

## **Enhancement of Avocado Productivity. Plant Improvement: Selection and Evaluation of Improved Varieties and Rootstocks**

### **Continuing Project: Year 8 of 20**

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UC South Coast Avocado Volunteers, J. Menge, D. Crowley, M. Clegg, B. Faber and on-farm  
cooperators*

### **Benefit to the Industry**

This project will help to maintain and enhance the California avocado industry by introducing consistently heavier producing, high-quality avocado varieties, better pollinizer varieties, and improved rootstock hybrids. Increasing the genetic diversity of varieties will decrease the risk of major pest and disease invasions on a susceptible monoculture.

### **Objectives**

- A. To produce new avocado varieties, superior to 'Hass' in consistent productivity and postharvest fruit quality and marketability, with fruit of optimum maturity and size year-round. This includes determining the different cultural needs of each cultivar. Index trees for distribution for sunblotch viroid with assistance of Drs. Allan Dodds, Jim Heick and Deb Mathews.
- B. To collaborate with other researchers worldwide in evaluating and exchanging promising plant material.
- C. To collaborate with Dr. Menge and Dr. Crowley on rootstock selection and evaluation for both root rot resistance and salinity tolerance.
- D. Evaluate the potential of new and established cultivars (B flower types) for use as pollinizers in collaboration with Dr. Ben Faber; assist Dr. Mike Clegg on coordination of pollinizer research plots as requested.
- E. To assist Drs. Morse and Hoddle on identifying plant material tolerant to *Persea* mite and the avocado thrips as requested.
- F. To maintain and improve the CAS variety block and the *Persea* germplasm block located at the UC South Coast Research and Extension Center.
- G. To insure the timely and effective dissemination of information developed from this research program.

## Summary

### **A. To produce new avocado varieties, superior to ‘Hass’ in consistent productivity and postharvest fruit quality and marketability, with fruit of optimum maturity and size year-round.**

There are 2 components of this objective. The first is the continued monitoring of varieties from the Dr. B. Bergh/Gray Martin selection program. The second component is the new phase of scion selection. Activities for both components are summarized below.

#### **Component 1. Continued monitoring of Bergh/Martin selections**

Various field trials have been established to monitor the performance of a number of the Bergh/Martin selections. The following is a list of the cooperator trials we are maintaining. In 2002 we installed data loggers to monitor air and soil temperature and relative humidity at all sites. We plan to use this data to help us assess the selection’s response to low/high temperature when these events occur.

There are also additional plantings of the Bergh/Martin selections scattered throughout southern California. We periodically visit these sites to evaluate trees and discuss tree performance with the cooperators.

#### *Topworked trials at Non-UC Sites*

Santa Paula (Ventura County); topworked in 1998; ‘GEM’, ‘Harvest’, ‘Sir Prize’, ‘RT5176’, ‘OA184’, ‘Marvel’, ‘Hass’; 10 replicates.

De Luz (San Diego County); topworked in 1998; ‘Lamb Hass’, ‘Sir Prize’, ‘GEM’, ‘Marvel’, ‘5-552’, ‘Nobel’, ‘Hass’, ‘Harvest’; 10 replicates.

De Luz (San Diego County); topworked in 1998; approximately 80 ‘GEM’ trees divided roughly into 3 groups at the cooperator site.

San Luis Obispo (San Luis Obispo County); topworked in 1998 (Trees suffered from freeze in 12/98 necessitating re-grafting of some selections in 1999; ‘RT5176’, ‘Hass’, ‘Sir Prize’, ‘GEM’, ‘Harvest’, ‘OA184’; 9 replicates.

#### *Clonal trials at Non-UC Sites*

Oxnard (Ventura County); planted in 1996; ‘Lamb Hass’, ‘Sir Prize’, ‘GEM’, ‘OA184’, ‘Marvel’, ‘Nobel’, ‘Hass’, ‘Harvest’. (This trial was flooded in 1997 and many trees died due to this, however we are now working with the current owners to collect data from the trees which survived after the winter of 1997)

HTH Ranch (Ventura County); ‘Lamb Hass’, ‘Marvel’, ‘GEM’ and ‘Hass’ A non-replicated trial used for dry weights and fruit evaluation only.

*Topworked trees at UC, Riverside Campus – ongoing; Replacement trees in Field 10.*

*Topworked trees at UC, South Coast Research and Extension Center (SCREC); Field 4 at the Center has topworked trees (variable number of replicates) from which we collect data. These trees were topworked onto seedling rootstock trees in 1994 – 1996.*

*San Joaquin Valley Variety Trial – 1999 at two sites (Porterville, Lindcove) with clonal trees (Thomas rootstock); ‘Sir Prize’ ‘Lamb Hass’, ‘Harvest’, ‘GEM’, ‘Nobel’, ‘Marvel’, ‘Pinkerton’, ‘Fuerte’, and ‘Zutano’; 20 replicates per scion variety at each site. We had trouble with tree establishment for certain varieties, therefore surviving tree numbers varies with site and variety.*

We have also had problems with certain varieties dropping fruit prior to harvest; however we do have 1 season's worth of dry matter testing and plan to collect further data this upcoming year.

***Yield data from Bergh/Martin selections.*** We have collected yield data for the sixth year from Field 4 at UC-SCREC (UC South Coast Research and Extension Center). Data collection for 2004 shows that for most varieties, this was an 'on' year (Figure 1). The 'Lamb Hass' at this point has the largest cumulative yield over the six year period. Note also the extreme alternate bearing of the 'Sir Prize' during this time. The fruit load was so heavy in 2004 that the trees had virtually no flowers during the spring 2004 flowering season. Comparing the coefficient of variation shows that there is a tendency toward less extreme alternate bearing in 'GEM' (Figure 2; this is calculated by dividing the standard deviation by the mean and gives one an idea of the relative variation of the data for a particular variety).

We have also collected the fourth year of yield data from the Oxnard site and are in the process of finishing the harvesting at the Santa Paula site in Ventura County (Figures 3 and 4), the Righetti site near San Luis Obispo (Figure 5). Data from the De Luz site is incomplete at this time.

