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For maximizing yield one needs:

Effective pollination



Efficient pollinator
(many honey bees)



Sufficient
cross pollination



Pollinizers in
close proximity



Avocado Flower Phases

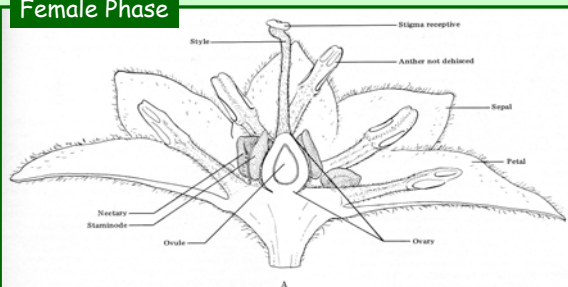


Female Phase Flower
'Reed'

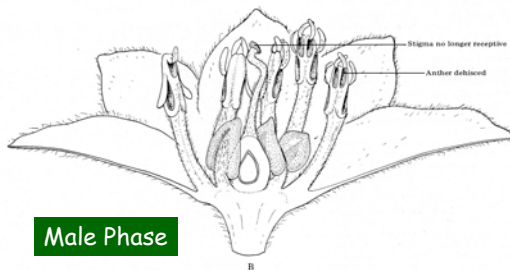


Male Phase Flower
'Fuerte'

Female Phase



Male Phase



The avocado flower

Source: McGregor, S. E.
1976. *Insect pollination of
cultivated crop plants.*
USDA Handbook No. 496.

Pollination Terms

Pollination - the transfer of pollen from the anther to the stigma

- **Cross pollination** - the pollen deposited on the stigma is from a different variety
- **Close pollination** - the pollen deposited on the stigma is from a flower of the same variety
- **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, Walter Hole

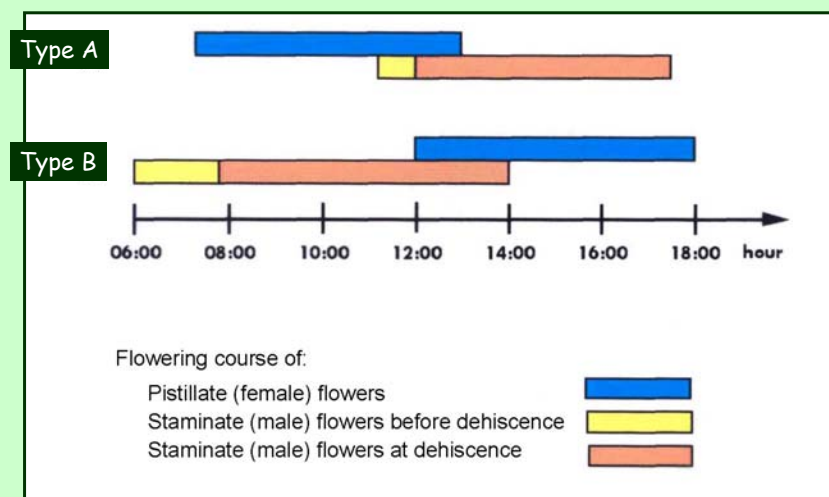
Pollination Terms

Effective Pollination - pollination which leads to fertilization

Non effective pollination - pollination which does NOT lead to fertilization

Fertilization - the fusion of the male gamete with the female gamete forming the zygote

