

## OUTCROSSING IN AVOCADO: IS THERE A RELATIONSHIP TO FRUIT YIELD

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In avocado groves where Hass trees are planted near trees of other varieties, high fruit counts on Hass have been observed. This is in comparison to lower fruit counts in areas where only Hass trees are present. The cause of the higher fruit yield may be the result of outcrossing by the other avocado variety. The correlation between outcrossing and yield is being investigated in the laboratory of Dr. M.T. Clegg. This report summarizes the progress of this project.

The design of the study took into consideration three different outcrossing pollen source (Bacon, Fuerte and Zutano) as well as climatic regions (inland and coastal) and distance from the outcrossing pollen source (one row, five rows and 15 rows away from pollen source). Collection sites were chosen based on two criteria:

- 1) A large plantings of Hass trees
- 2) One tree or row of Bacon, Fuerte or Zutano trees located close to the Hass trees.

The collection sites were in privately owned Hass groves with the inland sites located in Temecula and coastal sites located in the counties of Ventura and Santa Barbara.

For Temecula and Ventura, each area had three collection sites, one for each outcrossing pollen source, Bacon, Fuerte or Zutano. In Santa Barbara, there were only two collection sites. One site had Bacon as the outcrossing pollen source; the other had Fuerte. Within the collection site, sampling was performed on two trees at each of the distance classes (1 row, 5 rows or 15 rows from the outcrossing pollen source). Sampling for each tree involved the collection of twenty fruit for DNA analysis and the counting of total number of fruit for fruit yield estimates. The collections of Hass avocados were performed in each of the years 1993, 1994, 1995 and 1996.

Analysis of Hass embryo DNA was performed with the use of a molecular marker called RAPD (random amplified polymorphic DNA). One RAPD marker identified pollination by Fuerte in Hass fruit. The other RAPD marker would detect pollination by Zutano or Bacon. The calculation of percent outcrossing is derived by the following formula:

$$\frac{\text{number of Hass fruit showing a Fuerte (or a Zutano/Bacon) RAPD band}}{\text{number of Hass fruit analyzed for the presence of the RAPD band}}$$

In our last progress report (March, 1995), data for the 1993 and 1994 collections showed a decline in the value of percent outcrossing with increasing distance from any

of the three outcrossing pollen sources (Bacon, Fuerte or Zutano). There was no clear relationship between percent outcrossing and climatic region or outcrossing pollen source. One caveat for 1993 and 1994 data was collection of the Hass fruit was done after the start of harvest. This resulted in an incomplete collection of the available fruit and an inability to assess fruit yield. The result may be an incomplete picture for outcrossing and fruit yield.

A more complete collection was performed in 1995 and 1996. For the 1995 collection, 867 Hass avocado were collected. DNA has been extracted from all the individuals and is currently being analyzed for the presence of Fuerte and Zutano/Bacon RAPD markers. For the 1996 collection, a total of 802 fruit was collected. The DNA from the embryo is currently being extracted.

The laboratory is also involved with two other projects on outcrossing and fruit yield. The first is a collaboration with Dr. Guy Witney and Gray Martin of the University of California, Riverside, on the development of a better B-type pollinator. Used as the outcrossing pollen sources, the B-type pollinators, BL667, OA184, 4-18-15 and Harvest, will be used in the comparison of percent outcrossing Vs fruit yield on Hass. The questions to be addressed are: 1) Does a particular B-type pollinator contribute more to outcrossing? 2) Does outcrossing by a B-type pollinator correlate with fruit yield?

The design of the experiment was developed by Gray Martin. In a plot, the plantings alternated between one B-type pollinator (either Bacon, BL667, OA184, 4-18-15 or Harvest) and one Hass tree to form a 6 tree by 4 tree plot. A total of 12 B-type pollinator trees and 12 Hass trees were planted in a plot. Included in this study was control plot which had no pollinator trees. Within the field, each of the six plot designs was duplicated at another site, making a total number of 12 plots in the field.

For the 1996 collection, five fruit were collected from each of the 12 Hass trees, for a total of 60 Hass fruit per plot, 720 fruit for the entire experiment. DNA from the Hass embryo is presently being extracted. The development of RAPD markers identifying each of the 5 B-type pollinators is currently underway. The RAPD markers will identify which B-type pollen was involved in pollination of the Hass fruit. Once the RAPD markers have been developed, the analysis of %outcrossing per B-type pollinator and %outcrossing Vs fruit yield can be started.

The second project involved a grove owned by Len Frances. High fruit numbers were observed on Hass trees neighboring topworked Zutanos. This was in comparison to low fruit number in areas with only Hass. The question was, "Is there a correlation between outcrossing by Zutano and fruit yield?"

Ten Hass fruit were collected from each of five sites within the grove. The sites, chosen by Len Francis, consisted of two to five trees. Two sites (sites 3 and 4) contained topworked Zutanos among Hass trees. Sites 2 and 5 had only Hass trees with no Zutanos. And site 1 had only Hass trees located close to 70 beehives.