***Fruit characteristics of Bergh/Martin selections.*** As an on-going process we are collecting fruit samples from all sites approximately every 4 to 5 weeks from winter through late fall. These fruit are evaluated using standard protocols for such characteristics as fruit shape, peel texture, peel color, flesh color, the percent seed, flesh and skin and skin thickness.

***Seasonal dry matter content of Bergh/Martin selections.*** We collected dry matter data as in previous years. The general pattern for dry weight accumulations for each variety in 2004 is consistent with the 2000 – 2003 data as previously reported.

***Bloom evaluation of Bergh/Martin selections.*** The bloom of spring 2004 was evaluated on the trees in the unreleased variety block at UC-SCREC. This is the third year of this type of data collection. Bloom was rated for intensity, and an estimate of the number of open flowers was made for each tree. This was done weekly throughout the bloom season. Figure 6 illustrates the relative timing of each variety over the 3 year period. Note that the bloom in 2004 was very much abbreviated. This could be due to a number of reasons including the unseasonable hot and dry weather we had in late April and May.

***Release of Bergh/Martin selections.*** The UC Office of Technology Transfer has obtained patents for two of the Bergh/Martin selections, 'GEM' (U.S. Plant Patent No. 14,239) and 'Harvest' (U.S. Plant Patent No. 14,238) effective October 14, 2003. Budwood for this variety was collected by various nurseries in the spring of 2004. Growers interested in these varieties can either contact M. L. Arpaia, D. Stottlemeyer or Dr. William Tucker at the UC Office of Technology Transfer for more information.

## **Component 2. New Material for the Breeding Program**

We are taking 2 approaches towards generating new material for the California industry. These approaches are the outcome of discussions with B. O. Bergh, U. Lavi (Avocado breeder, Volcani Institute, Israel) and A. W. Whitley (Australia). The first approach is to plant out seedlings from interesting maternal sources; this is done without any effort to control paternity. This approach was suggested by U. Lavi. In spring 2000, we planted the first 217 seedlings from mixed maternal sources to provide material for the "next generation" of avocado selections using this

approach. An additional 237 seedlings were planted out in 2002 and 186 seedlings in 2003. So far, 242 seedlings have been planted out in 2004 with another 350 seedlings to be planted this fall. We anticipate an additional 350 seedlings will be planted out in Spring 2005. Table 1 shows the maternal parents of the current seedling population planted at UC-SCREC.

Table 1. Open pollinated seedlings from varying maternal sources planted at the UC South Coast Research and Extension Center from 2000 to 2004.

Year Planted	Maternal Source								Total Planted
	5-552	Marvel	Nobel	GEM	Gwen	Lamb Hass	Thille x GEM	GEM x BL516	
2000	32	90	37	39	14	5			217
2002		75	51	91		20			237
2003		50	25	41	55		15		186
<b>2004</b>	<b>30</b>	<b>61</b>	<b>48</b>	<b>42</b>	<b>55</b>			<b>6</b>	<b>242</b>
Totals	62	276	121	213	124	25	15	6	882

Of the 217 trees planted in 2000, 73 produced fruit and were evaluated this year. Three seedlings show some promise and have been grafted onto Duke7 rootstock for further evaluation. A fourth seedling tested very high in percent dry weight at 35, 12% on 1/5/04. Thinking this was a mistake, it was retested on 3/1/04 and came in at 42.64%! This may well be a very early maturing variety as such is being watched closely for the upcoming season.

In the second approach we have taken the more traditional approach of Dr. Bergh by establishing isolation plots in various locations. Table 2 lists the location, year established and selections in each isolation block. The potential parents were selected under consultation with Dr. Bergh. A total of 433 seed were collected for germination from the isolation blocks including the first group of seeds from the Nakamura site in 2004.

Table 2. Isolation blocks established in 1999 – 2001.

Parents	Year established	Location
GEM x Marvel	1999 (topwork)	UC, Riverside
GEM x Thille	1999 (topwork)	UC, Riverside
Gwen x Sir Prize	2000 (topwork)	UC, Riverside
Gwen x Gwen	2001 (clonal tree)	Nakamura, Ventura Co.
Lamb x GEM	2001 (clonal tree)	Nakamura, Ventura Co.
Lamb x Nobel	2001 (clonal tree)	Nakamura, Ventura Co.
Lamb x Thille	2001 (clonal tree)	Nakamura, Ventura Co.
Lamb x Reed	2001 (clonal tree)	Nakamura, Ventura Co.
Stewart x Reed	2001 (clonal tree)	Nakamura, Ventura Co.

**Sunblotch Viroid indexing.** One hundred forty six trees at the UC-SCREC were tested for the sunblotch viroid between October 1, 2003 and September 30, 2004. Of these trees, 3 tested positive for the Sunblotch Viroid and have been removed. Two of the positive trees were in field 46 and represent our continuing effort to eliminate sunblotch from that field. One positive tree was found in field 44. This is the first positive tree in that field and it was removed immediately.

All surrounding trees were tested but all were negative. Current plans are to retest the adjacent trees again in 2005 to make sure the viroid has been eliminated from this field.

**B. To collaborate with other researchers worldwide in evaluating and exchanging promising plant material.**

**Introduction of new germplasm.** We have continued to plant out new varieties as they come out of quarantine. Last year's release of Ardith (re-introduced from Israel) and the VC series of Israeli rootstocks has gone well as all of the trees are established in the field at the UC South Coast REC. Trees from the VC series were provided to Dr. Menge for field testing.

The next scheduled release of quarantine trees will be in the spring of '05 when the two Andes selections and Puebla will be available for planting out. The Andes selections are believed to be seedlings or budsports of Hass and were selected in Chile by the Andes Nursery Association. This material came to California under a test agreement. Once the trees are released from quarantine we plan to plant out a limited number of trees for evaluation at South Coast Research and Extension Center. The Puebla, which is a heritage variety originating in California was brought back to California in 2002 from the germplasm collection of the Catholic University of Valpariso, Chile. With the aid of Dr. Ben Ya'acov, who confirmed the identity of the variety in Chile, we elected to bring this variety back to California for placement in the variety collection. Other Puebla trees in California are of uncertain identity and this introduction will aid us in identifying Puebla trees growing throughout southern California. The planting of this material may need to take place in fall of '05 as they will most likely require a hardening off period in the UCR lathhouses before they can be planted into field 44.

