

Identification of the pollen donor in avocado, at the pollination and harvest stages

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Pollen from 12 different cultivars of avocado (*Persea americana* Mill.) were compared using a Scanning Electron Microscope (SEM). We have found that spikes (features which cover all the exine surface, of which each one is smaller than one micrometer), differ from one cultivar to the other, particularly in their shape and also in their size. The diameter of a pollen grain, which is spherical in shape, is variable between different cultivars. Other criteria that may help to distinguish between pollen grains are: the density of spikes on the exine surface and the occurrence rate of double spikes.

At the end of the female opening stage, pollen grains that are found on flowers' pistils, were sampled from 'Hass' and 'Horshim' blocks and were identified using the method mentioned above. The samples were taken from trees at close proximity to the 'Ettinger', as well as from trees at greater distances from this cultivar. As a whole the rates of cross pollination were higher in the 'Hass' block. In both blocks most of the pollen grains were recognized as self's. We could see a gradual decline in rates of pollination of the 'Ettinger', proportionally to the increase in distance from this cultivar. As only small number of samples were examined, these findings must be regarded as being preliminary only.

From an overhead viewpoint the papillae cells have shown a great similarity to pollen grains. Thus, some insects most probably regard the papillae cells as pollen grains. It seems that this mimicry is not accidental, and may serve as a means to attract insects.

Isozyme analysis was used to determine the male parent of mature fruit and young fruitlets. We used six enzyme systems: alcohol dehydrogenase (ADH-2), glutamate oxaloacetate transaminase (GOT-1), leucine aminopeptidase (LAP-2), malate dehydrogenase (MDH-1), phosphoglucomutase (PGM-1) and triose-phosphate isomerase (TPI-1). Previous studies, have shown that all these markers assort independently, while each one of them has a co-dominant assortment of alleles.

The effect of different pollenizers on outcrossing rate was examined in 4 cultivars: 'Ettinger', 'Fuerte', 'Hass', and 'Horshim'. We found that rates of fruits that result from cross pollination or self pollination depended mainly on three factors: the maternal tree, the pollenizer and the distance between them.

Due to the massive abscission of reproductive organs in avocado, a very small portion of pollinated flowers develop into fruit. By using the two methods mentioned above we were able to identify the pollen donor both at the early stage of pollination (where pollen grains are found on the stigma) and at a final stage of fruit maturation. Our findings suggest that most of the pollination occurs within a limited range of a few trees from the pollenizer.

However, some pollination takes place at a greater distance, sometimes even several hundred meters from the pollenizer. Evidence shows that pollination occurs within the same tree and also occurs among trees of different cultivars belonging to the same flowering group. This study

supports the possibility that pollination leading to fruit set might occur as a result of an overlap between two flowering stages within one cultivar, or within the same tree.

As a whole, the two cultivars 'Hass' and 'Horshim' exhibited a marked response to cross pollination as expressed by high rates of hybrid fruit. By contrast, we found an opposite situation in the 'Ettinger'. In the 'Fuerte' however, we identified an intermediate situation, which is probably the result of great variability in the rates; whether of hybrid or self's fruit and depending on the pollenizers' quality and their distance interval. It seems as if there is a correlation between the ability of a particular cultivar to pollinize and fertilize itself, with its ability to play a role as a pollenizer for other cultivars.

'Ettinger' excelled as pollenizer for 'Hass' and 'Horshim', but not for 'Fuerte'. 'Ein-verd' beat 'Ettinger' by higher rates of hybrids in 'Horshim' fruit. 'Topa-Topa' was a fairly good pollenizer for 'Fuerte', but at a distance not beyond one tree. It seems that 'Semil-43' is also a good pollenizer for 'Hass'.

The massive abscission of fruitlets and fruits that occurs usually in the avocado tree, can be considered as a selection process. Different pollenizers may grant their offspring's different chances to survive. We could notice this phenomenon in many cases. For instance, we found about 30% hybrid 'Hass' fruits as a result of 'Ettinger' pollination, although there were only three 'Ettinger' trees within a 100 meter distance from the sampled 'Hass' trees. Selection against fruitlets in the tree may also occur among offspring's that resulted from one pollenizer. Such is the case with homozygous genotypes in Lap-2 which has been proved in previous studies. Using the Lap-2, we could show that this type of selection intensity may differ from one orchard to the other, or even from one tree to the other.

We do not assume that the reproductive organs selection in avocado is just limited to one developmental stage. It seems that it is a continuous process which begins with pollen grains on a stigma and ends with fruition. Our findings support the possibility that at least some portion of the remarkable high ability of 'Ettinger' to serve as a male parent can be ascribed to advantageous germination of its pollen grains.

In two different blocks of 'Hass' trees that were close to 'Ettinger', we studied whether there was a correlation between the yield and the distance from 'Ettinger'. In one of the 'Hass' blocks a positive correlation has been found between yield and the proximity to 'Ettinger' during both seasons of 1986-7 and 1987-8. Comparatively, previous studies have shown that this tendency was more significant during the four preceding yield seasons. On the contrary, in the second block we found an opposite correlation between yield and the proximity to 'Ettinger' in the season of 1986-7, and a positive correlation in the season of 1987-8. During these seasons, both blocks have shown a great biennial alternation in yield levels.

Our findings point out that there might be a mutual relation between the ability of a tree to sustain large numbers of fruit and the survival of self fruitlets on it. Further evidence that confirms or rejects this possibility is necessary.

Our findings emphasize the benefits that might be gained from using proper pollenizers in orchards. On the same Horshim trees, fruit which resulted from 'Ettinger' pollination was heavier than that which resulted from 'Ein-vered' pollination and 'Fuerte' fruit which resulted from 'Topa-Topa' pollination was heavier than self fruit.

We pointed out that there is a possible linkage between two isozyme marker loci, with quantitative trait loci that belong to seed-weight (in Adh-2 and Pgm-1) and fruit-weight (in Adh-2). Hence, it seems that isozyme markers should be used as a valuable tool to improve the quality of avocado.