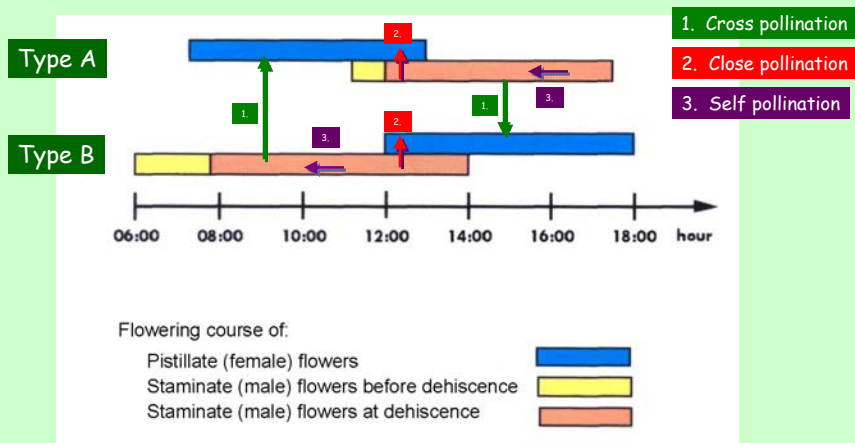
Avocado Flowering Sequence

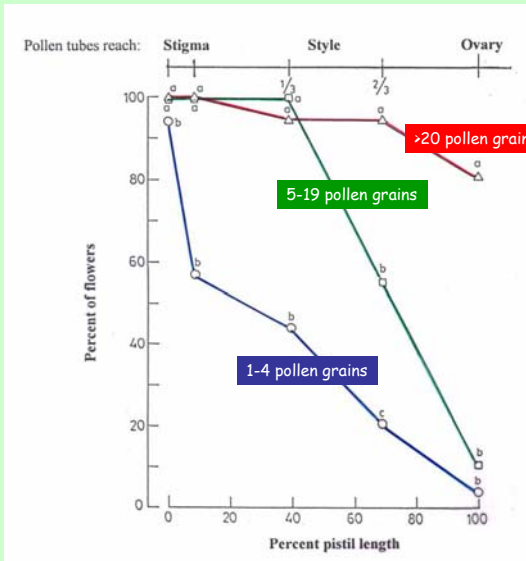


Within the tree overlapping of female and male flowers



Avocado flower pollination avenues





Avocado Pollen Germination Rate

- Hand pollinated 'Hass' stigmas by 'Ettinger' pollen

- After 4 hrs of germination and pollen tube growth

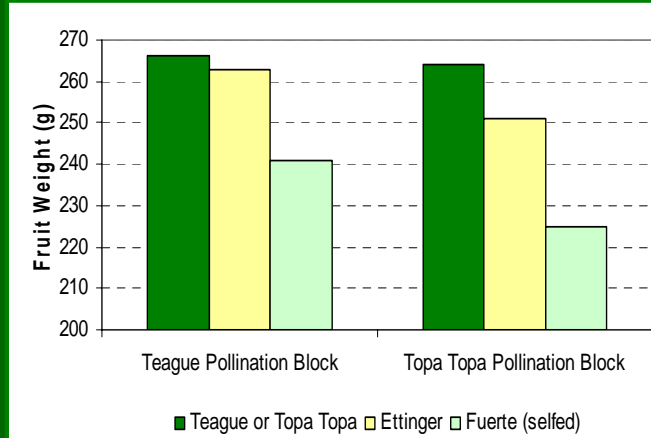
Shoval, 1987

Why does the avocado tree produce so many flowers?

- The whole tree acts like a giant "sunflower" with many small flowers
- More flowers are fertilized than the tree can carry to harvest
- Competition and selection - survival of the fittest!



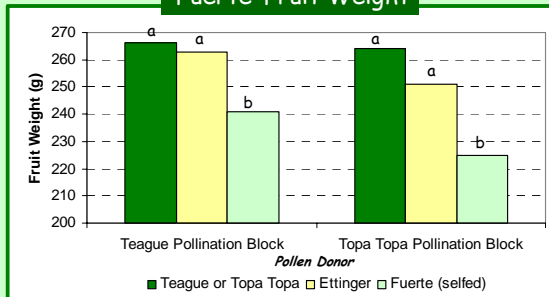
Survival of cross vs. self progenies



% of crossed 'Hass' fruits by 'Ettinger' and 'Fuerte' as a function of time after fruit set.

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

'Fuerte' Fruit Weight



Pollen Donor Effect

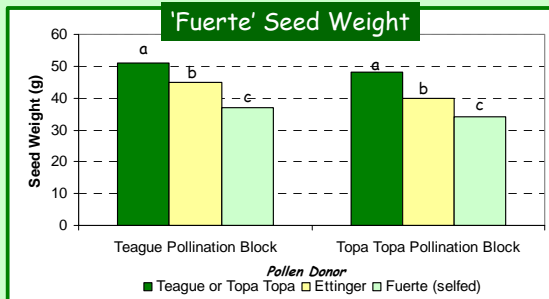
The pollen donor variety impacts fruit weight and seed size

Data from Israel for 'Fuerte' fruit with 'Teague', 'Ettinger' or 'Topa Topa' as pollen donors

The effect of pollen (paternal parent) on maternal tissue is known as metaxenia

Source: Degani et al. 1990. *J. Amer. Soc. Hort. Sci.* 25(4):471-473 via www.avocadosource.com