Finally, two additional varieties of interest have been brought in from Chile from the Andes Nursery Association (A.N.A.). This material arrived in September of 2004 and is now in quarantine for two years.

**C. To collaborate with Dr. Menge (Dept. of Plant Pathology, UCR), and Dr. Crowley on rootstock selection and evaluation for both root rot resistance and salinity tolerance.**

As of July 2003 we discontinued the two clonal rootstock trials planted in 1986 and 1988 respectively. We planted a new clonal rootstock trial at UC SCREC with Dr. Menge in spring 1999 and collected a third year of yield data from this plot in spring 2004. The 'Hass' and the 'Lamb Hass' are included in this trial on selected clonal rootstocks ('Hass' on Day, Duke7, Dusa, Evstro, G755A, Parida, PP4, Spencer, Thomas, Toro Canyon; 20 replicates 'Lamb Hass' on Day, Duke 7, Evstro, Thomas, Toro Canyon; 20 replicates).

We continue to collaborate with Dr. Crowley in his salinity research whenever possible and have assisted in the evaluation of a salinity/*Phytophthora* rootstock trial established in Santa Barbara using rootstocks from Dr. Menge's program, South Africa and Israel.

**D. Evaluate the potential of new and established cultivars (B flower types) for use as pollinizers in collaboration with Dr. Ben Faber; assist Dr. Mike Clegg on coordination of pollinizer research plots as requested.**

In conjunction with Ben Faber we established a pollinizer site in Ventura County (Oxnard) in spring 1999. We are using funding from BARD (a collaborative effort with Drs. Arnon Dag and Sharoni Shafir (Israel) and Dr. Tom Davenport (University of Florida)) to collect floral data as well at this site as well as 2 other sites. Below we have included a progress report of both our CAC and BARD funded efforts. Dr. Loretta Bates oversaw the field research efforts for the 2004 season. In late March 2004, Dr. Gad Ish-Am visited the research sites and discussed avocado flowering with Arpaia, Davenport and Bates.

The 2004 research was conducted at three sites in Ventura County California from April through June 2004. Two sites are located on the flat coastal plain south of Camarillo, California and the third site is northeast of the city of Santa Paula, California on the lower south-facing slopes of the coastal mountains. The two coastal sites were in commercial groves of Mr. Paul DeBusschere. The southern site is the location of the pollinizer trial and the site 3 miles north is the location of the variety trial (yield reported in Figure 3). The pollinizer site was designed as a complete randomized block design to examine proximity effects of various pollinizers on 'Hass' productivity under commercial conditions. There are six replicated blocks. Each block consists of 25 rows of 20 trees. Each row is split into 2 subsamples of 10 trees. There is a pollinizer variety interplanted with the Hass every 6<sup>th</sup> row. Each subsample has a different pollinizer variety interplanted with 'Hass'. The 'Hass' trees are spaced in 2 blocks, 25 ft x 17 ft. In the remaining 4 blocks the trees are spaced 25 ft x 12.5 ft. We have 10 pollinizer trees per subsample. The variety site was originally planted as a completely randomized block design to evaluate new cultivar varieties from the UC Scion Breeding Program. The trees were planted in 1996. All trees are grafted on clonal Duke 7 rootstock. Due to flooding shortly after the planting of this trial, there are a mixed number of replications. There are 5 to 6 replications per variety. The inland site is in the commercial groves of Mr. Logan Hardison (~25 miles inland). The inland site is a high density commercial planting with pollinizer rows intermixed with 'Hass'.

Temperature and humidity data were collected continuously through the months of April and May by remote sensors in weather stations at each site. Tree flowering phases and flowering stages of individual flowers were observed in the following avocado varieties, Hass, Lamb Hass, Ettinger, Fuerte, Zutano, Bacon, Harvest, Gem, SirPrize, BL516 (Marvel) and BL667 (Nobel).

Observations of tree flowering phases were made April 13-15, April 21-23 and April 28-30, 2004 at the DeBusschere south site and the Hardison site. Observations of flowering stages of individual flowers were recorded May 5-7, May 12-14, and May 19-21, 2004 at both of the coastal sites.

For tree flowering phases, observations were made approximately every hour on three randomly selected trees of each variety. On each tree, a minimum of fifteen flowers on each of three inflorescences on the north side and on the south side were examined. The flower stages were recorded according to the method of Ish-Am and Eisikowitch (1991; New insight into avocado flowering in relation to its pollination, Calif. Avocado Soc. Yrbk. 75:125-137).

To characterize the daily sequence of flowering stages of individual flowers, inflorescences were labeled and flagged on randomly selected trees of each variety. As flowers opened as female, they were marked with colored ink indicating the order of initial opening. Observations were made approximately once each hour for each flower on each measurement day. For each measurement period of 2-3 days, observations were made on 15 to 25 flowers per cultivar.

One goal of the 2004 study was to collect data at a wide range of temperatures, both day and night. Except for two abnormally hot periods, the temperatures at all sites were cool (less than 25°C maximum) on most of the measurement days during April and May of 2004. The coastal plain sites were especially cool and humid, characterized by a daily pattern of morning fog or heavy dew followed by late morning sun. The upland Hardison site was somewhat warmer and drier. Both sites experienced strong on-shore winds commencing by mid-day and continuing until near sundown on most days.

As a result of the cool humid weather, the flowers typically remained open in the morning from the previous day or night or opened after fog lifted, usually by mid-morning. In the early morning, Type A flowers such as Hass, Harvest and Lamb-Hass were often completing male floral stages from the previous day. Flowers opened as females in the afternoon and frequently, they had not yet opened as males by sundown. In Type B flowers (SirPrize, Fuerte, Zutano, Ettinger, BL516, BL667, and Bacon) it was common to see flowers open only as males during the day hours, with flowers opening as females near sundown (or later).

