

Enhancement of Avocado Productivity Plant Improvement – Selection and Evaluation of Improved Varieties and Rootstocks

Continuing Project; Year 6 of 20

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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. During the last year we have installed data loggers to monitor air and soil temperature and relative humidity at all sites.

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', 'SirPrize', 'RT5176', 'OA184', 'Marvel', 'Hass'; 10 replicates

De Luz (San Diego County); topworked in 1998; 'Lamb Hass', 'SirPrize', 'GEM', 'OA184', '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', 'SirPrize', 'GEM', 'Harvest', 'OA184'; 9 replicates

Clonal trials at Non-UC Sites

Oxnard (Ventura County); planted in 1996; 'Lamb Hass', 'SirPrize', 'GEM', 'OA184', 'Marvel', 'Nobel', 'Hass', 'Harvest'. (Originally known as the Newman Ranch site. 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)

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); 'SirPrize' '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.

Yield data from Bergh/Martin selections. We have collected yield data for the fourth year from Field 4 at UC-SCREC (UC South Coast Research and Extension Center). Data collection for 2002 shows that for most varieties, this was an 'off' year (Figure 1). The 'GEM' at this point has the largest cumulative yield over the four year period. It also shows less alternate bearing tendencies than some of the other varieties. We have also collected the second year of yield data from the Santa Paula and Oxnard sites in Ventura County, the Righetti site near San Luis Obispo, and the De Luz site in San Diego County (Oxnard site, Figure 2; Santa Paula site, Figure 3; San Luis Obispo site, Figure 4). We were unable to collect a complete set of data from the San Joaquin Valley variety trials this season due to excessive fruit drop in some varieties following a multiple day cold spell in late January. The variety most affected and which dropped in excess of 90% of its fruit at the Lindcove site was 'Harvest' even though minimal foliar and stem damage was observed. We will continue to monitor these sites for relative cold and heat tolerance.

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. Figure 5 presents the trends in dry weight for the 'GEM' at the San Luis Obispo site. Similar trends were observed at the other 6 sampling sites (Irvine, Riverside, Santa Paula, Oxnard and De Luz). The general pattern for dry weight accumulations for each variety in 2002 is consistent with the 2000 and 2001 data presented last year. A comparison between dry weight accumulations between three maturity seasons for the 'GEM' variety is presented in Figure 6. This data is from the San Luis Obispo site. All three seasons show the same general trends.

Bloom evaluation of Bergh/Martin selections. The bloom of spring 2002 was evaluated on the trees in the unreleased variety block at SCREC. This is the first 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. Figures 6 – 11 illustrate the relative timing and bloom intensity of the new material as compared to ‘Hass’. We observed in this first year that the ‘Nobel’ and ‘Marvel’ (Figures 7, 8) had somewhat similar timing to ‘Hass’ as did the ‘Lamb Hass’ (Figure 11). ‘GEM’ (Figure 9) and ‘Harvest’ (Figure 10) have a slightly later bloom period than ‘Hass’.

Release of Bergh/Martin selections. The UC Office of Technology Transfer has filed patents for two of the Bergh/Martin selections, ‘GEM’ and ‘Harvest’. The decision to move forward with patenting for these 2 selections differed for each. We believe that ‘GEM’ has commercial potential for the California industry and wish to make this selection more widely available to growers. The ‘Harvest’, on the other hand, had been given by G. Martin to researchers in both Spain and South Africa where there is interest in the variety from a commercial perspective. While we are not certain about the selection’s commercial potential for California, we were advised by UC-OTT to move ahead with patenting of the selection. We anticipate that the patenting process will be completed in 2003.