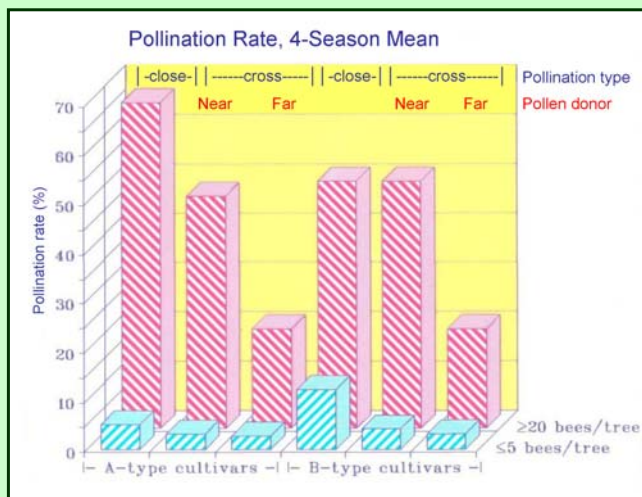
'Fuerte' Seed Weight



Getting the
pollen to the
flower



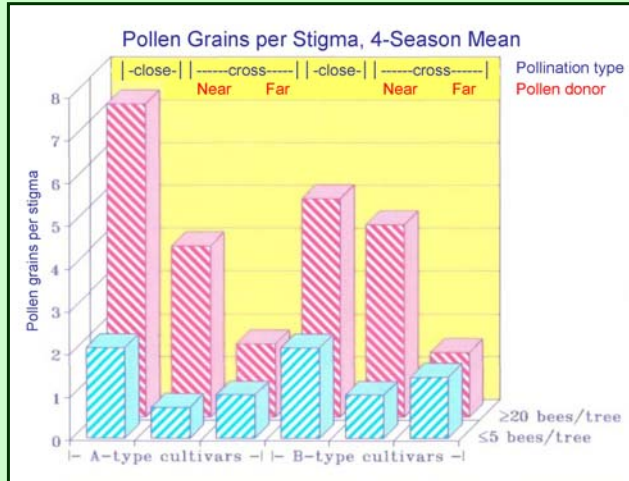
The need for honey bees - pollination rate



- Higher inherent rate of close pollination
- Need a pollinizer in close proximity
- Need sufficient numbers of honey bees
- "A" type cultivars have higher rates of close pollination

Source: Gad Ish-Am

The need for honey bees - pollen grains per stigma



Influenced by

- Pollination type (close is highest)
- Number of bees per tree (>20)
- Pollinizer distance
- "A-type" varieties have higher amounts of pollen on the stigma from close pollination

Source: Ish-Am, 1994. PhD Thesis

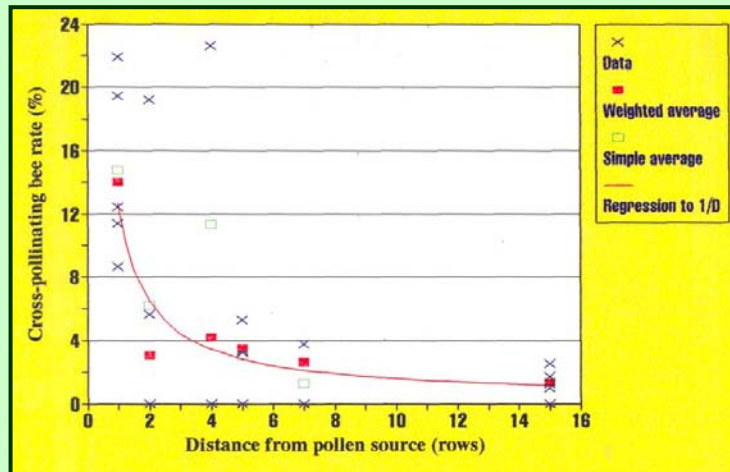
PROXIMITY

Hass ("A" flower type)



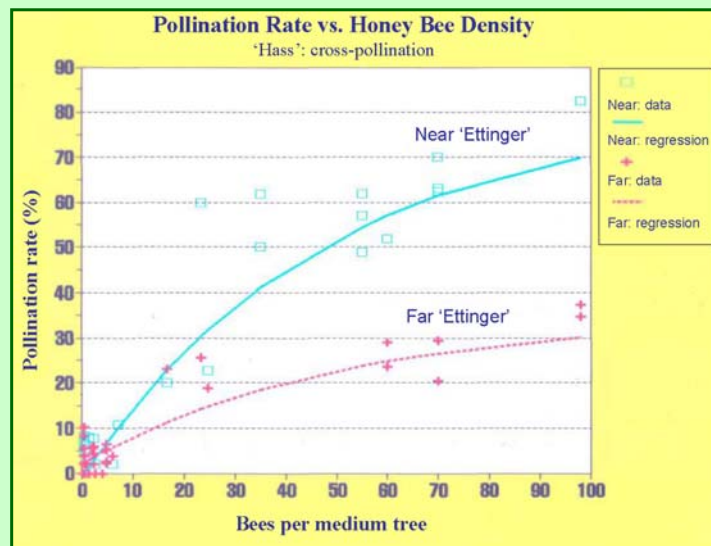
Ettinger ("B" flower type)