For type B flowers tagged as females on day 1 of a measurement period, opening as males did not occur on day 2 but rather in the morning of day 3 of the measurement period. Type A flowers tagged as females did open as males the following day, although sometimes very late and as mentioned previously, sometimes completing the male stages on the morning of day 3.

The time of opening of Type A flowers as females and Type B flowers as males may be correlated with the minimum temperature of the previous night (correlation coefficient -0.7553 for pooled Type A and Type B data). Data analysis is continuing which should allow a more definitive statement of that correlation.

Table 3 gives examples of tree phases observed on a cool day (April 23; maximum temp, 20.2°C; minimum temp, 7.4°C) at the south DeBusschere site and on the warmest day (April 30; maximum temp, 29.9°C; minimum temp, 11.7°C) at the Hardison site for the varieties Harvest (Type A) and BL516 (Type B).

Table 3. Flowering behavior of 'Harvest' (A floral type) and 'BL516' (B floral type) under			
<u>Harvest</u>		<u>BL516</u>	
<i>Cool</i>	<i>Warm</i>	<i>Cool</i>	<i>Warm</i>
D4*	D1*, D2*, D3*, D4	B1*	B3*, C, D1, D2
E	B1, B2	B1*, B2*, B3*, D1	D1, D2
B1	B2, B3	D1, D2	D1, D2, D3
B1, B2	B3, C, D1, D2	D1, D2, D3	D2, D3
B1, B2, B3	D1, D2, D3, D4	D1, D2, D3, D4	D4
B3, C, D1	D1, D2, D3, D4	D2, D3, D4	B1, D4
B3, D1, D2	D2, D3, D4	B1, D4	B1, B2, D4
D1, D2, D3, D4			B1, B2, B3
			B2, B3
			B3, C

\*Stages from previous day.

Analysis of the floral data is continuing and will include additional analyses of the correlations between floral stages and temperature averages, maxima and minima. In addition to the analysis of floral biology observations for 2004, HPLC analysis of sugars in honey collected during the 2003 flowering season is continuing.

We harvested the DeBusschere Pollinizer plot April 13-15, 2004 for yield. Figure 7 presents the data for 2004. The yield this year was very heavy from the plot, averaging 220 fruit per tree. The 4-year cumulative fruit count for the trial is presented in Figure 8. As both figures demonstrate, proximity to a pollinizer at this site continues to influence yield. This effect was especially dramatic this year (Figure 7).

The ‘SirPrize’, a variety released by UC in the mid 1990’s has surpassed the other pollinizers in terms of yield. We are monitoring the SirPrize more closely this year to collect better data on its bloom phenology in relation to the ‘Hass’. As part of Dr. Gad Ish-Am’s March 2004 visit, we spent time in the field examining the flowering phases of the ‘SirPrize’ as well as the other varieties. We noted in March, that this variety had abnormal pistils on the majority of the flowers. We are monitoring this further. This may account for the “erratic” bearing habit of the ‘SirPrize’.

The DeBusschere plot is bordered by a hedge of eucalyptus trees on the east and west sides of the field and between rows 24 and 26 there is a Lombardi poplar wind break. These windbreaks have a negative impact on tree yield and vigor. Figure 9 shows the impact of these windbreaks on average yield of ‘Hass’ trees. In order to calculate this data we calculated the average fruit count for each row (12 means per row for non-pollinizer rows and 24 means per row for pollinizer rows).

Figure 10 illustrates the relative size of the pollinizer trees to their companion ‘Hass’ trees in April 2004. Many of the pollinizer trees were as tall as or taller than the nearby ‘Hass’ trees so in Fall 2003, these trees were topped to approximately 6 to 8 feet.

Table 4. Average ‘Hass’ dry weight, fruit length/width ratio and seed length/width ratio harvested from pollinizer rows. Mean separation by LSD, P< 0.05.			
Pollinizer	Dry weight (%)	Fruit length/width ratio	Seed length/width ratio
Bacon	25.34 ab	1.39	1.13 bc
BL516 (Marvel)	24.45 c	1.40	1.14 bc
BL667 (Nobel)	26.20 a	1.43	1.15 abc
Ettinger	25.30 abc	1.37	1.11 c
Fuerte	24.80 bc	1.39	1.19 a
Harvest	24.95 bc	1.45	1.18 ab
Sirprize	24.94 bc	1.37	1.15 bc
Zutano	26.08 a	1.37	1.11 c
Significance	0.05	ns	0.05



At the time of the fruit harvest, we collected 8 ‘Hass’ fruit (6.77 oz average size) from each pollinizer row (6 replications). Dry weight was determined on each fruit. We also measured the length and width of fruit from 3 of the replications. Table 4 presents these results. Note that there were significant differences in both dry weight and the seed length/width ratio due to pollinizer. The ‘Hass’ fruit that was harvested from the ‘BL667’ and ‘Zutano’ rows had significantly higher dry matter than fruit harvested from the ‘Harvest’, ‘Sirprize’, ‘Fuerte’ and ‘BL516’ rows. We were not able to detect any significant effects on fruit shape as measured by the length/width ratio due to the pollinizer variety. We found, however, that there were slight but significant differences due to pollinizer variety on the length/width ratio of the seeds. ‘Hass’ fruit from the ‘Fuerte’ and ‘Harvest’ rows had slightly more elongated seeds as compared to seeds from the ‘Zutano’ and ‘Ettinger’ rows. We plan to do more in-depth sampling this coming fruit season to verify these observations.

**E. To maintain and improve the CAS variety block and the *Persea* germplasm block located at the UC South Coast Research and Extension Center.**

An accurate plot map has been generated for the CAS Variety Block at UC-SCREC. Any changes to the planting are being recorded in the master database maintained by David Stottlemeyer. The UC-SCREC avocado volunteers have been instrumental in maintaining this block. The volunteers graft several new and/or historical varieties on an on-going basis. Fields 44 and 46 have been maintained and kept in order through regular pruning and constant observation by both the lab personnel and the volunteer staff. In addition, the sprinkler lines in field 46 have been replaced and updated in coordination w/the SCREC personnel.