Component 2. New Material for the Breeding Program

We continue the re-activation of the breeding program. We are taking 2 approaches towards generating new material. These approaches are the outcome of discussions with B. O. Bergh, U. Lavi (Avocado breeder, Volcani Institute, Israel) and more recently 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. An additional 180 open pollinated seedlings are currently being transplanted into sleeves at SCREC to be planted in the field in spring 2003. Table 1 shows the maternal parents of the current seedling population planted at SCREC. Interestingly, we had 1 seedling flower and set fruit in 2001, only 1 year from planting. The maternal source of this fruit was ‘Nobel’ (BL667). Although the fruit quality is not acceptable (extremely large seed), these results are encouraging since we know that we have germplasm for the breeding program that is very precocious.

Table 1. Open pollinated seedlings from varying maternal sources planted at the UC South Coast Research and Extension Center in 2000 and 2002.

Year Planted	Maternal Parent						Total Planted
	5-552	Marvel	Nobel	GEM	Gwen	Lamb	
2000	32	90	37	39	14	5	217
2002		75	51	91		20	237
Totals	32	165	88	130	14	25	454

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. The first seeds from an isolation block (GEM x Thille) at UCR were collected this year and are being germinated at SCREC for planting in either 2003 or 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 SirPrize	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. Seventy-two trees at the South Coast Research and Extension Center have been tested for the sunblotch viroid since September 1, 2001. All have tested negative for the viroid. One tree at the Pine Tree variety trial tested positive for the sunblotch viroid. This tree has been removed. All the trees in field 4 at UC SCREC have been sampled and have tested negative for the sunblotch viroid.

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

Introduction of new germplasm. In May 1999 D. Stottlemyer, T. Chao and M. L. Arpaia visited Israel. One of our objectives was to visit with Dr. A. Ben-Ya'acov to review the status of the various rootstock selections, which he had made over the years. In May 1999 M. L. Arpaia brought material from 5 selections plus budwood of the 'Ardith' and the 'Galil'. The 'Ardith' is already in CA and is actually a selection from Dr. Bergh which has been commercialized in Israel. The purpose of this introduction was to confirm trait characteristics of the tree currently in the avocado variety collection at UC SCREC. M. L. Arpaia revisited Dr. Ben-Ya'acov in March 2000 and obtained additional material. Budwood from the 5 selections obtained in May 1999 was also once again acquired. The majority of this material is rootstock selections. Some of the material is known to be tolerant to root rot. This material is will also be evaluated by Dr. John Menge's program. A number of the rootstocks, while having no known root rot tolerance, were selected based on Dr. Ben Ya'acov's recommendation due to salinity tolerance, poor drainage tolerance or other characteristics. We tested this material for the presence or absence of sunblotch when the material entered quarantine. Unfortunately, one selection, VC49 (introduced in 3/00), tested positive and was subsequently destroyed. The remaining material is currently in quarantine at UC, Riverside and is scheduled to be released for propagation and subsequent testing during 2003 year. Table 3 lists the material brought to California in 1999 and 2000.

Table 3. Material introduced into California from Israel in 1999 and 2000. Material is from the rootstock selection program of Dr. A. Ben Ya'acov and the scion selection program of Drs. E. Lahav and U. Lavi. The material obtained in 1999 was given to John Menge in June 1999.

VC#	Date of collection
6	April '00
7	April '00
15	April '00
26	April '00
28	April '00
31	April '00
40	<i>June '99, April '00</i>
49	June '99, April '00 (discarded due to sunblotch)
51	April '00
65	June '99, April '00
66	June '99, April '00
75	April '00
802	April '00
803	April '00
804	April '00
817	June '99, April '00
Ardith	June '99
Galil	June '99

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.

In Spring 1998 we topworked trees in the old 'Gwen' rootstock trial to the 'Lamb Hass' variety. This allows us to assess its performance on the following rootstocks: G755A, G755B, G755C, Toro Canyon, Orchard, Duke 7, D9, Thomas, Topa Topa. The first yield data from this trial has been collected in 2001. The "take" in this trial has been mixed but we have successfully established sufficient trees for evaluation. We planted a new clonal rootstock trial at UC SCREC with Dr. Menge in spring 1999. 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). The first yield data was collected during in spring 2002.

