

## Effect of Pollen Parent on Pollen Tube Growth in Hass Avocado

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### ABSTRACT

*This report supplies more information on the pollen-stigma intercompatibility reported on last year. Flowers of the cultivars Hass (A and E trees) and Ettinger were used as female parents and the cultivars Hass (A and E trees), Ettinger and Fuerte (A and E trees) were used as pollen parents for in vitro pollination experiments. As in the previous report, Ettinger as a pollen donor outperformed the other pollen parents, while Hass (A) was the best female parent. This means that if these results could be extrapolated to an orchard situation, Hass orchards interplanted with Ettinger should give higher percentage fruit set than pure Hass orchards.*

### OPSOMMING

*Hierdie verslag gee meer inligting oor stuifmeel-stempel verenigbaarheid waaroor daar verlede jaar verslag gelewer is. Blomme van die kultivars Hass (A en E borne) en Ettinger is as vroulike ouers gebruik, terwyl die kultivars Hass (A en E borne), Ettinger en Fuerte (A en E borne) as stuifmeelouers vir die in vitro bestuiwingseksperimente gebruik is. Soos in die vorige verslag was Ettinger die beste stuifmeelouer, terwyl Hass (A) die beste vroulike ouer was. Dit beteken dat indien die resúdate na 'n boordsituasie geékstrapoleer kon word, Hass boorde wat met Ettinger gemeng is, beter vrugset behoort te lewer as suiwer Hass boorde.*

### INTRODUCTION

Apart from the fact that a better understanding of pollination and fruit set in avocado could lead to a refining of orchard management programmes, poor pollination could also be one of the factors affecting fruit drop and small fruit in certain cultivars. Small fruit in Hass has recently been identified as one of the research priorities by SAAGA and we are hypothesising that at least one of the factors affecting fruit size in Hass, could be related to self-pollination and that fruit size could be improved by cross-pollinating Hass with large-fruited cultivars. This hypothesis is based on the occurrence of the phenomenon metaxenia, mentioned by Sedgley and Griffen (1989) in other one-seeded fruit types like macadamia and pistachio nuts. This paper reports on a repetition of

those experiments mentioned in the 1994 report, but is also the first attempt to find suitable pollen donors from cultivars with larger fruit, that could be used for pollinating Hass trees.

## MATERIAL AND METHODS

### Effect of environment on pollination

During the period 16 August 1994 to 10 October 1994 twenty flowers each from four labelled Hass trees were observed for determining the actual sexual stage of the particular flowers. During the same period the daily maximum and minimum temperatures were recorded as well as the relative humidity, wind speed and insect activity. The latter was scored as the number of bees observed at a particular moment on one side of the tree, during flower observation.

### *In vitro* pollination

At least four constantly high producing (A) trees and constantly low producing (E) trees each of the cultivars Hass and Fuerte were identified as well as four Ettinger trees. These trees were used as pollen parents for *in vitro* pollination experiments with Hass A and E female stage flowers. For each combination (Table 1), 4 replications of 25 female flowers were pollinated with pollen from each of the pollen parents. Flowers in the female phase were collected at the very beginning of anthesis and placed in agar-containing petri dishes with their pedicels stuck into the agar. After pollination with pollen from the appropriate pollen parent, flowers were incubated at 27°C for 24 hours. Flowers were then fixed in Carnoy for 12 hours before being transferred to 70% ethanol. The pistil from each flower was carefully removed, cleared and stained in Aniline Blue. Using an epifluorescence microscope, the numbers of pistils with pollen tubes reaching the ovary were recorded separately for each replication. The results were analyzed by the third author, using G L M procedures in Genstat. The logistic regressions produce odds ratios which predict the odds in favour of a subject having a certain characteristic, relative to another characteristic.

**Table 1**  
Predicted percentage pistils with pollen tubes reaching the ovary, 24h after *in vitro* hand-pollinations between different avocado cultivars.