**F. To insure the timely and effective dissemination of information developed from this research program.**

The current avocado web site at: [www.ucavo.ucr.edu](http://www.ucavo.ucr.edu) has been on-line since June 1998. The site is periodically revised and updated with new information and photographs of different varieties. Questions sent via e-mail or forwarded from the California Avocado Commission are answered on an ongoing basis.

Figure 1. Variety trial yield data (average fruit count per tree) collected from Field 4 at the UC South Coast Research and Extension Center in Irvine, CA from 1999 – 2004. Trees were topworked onto seedling rootstock in 1994 – 1996. Harvest for the selections denoted with a “\*” is incomplete as of September.

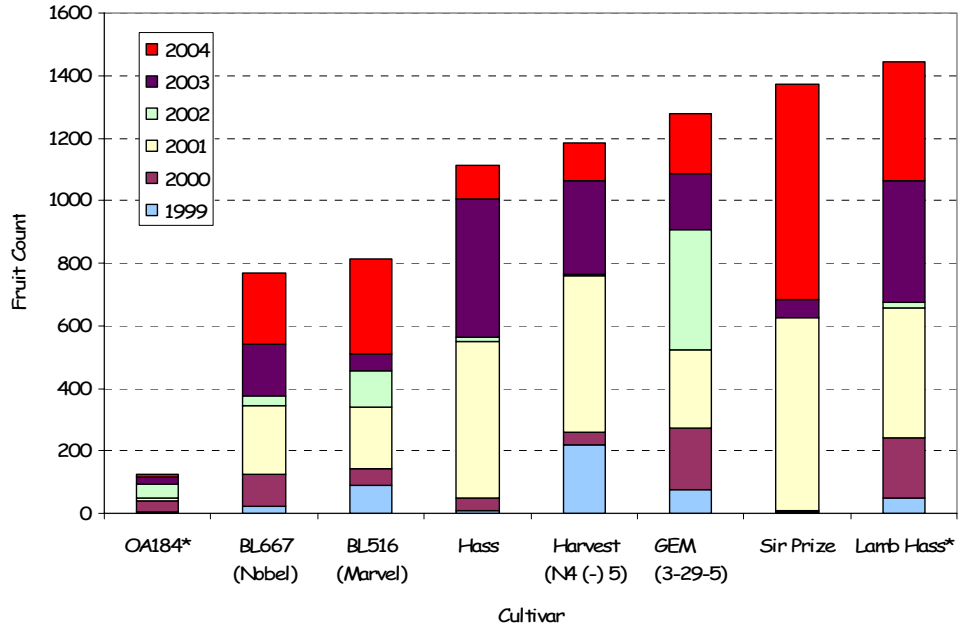


Figure 2. The Coefficient of Variation (%) in yield (fruit number) for each variety from Field 4 at the UC South Coast Research and Extension Center in Irvine, CA from 1999 – 2004.

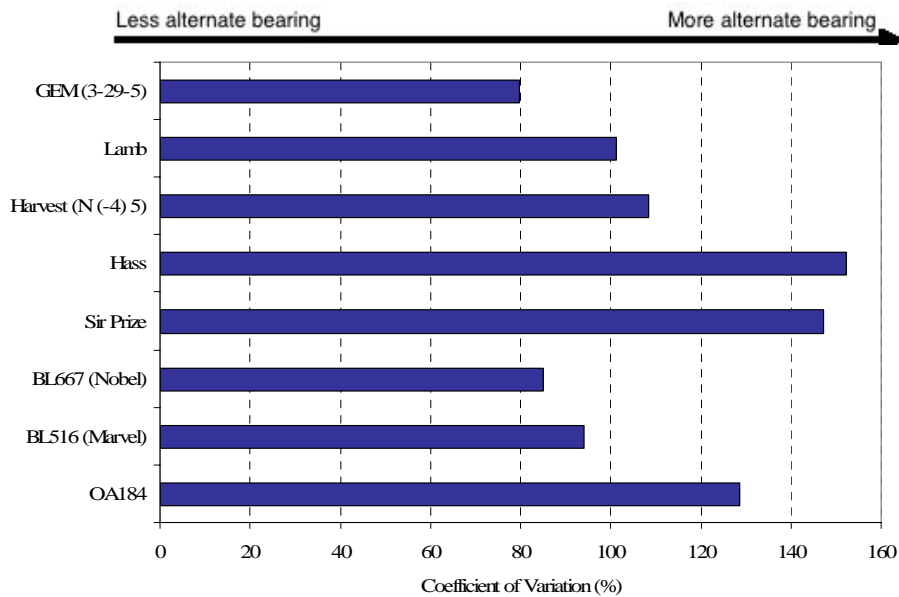


Figure 3. Variety trial yield data (average fruit count per tree) collected from DeBusschere Ranch, Oxnard, CA for 2001 – 2004. Trees were planted on clonal Duke 7 rootstock in 1996.

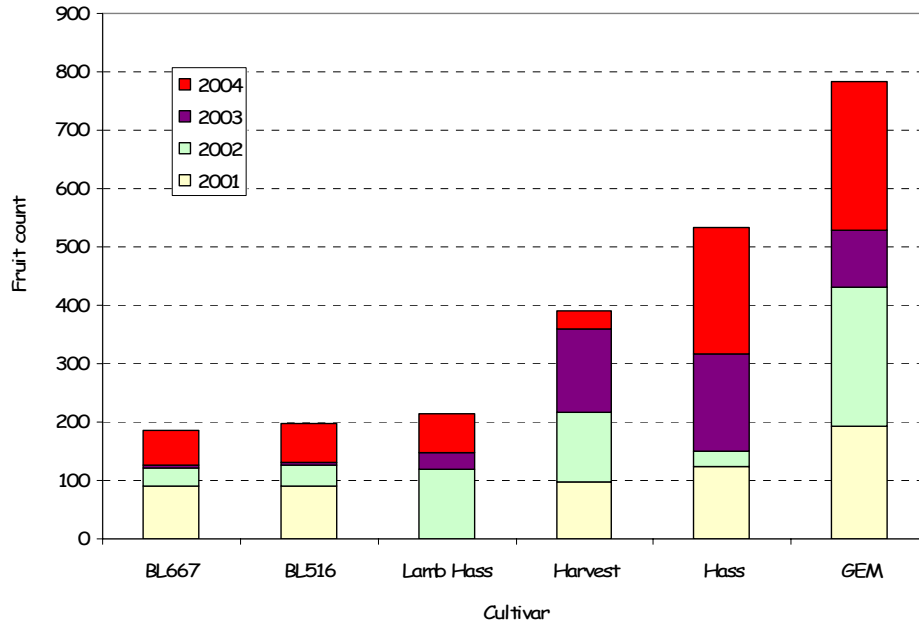


Figure 4. Variety trial yield data (average fruit count per tree) collected from Pine Tree Ranch in Santa Paula, CA for 2001 – 2004. Trees were topworked onto seedling rootstock in 1998.

