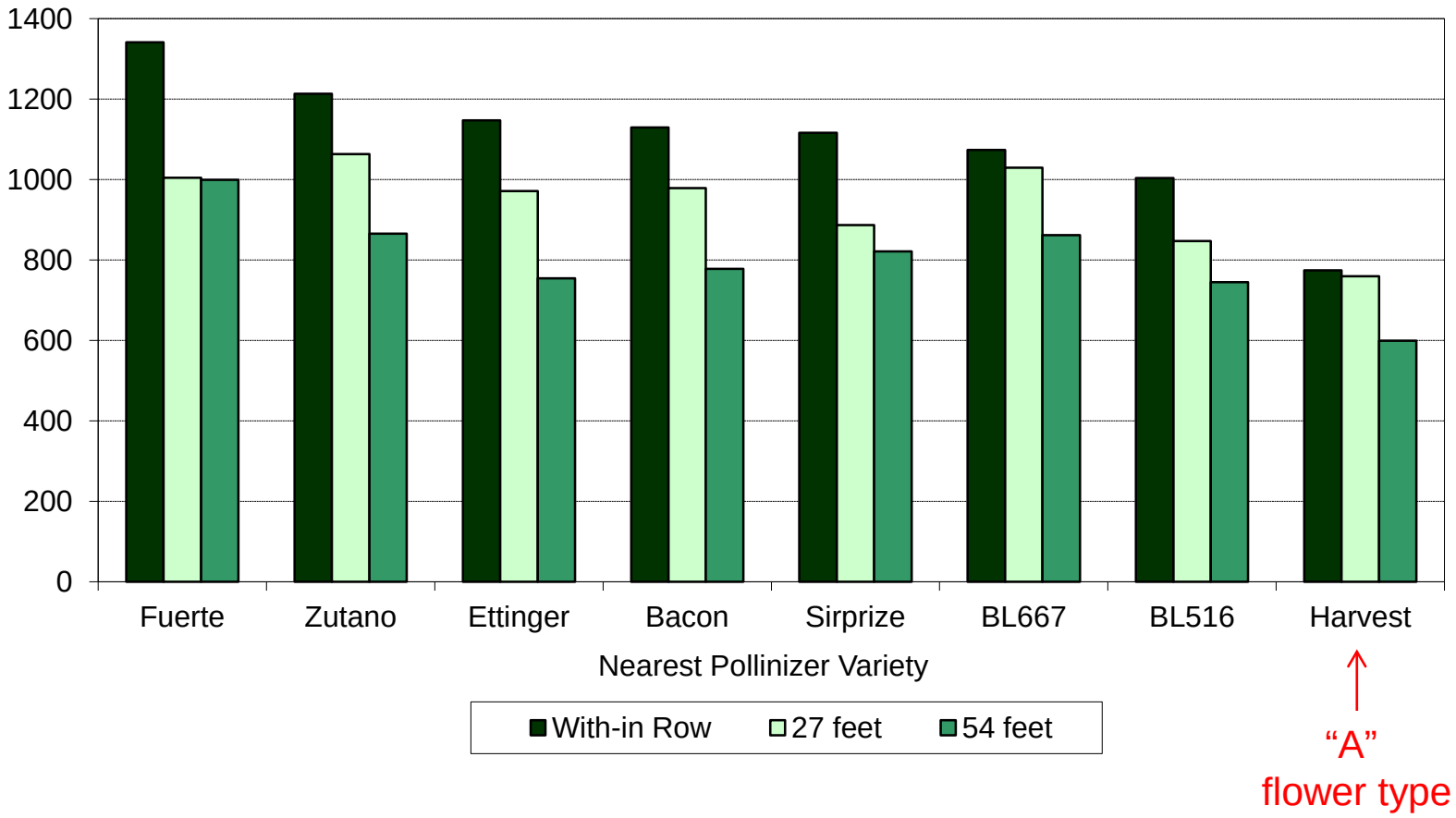
Pollinizer Varieties: 8
Field trial replicates: 6
Pollinizers interset with Hass

Debusschere Pollination Project – 2001 – 2008
Cumulative fruit count as a function of distance from pollinizer