<i>Pistil parent</i>	<i>Pollen parent</i>				
	<i>Hass A</i>	<i>Hass E</i>	<i>Ettinger</i>	<i>Fuerte A</i>	<i>Fuerte E</i>
Hass (A)	33.3	17.3	76.4	72.8	66.2
Hass (E)	27.8	13.9	71.7	35.4	44.9
Ettinger	70.1	49.5	53	65.4	47.4

## RESULTS

### Effect of environment

Figure 1 shows the effect of temperature on the sexual phase of the open flowers expressed as a percentage of the number of flowers collected each day during the period of observation. Since Hass is an A-cultivar, and flowers were collected in the afternoon, all open flowers were supposed to be male, but as can be seen from the 'mixed' bars, on some days anthesis for the female phase was impaired until the afternoon. This abnormal behaviour mostly coincided with low maximum temperatures. Bee activities in relation to maximum and minimum temperatures are given in Figure 2. Bees seemed to have become very active during the beginning of September which coincided with peak flowering and then gradually became less active towards the end of flowering at the beginning of October.

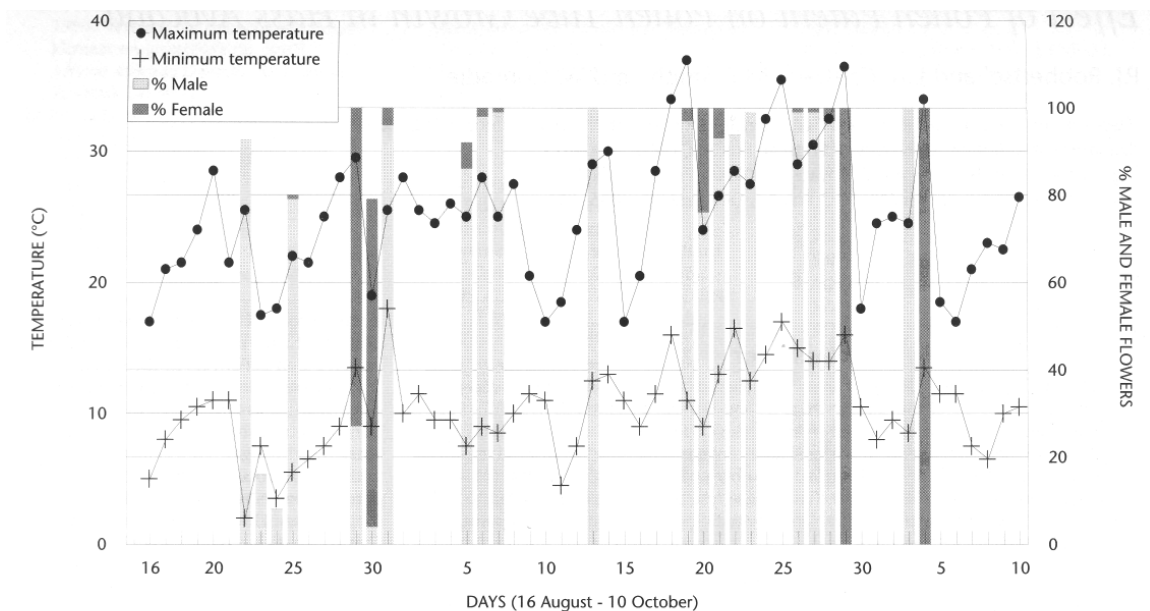
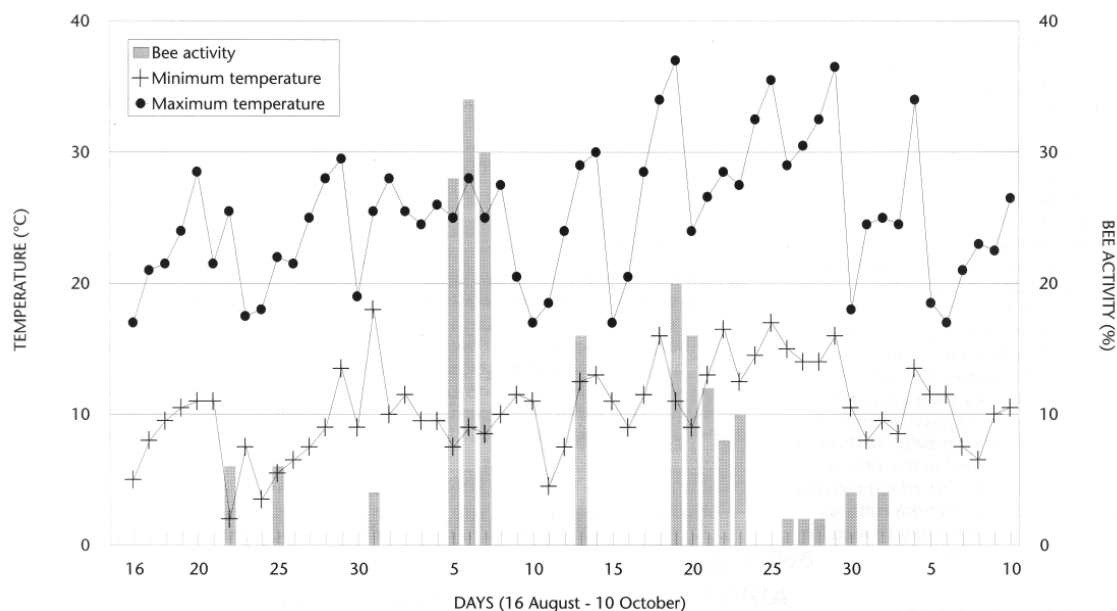