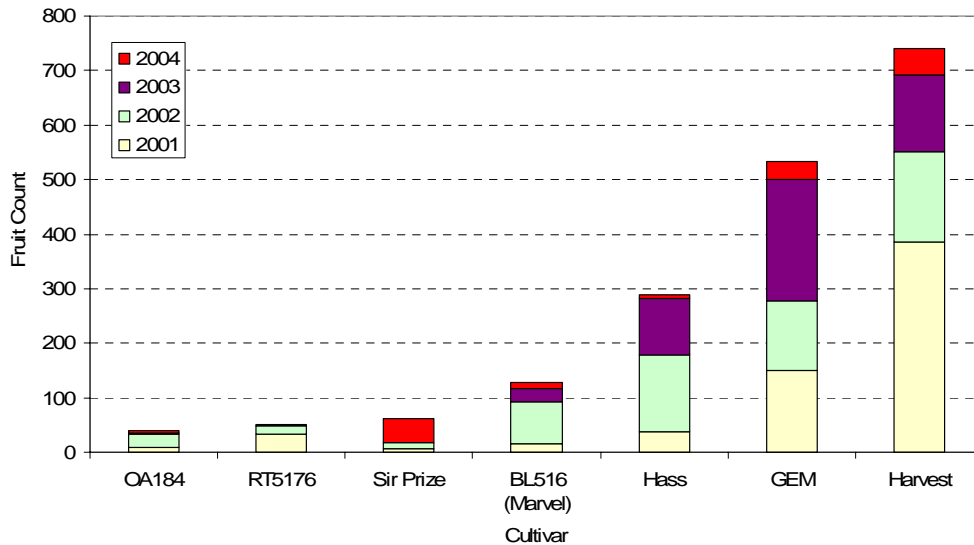


Figure 5. Variety trial yield data (average fruit count per tree) collected from Righetti Ranch in San Luis Obispo, CA for 2001 – 2004. Trees were topworked onto seedling rootstock in 1998 - 99.

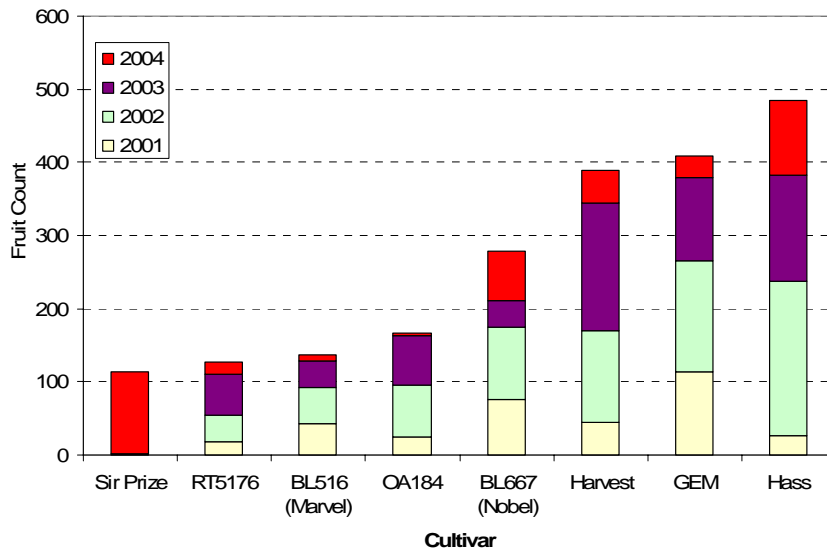


Figure 6. Comparison of average bloom dates for two years for all varieties from February through May at the UC South Coast Research and Extension Center, Irvine, CA.

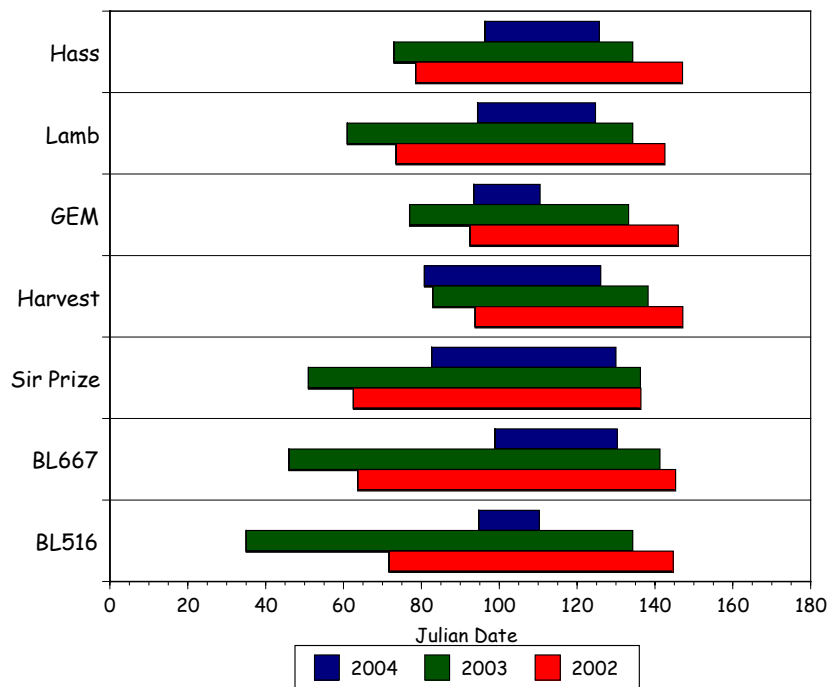


Figure 7. ‘Hass’ yield (fruit count) from the DeBusschere pollinizer trial in Oxnard in 2004 as influenced by pollinizer variety and distance from the pollinizer.