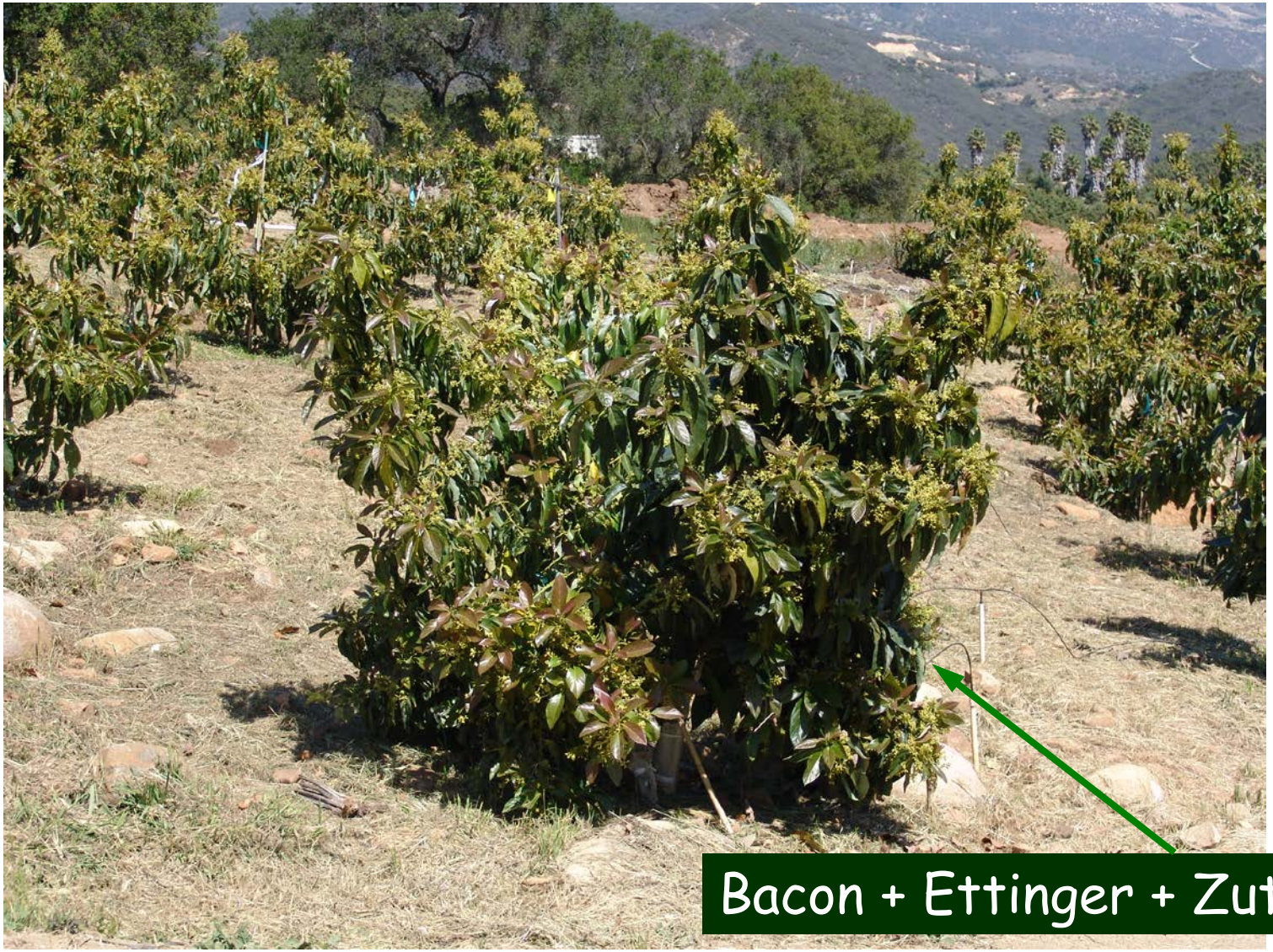


Debusschere Pollination Project – 2001 – 2008

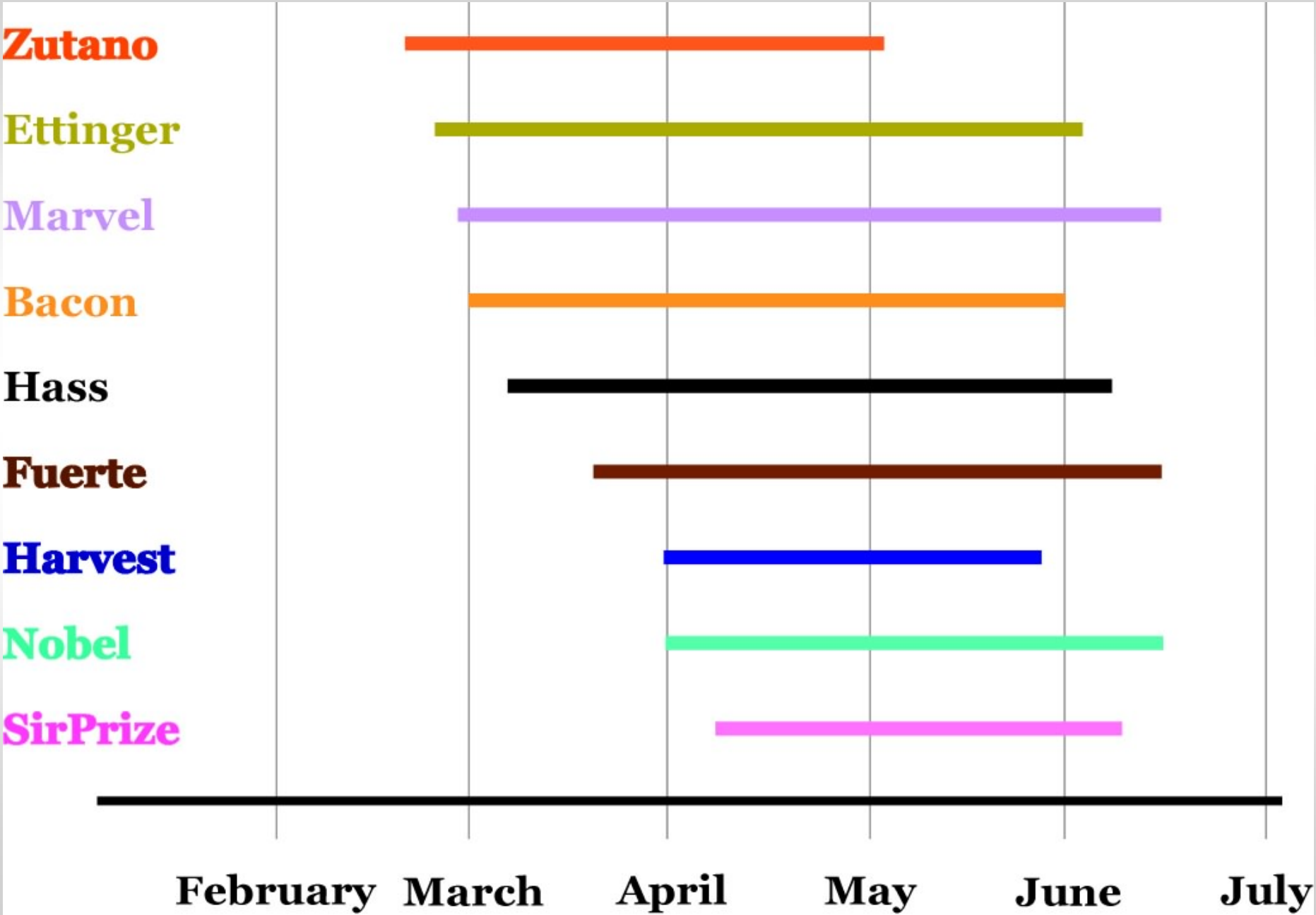
Cumulative fruit count as a function of Pollinizer variety and distance from pollinizer