We continue to collaborate with Dr. Crowley in his salinity research.

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. The varieties included in this trial are 'Ettinger', 'Fuerte', 'Bacon', 'Zutano', 'Harvest', 'SirPrize', 'Nobel' and 'Marvel'. There are 60 trees of each variety divided into 6 replicates of 10 trees each. The trees in this trial were used in the Avocado Pollination and Bee Biology project headed by Drs. N. Waser and B. Fetscher. The first year of differential yield data was reported by Dr. Fetscher last year and again summarized in Figure 12. We harvested the plot once again in March 2002. The yield data from 2002 is presented in Figure 13. Two things are obvious thus far from this data. First, in 2001, there was a strong influence of pollinizer variety on 'Hass' yield as a function of pollinizer and distance from the pollinizer tree (Figure 12). This effect is not present in the 2002 data but note that the overall production went from an average of 49 fruit per tree in 2001 to 190 fruit per tree in 2002. We also have collected canopy volume data of the 'Hass' trees in the plot and will factor yield in subsequent years as a function of canopy volume, distance from pollinizer and distance from windbreaks (this appears to influence tree size as well).

We continue to discuss with Dr. Clegg ways to incorporate the B flower type selections into an organized research program to evaluate the value of outcrossing and which pollinizers to utilize and to discuss future directions for the breeding program.

E. To assist Drs. Morse and Hoddle on identifying plant material tolerant to *Persea* mite and the avocado thrips.

We continue to discuss periodically with Dr. Hoddle the influence of tree phenology and variety on relative susceptibility to *persea* mite. We assisted Drs. Hoddle and Morse on their thrips studies in 2002 by measuring dry matter content of fruit from trees with differential thrips treatments.

F. 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. Any changes to the planting are being recorded in the master database maintained by David Stottlemeyer. The South Coast REC avocado volunteers have been instrumental in maintaining this block. The volunteers graft several new and/or historical varieties on an ongoing basis.

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

The current avocado web site at: www.ucavo.ucr.edu has been on-line since June 1998. The site has been 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 - 2002. Trees were topworked onto seedling rootstock in 1994 - 1996.

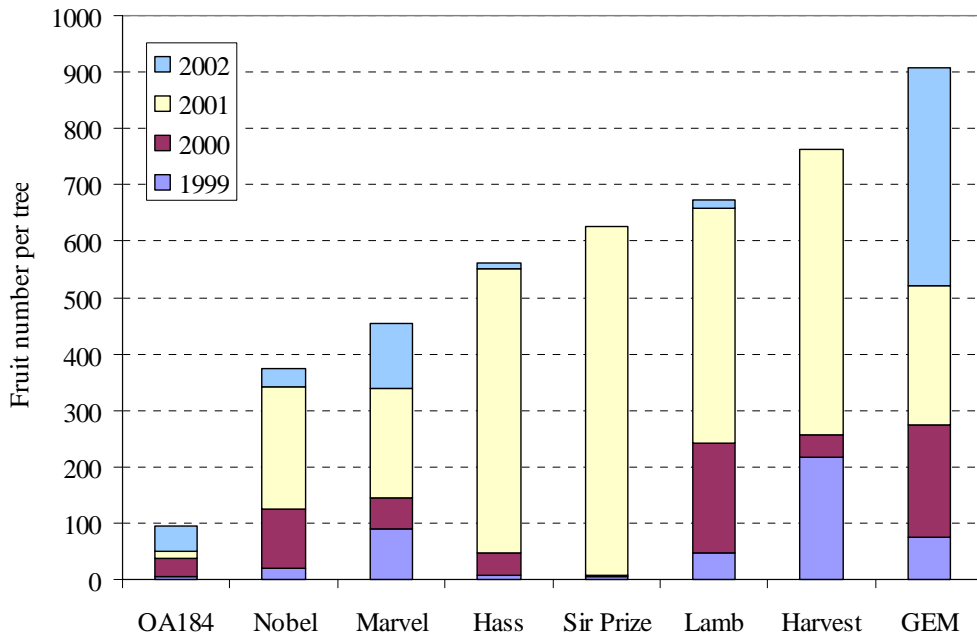


Figure 2. Variety trial yield data (average fruit count per tree) collected from DeBusschere Ranch, Oxnard, CA. Trees were planted on clonal rootstock in 1996.