Figure 1

Daily maximum and minimum temperatures over the period 16 August – 10 October showing the sexual phase of Hass flowers expressed as percentage flowers in a particular phase.



**Figure 2**  
Daily maximum and minimum temperatures and bee activity expressed as number of bees seen on one side of observed Hass trees.

### ***In vitro* pollination**

The results are presented in Table 1. For all the female parents the self-pollinations gave much poorer results than any of the cross-pollinations. Where Hass E was used as the female parent, the chances for pollen tubes to reach the ovary was only 43% ( $\pm 2.6$ ) compared to 62% ( $\pm 2.3$ ) where Hass A was used as the female parent. The best pollen tube growth was obtained where Ettinger and Fuerte A were used as the pollen parents. The chances for pollen tubes to reach the ovary were 66% ( $\pm 2.7$ ) for Ettinger, 59% ( $\pm 2.6$ ) for Fuerte A and only 47% ( $\pm 5.3$ ) and 44% ( $\pm 2.9$ ) respectively for Hass E and Hass A.

## **DISCUSSION**

### **Sexual stage of flowers and bee activity**

As can be seen from Figure 1, on some days the rhythm of the flowers was disturbed by the low temperatures leading to a total failure of pollination and fruit set on those days. From these results it looks as if fruit set is limited to periods of at least a few 'stable' days in succession. Bee activity (Figure 2) is also affected by adverse conditions which do not always coincide with the flower biology and leads to a further reduction in the number of 'perfect' days for fruit set.

### ***In vitro* pollination**

The results obtained during this investigation support the statement made in the previous report (Robbertse *et al.* 1994) that the cultivars Ettinger and Fuerte are

competent pollen parents for Hass, that the avocado is a natural outbreeder and support results of Gazit & Gafni (1986) that Ettinger is an effective pollen donor for Hass. In our 1994 report, it was shown that the percentage pistils with pollen tubes reaching the ovary in open-pollinated Hass flowers, never exceeded 50%, while in this investigation this figure was never lower (results not presented). These low figures might indicate a lack of natural cross-pollination in spite of sufficient numbers of bees in the orchard during the same period (Figure 2).

As can be seen in Figure 1, temperature has a direct effect on the normal alternation of female and male stages of the flowers. A drop in temperature causes the flowers to open later during the day so that they are still in the female phase when they were supposed to be male. This also implies that under such conditions, the pollen parents Fuerte and Ettinger would not be able to supply the required pollen for cross-pollination.

Pollination in the avocado can be regarded as a syndrome regulated by different factors. For effective pollination on a specific day, at least the following conditions are required:

- It must be a clear day without too much wind and temperature above 25°C to allow flowers to open at the right time and sexual stage and for promoting insect activity
- An appropriate pollen parent for supplying high quality pollen must be available.
- Pollinators in sufficient numbers must be available and active.
- Trees must contain sufficient levels of nutrients for sustaining pollen tube growth.
- Pathogens must be under control, in order not to compete with pollen tube growth (Thomas *et al*, 1994).

Any one of these conditions can seriously affect pollination and consequently fruit set. The conditions that can be controlled to some extent, are the supplying of the best pollen parent, fertilising and pathogen control and for this reason the producer must go for it.

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