The percentage of cross-pollen carrying honey bees decreases with distance from the pollinizer



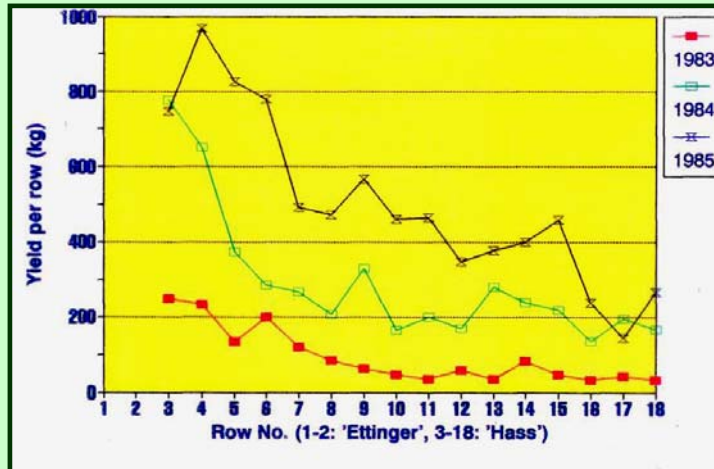
Source: Ish-Am and Eisikowitch, 1996.

Proximity to the pollinizer and bee density influence the amount of cross pollination



Source: Ish-Am, 1994. PhD Thesis

Distance from Ettinger significantly impacts Hass yield



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

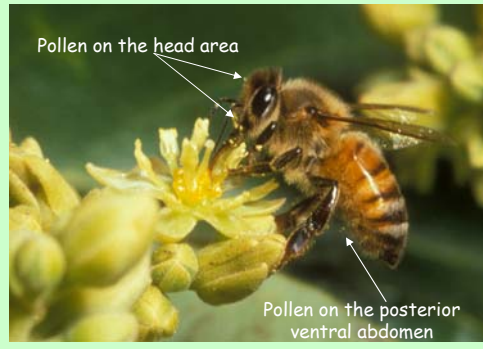
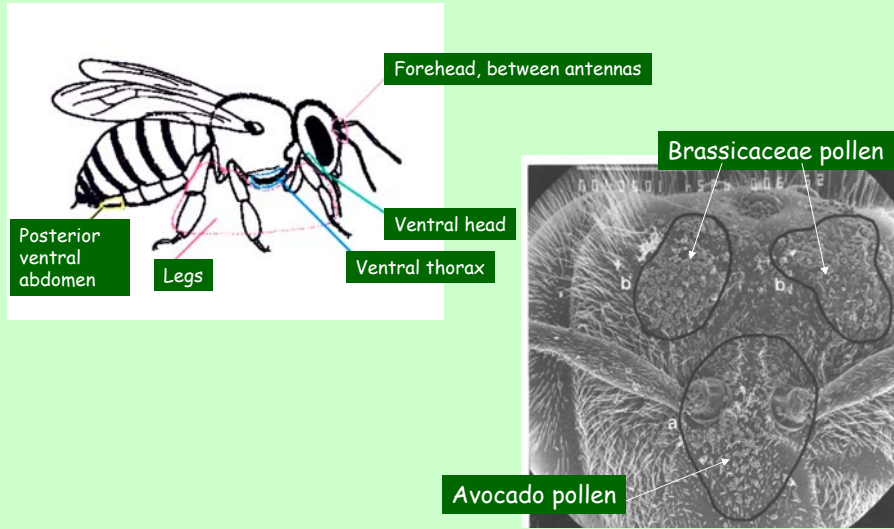
Multiple pollinizers

Insures better overlap (cross pollination) with 'Hass'



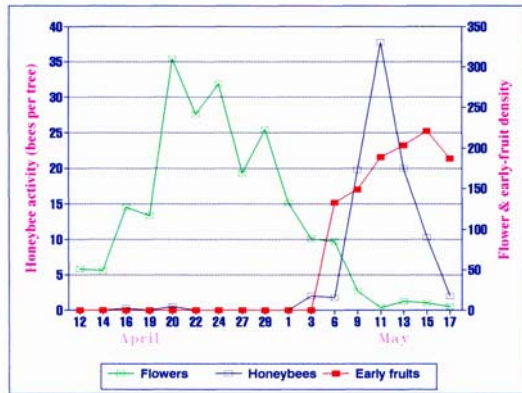
'Bacon', 'Ettinger', 'Zutano'