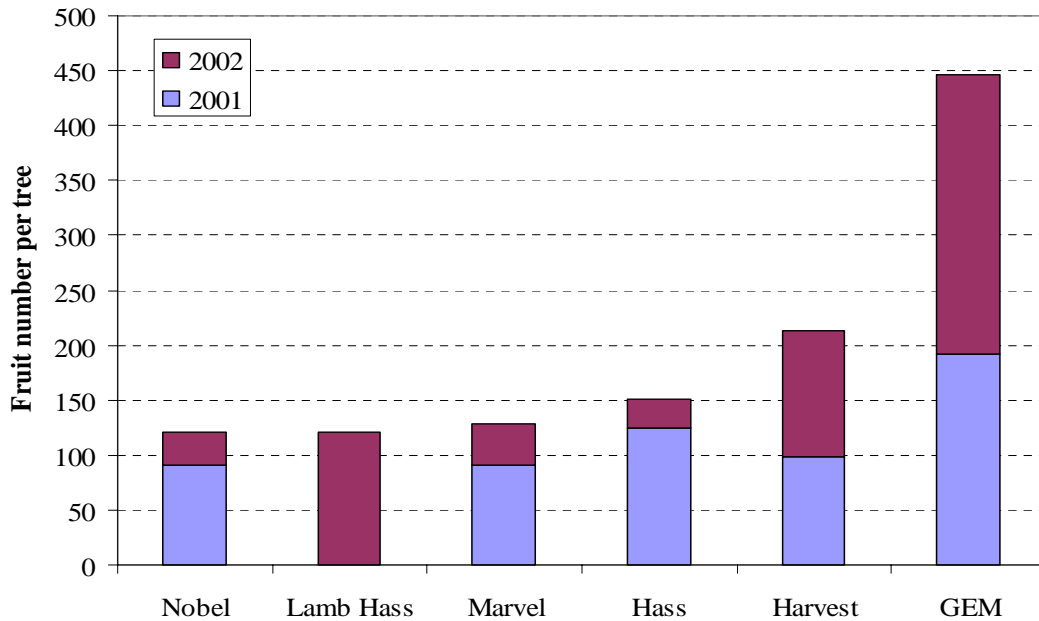


Figure 3. Variety trial yield data (average fruit count per tree) collected from Pine Tree Ranch in Santa Paula, CA for 2001 – 2002. Trees were topworked onto seedling rootstock in 1998.