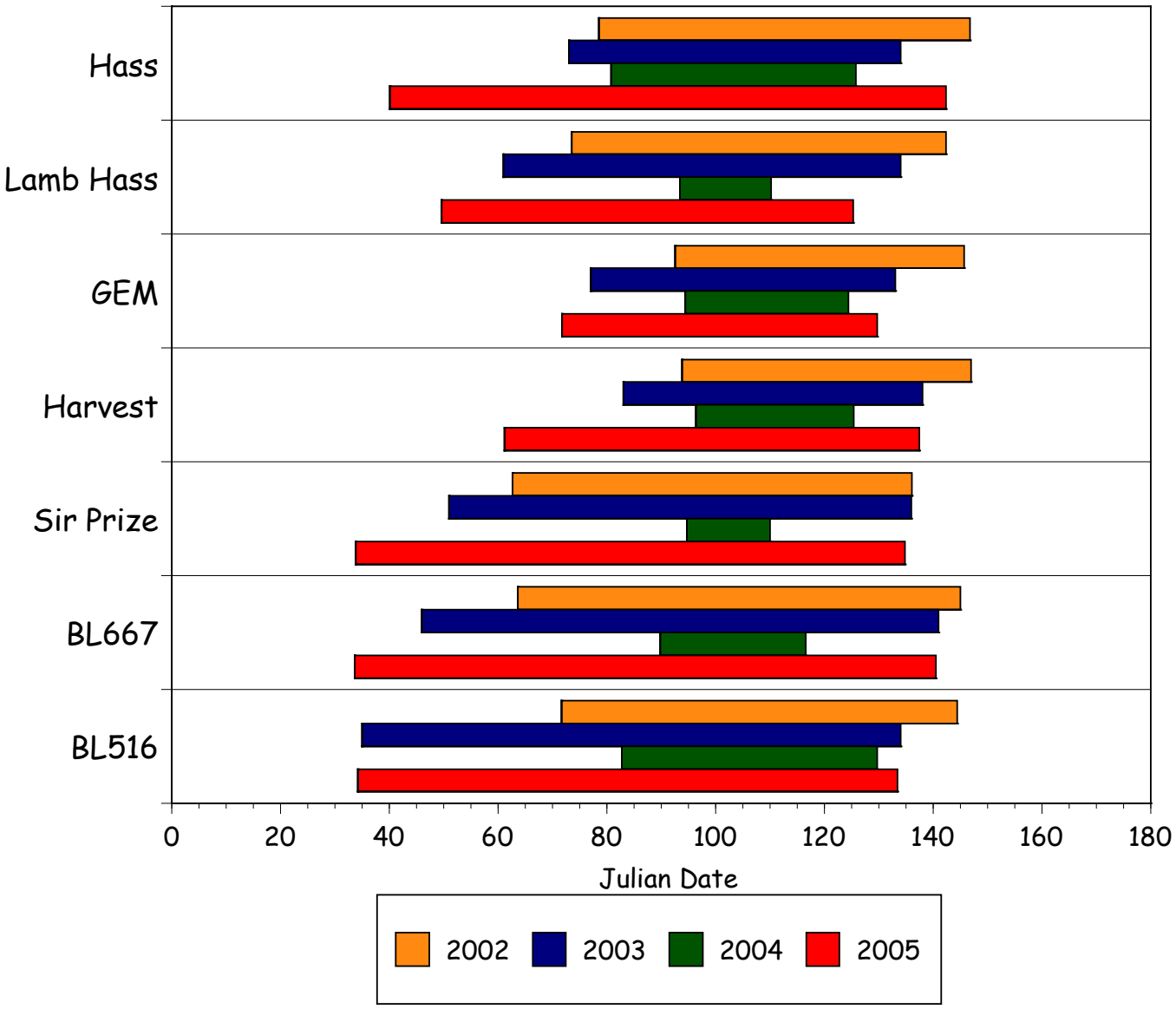
Multiple pollinizers



Flowering periods – Oxnard, 2002



Duration of bloom over 4 years



Irvine, CA

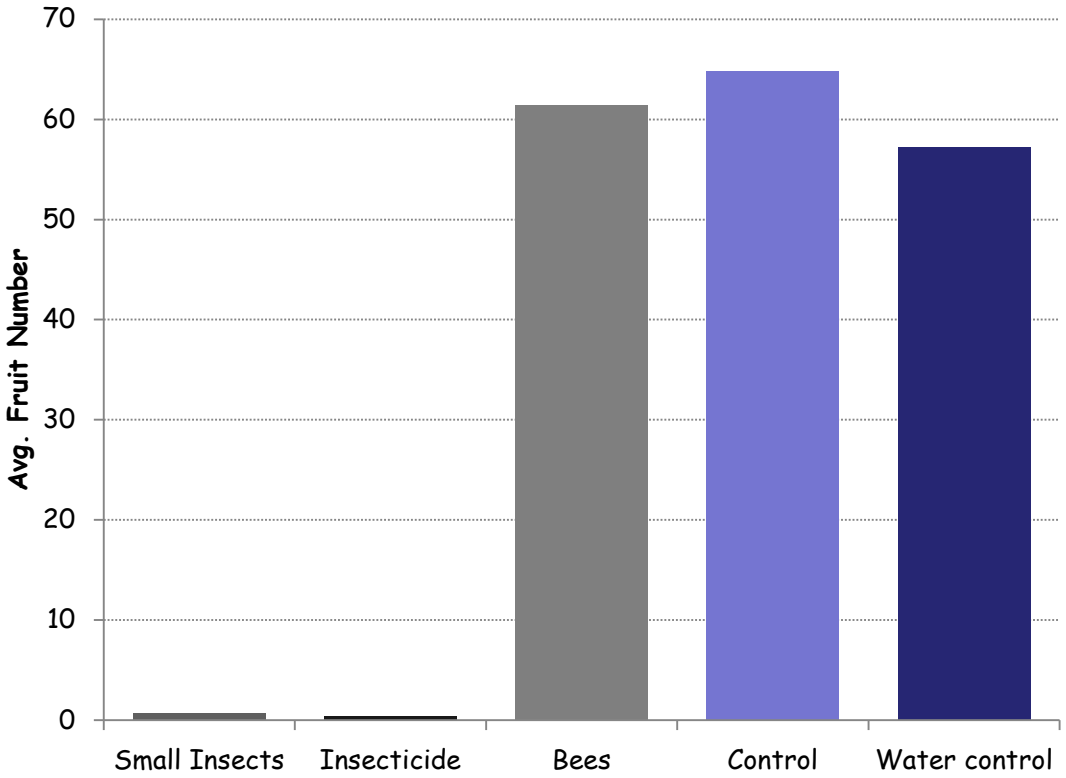
How do you get the pollen to the flower?

ACW Trial – 2010
M. Hoddle, M.L. Arpaia, R. Hofshi

4 Treatments:

1) Outside control
2) Net House with Bees
3) Net House Small insects
4) Net House where all trees sprayed to eliminate insects

ACW Trial – 2010
M. Hoddle, M.L. Arpaia, R. Hofshi