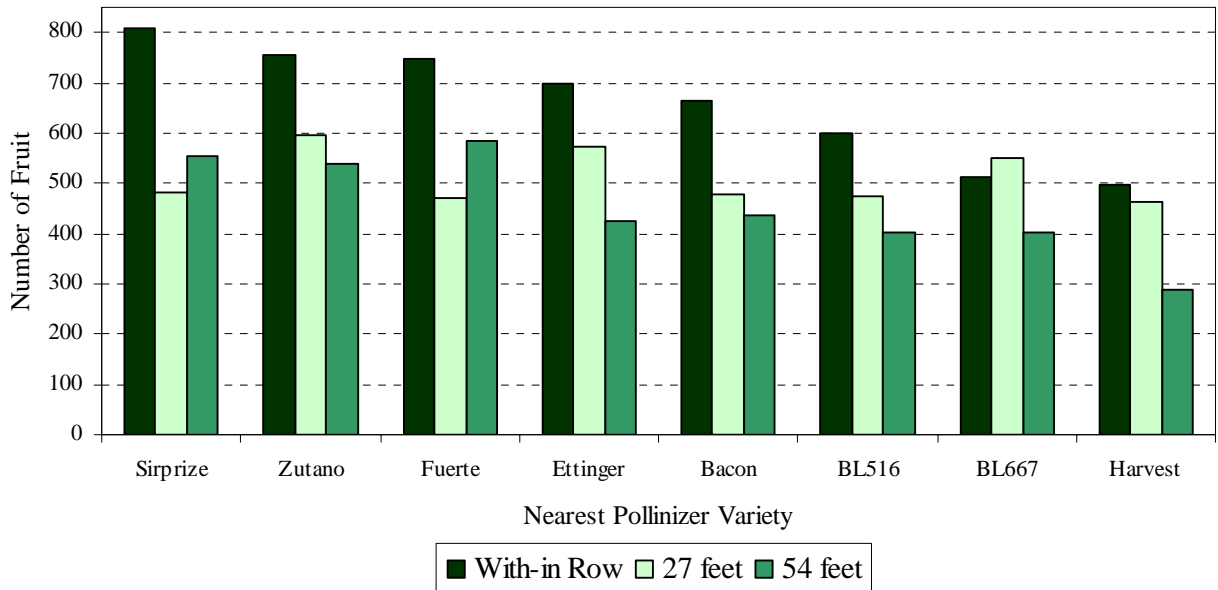


Figure 8. Cumulative ‘Hass’ fruit counts (2001 – 2004) from the DeBusschere pollinizer trial in Oxnard as influenced by pollinizer variety and distance from the pollinizer.

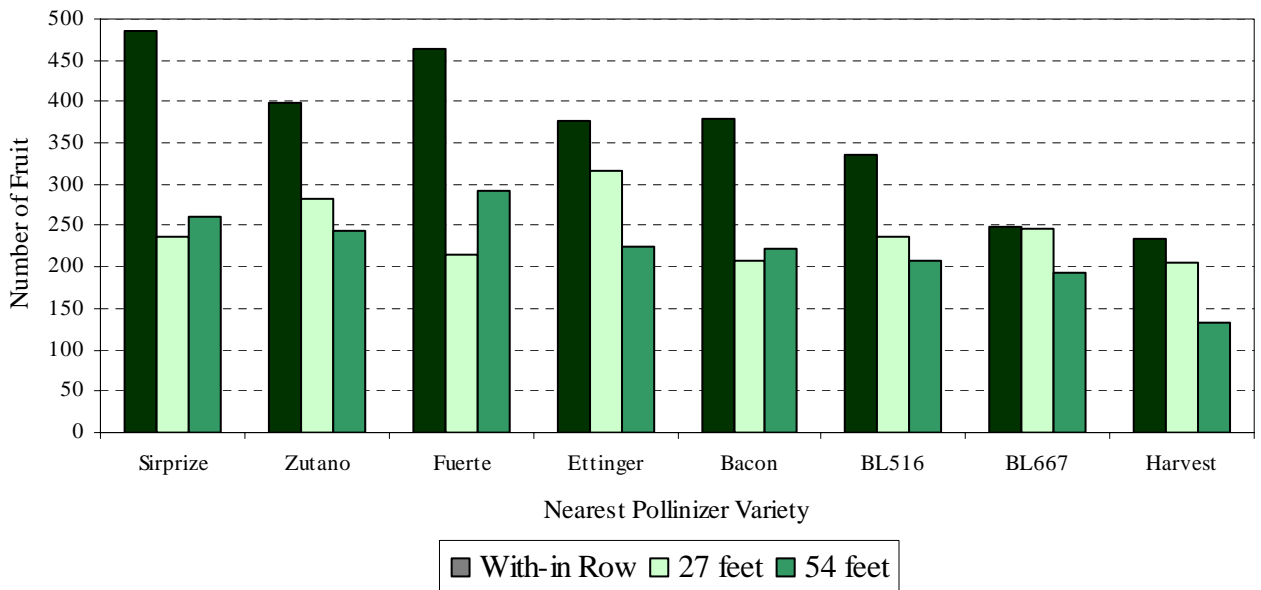
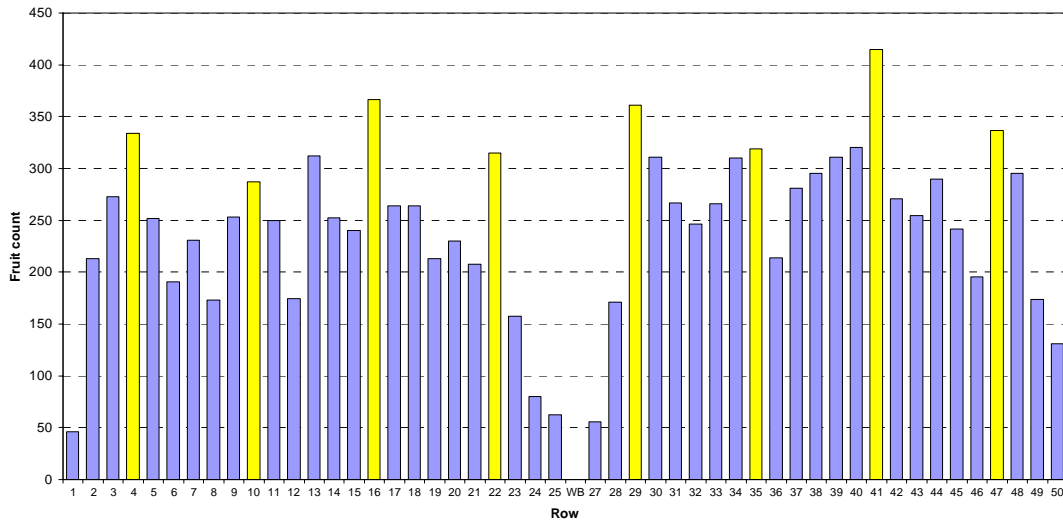