Table 1 gives the description of the collection sites and the resulting data for %outcrossing and fruit yield. "Outcrossing" is the number of Hass fruit which showed a Zutano/Bacon RAPD band. "Number of Fruit" is the number of Hass fruit analyzed for the presence of the RAPD band. The percent of this calculation, referred to as

%outcrossing, is shown in brackets. "Fruit Count" is the number of Hass fruit on each of two trees, except in Site 1 where only one tree was counted. "Average Number of Fruit" is the "Fruit Count" divided by the number of trees that were counted.

Figure 1 shows a graph of the data with %outcrossing on the x-axis and average number of fruit on the y-axis. There is a correlation between %outcrossing and fruit yield.

The statistical test, Kendall coefficient of rank correlation, tests for the significance of association between the two values, %outcrossing and average number of fruit. This test shows a positive correlation with a significance of 0.05. This positive correlation means a high amount of outcrossing by Zutano(/Bacon) corresponds with a high fruit yield. Lower values of %outcrossing means lower fruit yield.

It should be noted that the two caveats of this data set are:

- 1) the RAPD marker identifies pollination events by Zutano and Bacon. The presence of any Bacon in the grove will alter the results.
- 2) this is a small study with only ten fruit analyzed from each collection site. Any conclusions drawn from this data should be done with caution.

<u>Site</u>	<u>Outcrossing</u> Number of Fruit	<u>Fruit</u> <u>Yield</u>	<u>Average</u> <u>Number</u> <u>of Fruit</u>
1 Hass with beehive nearby	2/8 (25%)	~115	115
2 Hass (18 years) No Zutanos topworked within 6 tree distance Best 2 of 4 trees (Len Francis 'Site 2')	1/5 (20%)	38/59	48.5
3 Hass trees (18 years) next to 3 year old Zutano topworked graft (Len Francis 'Site 1')	5/6 (83%)	183/225	204
Hass                      Hass Zutano Hass                      Hass			
4 Best two Hass trees (18 years) Next to 3 year old Zutano Topworked graft (Len Francis 'Site 3')	4/5 (80%)	145/205	175
5 Hass Trees (18 years old) No Zutanos within 6 rows Best 2 trees of 4 (Len Francis 'Site 4')	0/3 (0%)	19/16	17.5

Table 1. Description of collection sites and corresponding data for %outcrossing and fruit yield. "Outcrossing" is the number of Hass fruit which showed a Zutano/Bacon RAPD band. "Number of Fruit" is the number of Hass fruit analyzed for the presence of the RAPD band. The percent value, referred to as %outcrossing, is shown in brackets. "Fruit Count" is the number of Hass fruit on each of two trees, except in Site 1 where only the fruit from one tree was counted. "Average Number of Fruit" is the "Fruit Count" divided by the number of trees that were counted.

## PERCENT OUTCROSSING Vs FRUIT YIELD

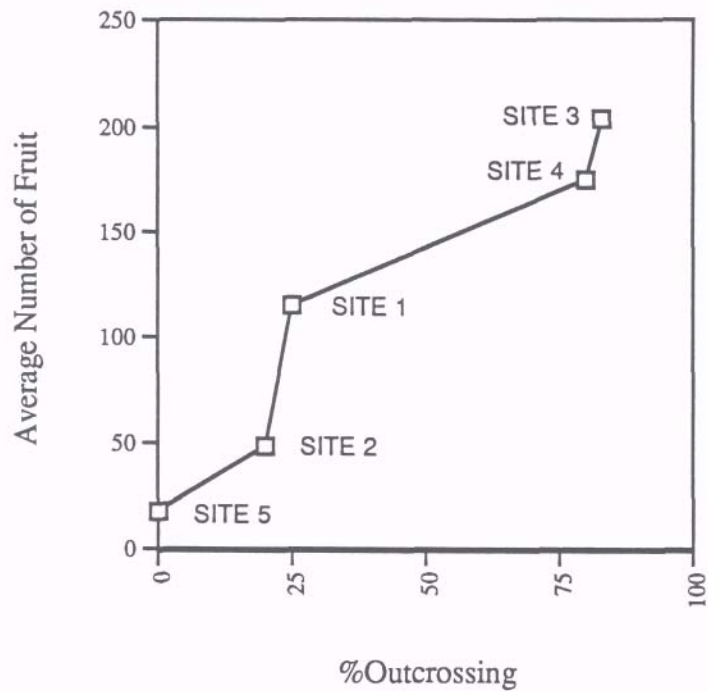


Figure 1. The graph shows the relationship between percent outcrossing when compared with average number of fruit. The x-axis is the %outcrossing which is calculated by the formula:

$$\frac{\text{number of Hass fruit which showed a Zutano/Bacon RAPD band}}{\text{number of Hass fruit analyzed}}$$

The y-axis is the average number of fruit on a tree at each site.