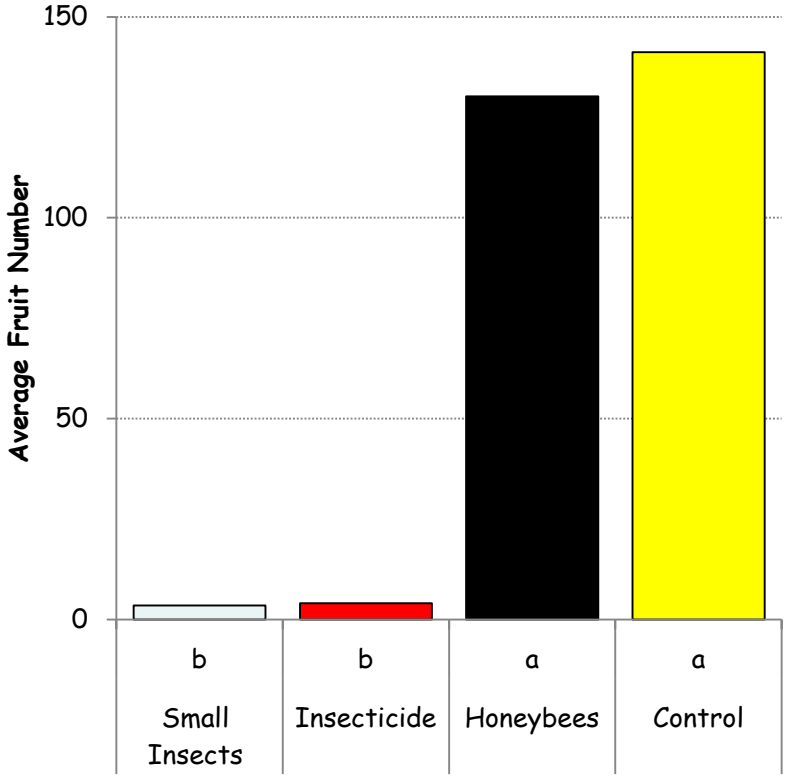


Encon Trial – 2011

R. Hofshi, J. Schmidt, F. Mena, F. Gardiazabal, M. L. Arpaia

4 Treatments:

1) Outside control
2) Net House with Bees
3) Net House Small insects
4) Net House where all trees sprayed to eliminate insects



5 Field Replications

14 trees per net house

To maximize yield one needs:

Effective pollination

↓

Efficient pollinator
(many honey bees)

Sufficient
cross pollination

↓

Pollinizers in
close proximity