Figure 9. The impact of windbreaks and pollinizers on 'Hass' fruit counts for the April 2004 harvest at the DeBusschere Pollinizer Plot in Oxnard, CA. (Yellow bars are fruit counts for 'Hass' in the pollinizer rows and are the means for 6 replications.)

**Figure 3. The impact of windbreaks and pollinizers on 'Hass' fruit counts for the April 2004 harvest of the DeBusschere Pollinizer Plot in Oxnard, California. (Yellow bars are fruit counts for 'Hass' in the pollinizer rows)**



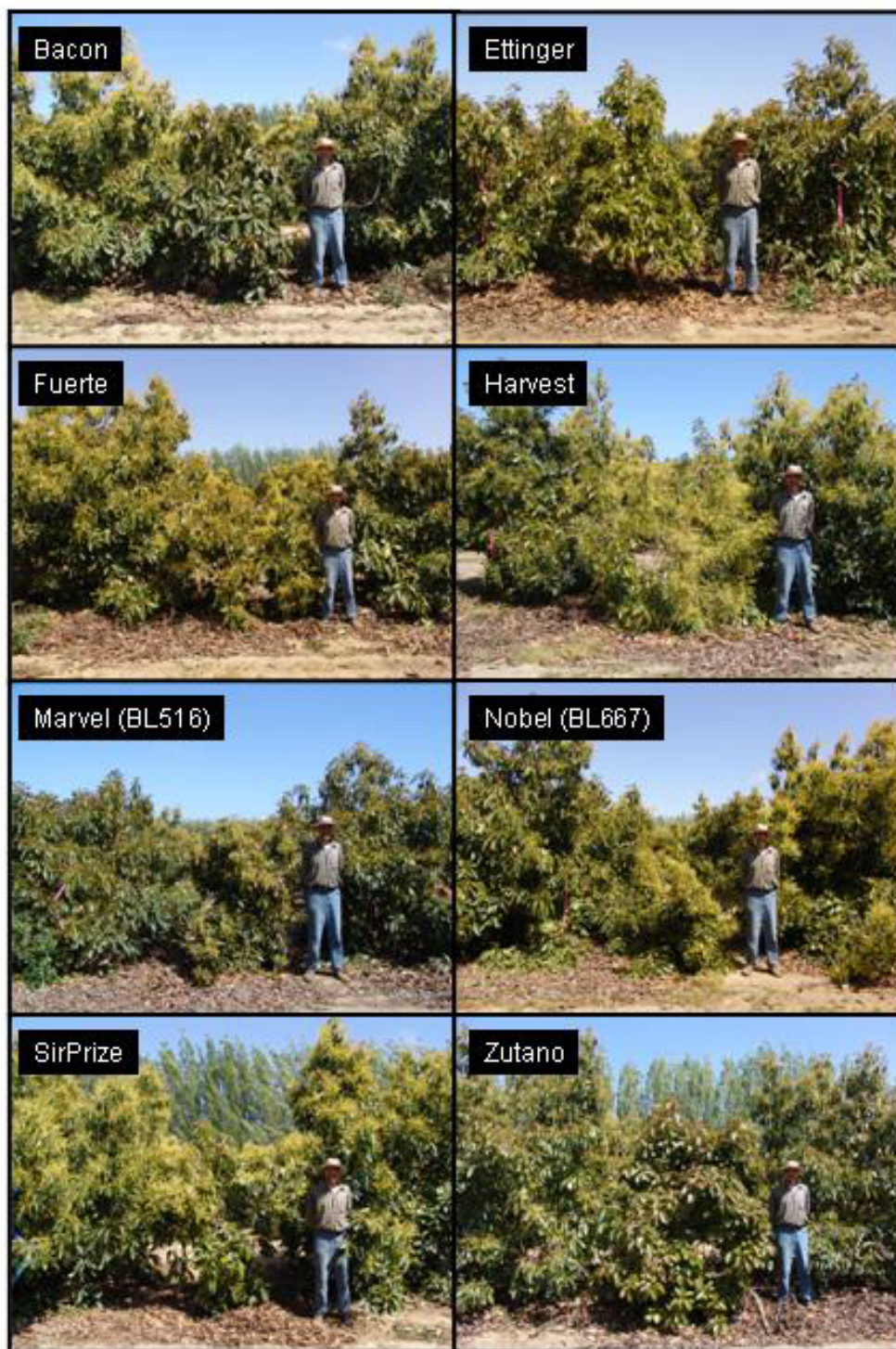


Figure 10. Relative size of pollinizer varieties to ‘Hass’ trees at the DeBusschere Pollinizer Plot in Oxnard, CA. Photos taken in April 2004. Trees of all pollinizers, with the exception of ‘Marvel’ and ‘Nobel’ were topped in Fall 2003.