Regions of avocado pollen transfer



Honey bees transferring avocado pollen between male and female flowers

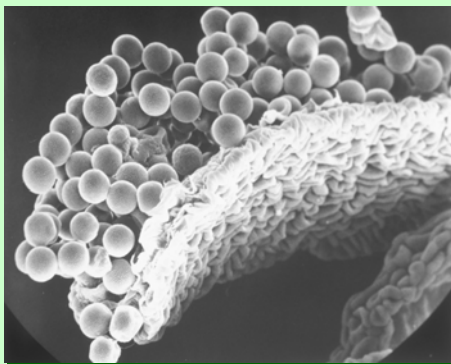
**Flowering Intensity, Honeybee Activity and Initial Fruit-Set
'Hass', Spring 1992**



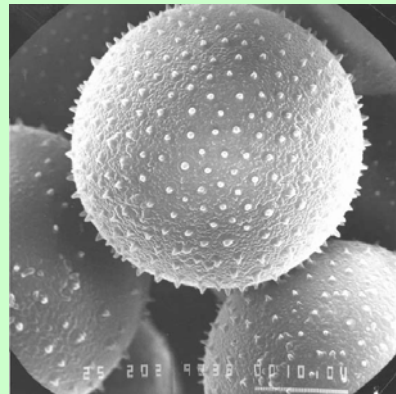
Source: Ish-Am, G. 1994. Ph. D. Thesis, Tel Aviv University, Israel.

No correlation found between avocado flowering intensity and honey bee activity in the presence of competing bloom

High correlation found between fruit set and honey bee activity

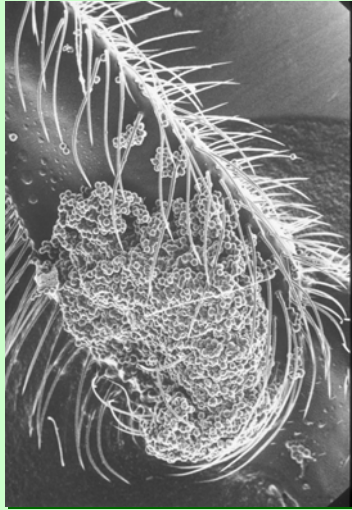


'Fuerte' pollen on anther flap

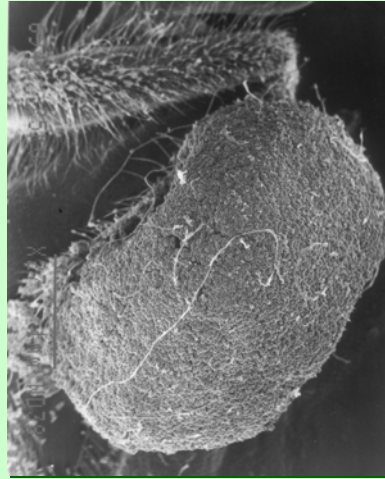


'Hass' pollen grain (SEM x2000)

From: G. Ish Am

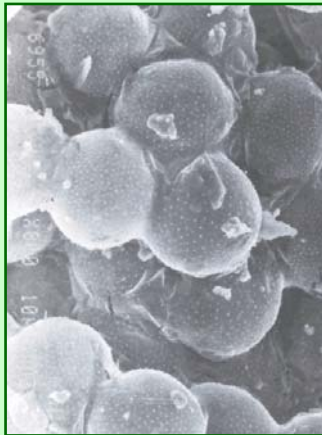


Pollen load on the hind leg of a honey bee containing avocado pollen



Pollen load on the hind leg of a honey bee containing white mustard pollen; *Note the large size and good organization.*

From G. Ish-Am



Close-up of Ettinger pollen in the pollen load of a honey bee



Close-up of white mustard pollen in the pollen load of a honey bee

From G. Ish-Am



How many bee hives per acre are needed?

1-4 strong bee hives per acre depending on the amount of competing bloom

How many honey bees per tree are necessary?

A minimum of 20 bees per medium size tree during full bloom

Count the bees you see traveling from flower to flower

Count by tree sector (divide tree in 6 sectors and count each sector for about 10-15 seconds)



For maximizing yield one needs:

Effective pollination



Efficient pollinator
(many honey bees)



Sufficient
cross pollination



Pollinizers in
close proximity



For more information about
avocado pollination
visit

www.avocadosource.com