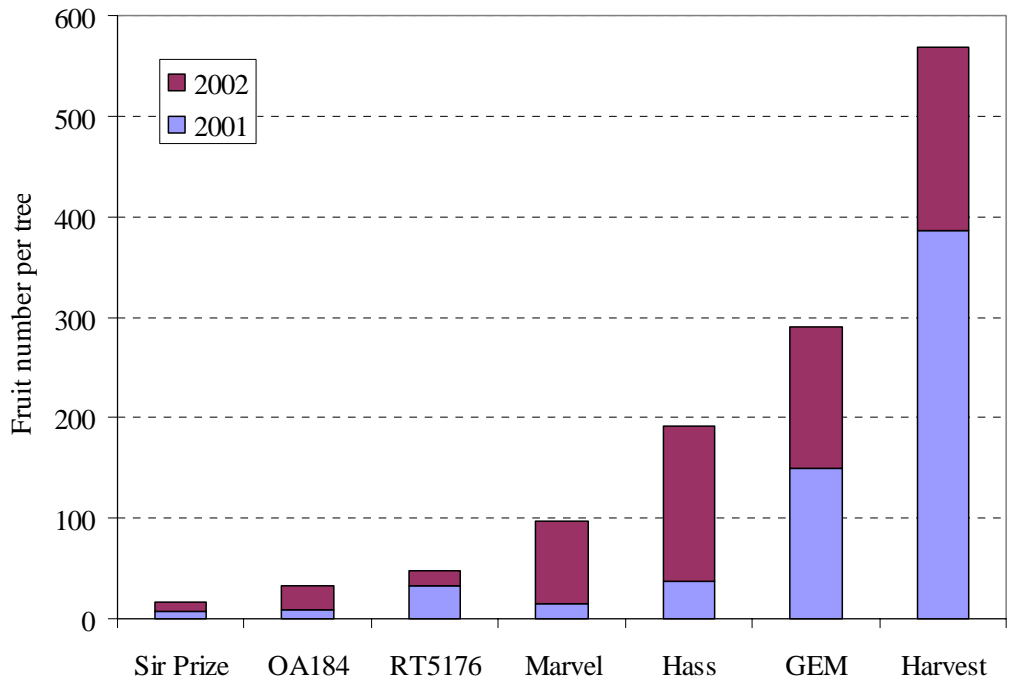


Figure 4. Variety trial yield data (average fruit count per tree) collected from Righetti Ranch in San Luis Obispo, CA for 2001–2002. Trees were topworked onto seedling rootstock in 1998-99.

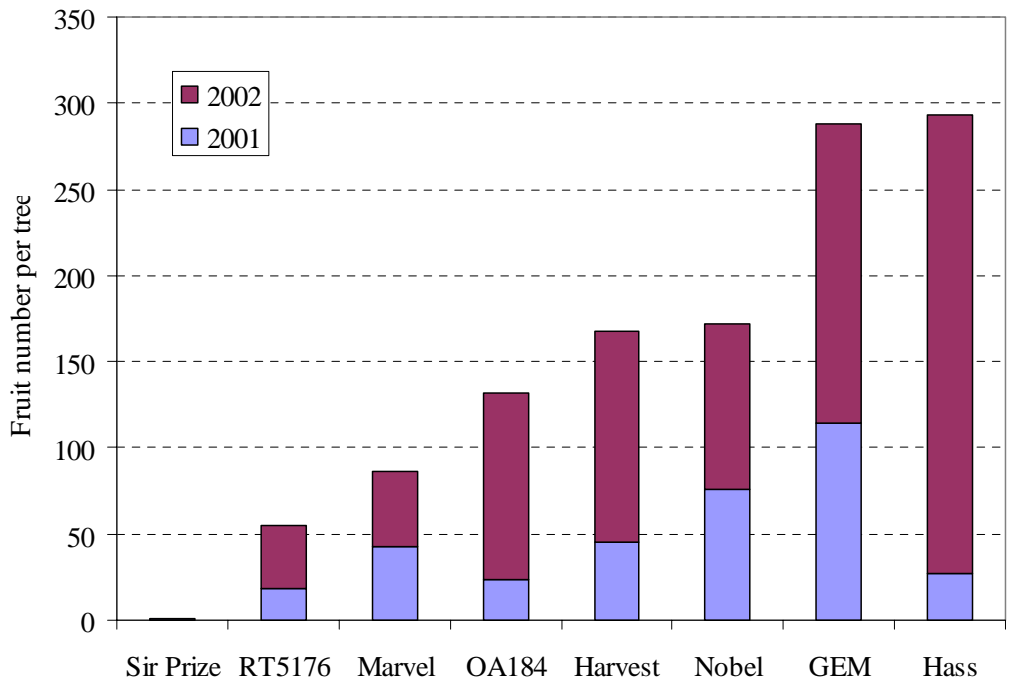


Figure 5. Comparison of changes in dry matter content (%) for 'Hass' and 'GEM' harvested from January 2002 through September 2002 from the Righetti Ranch site near San Luis Obispo.

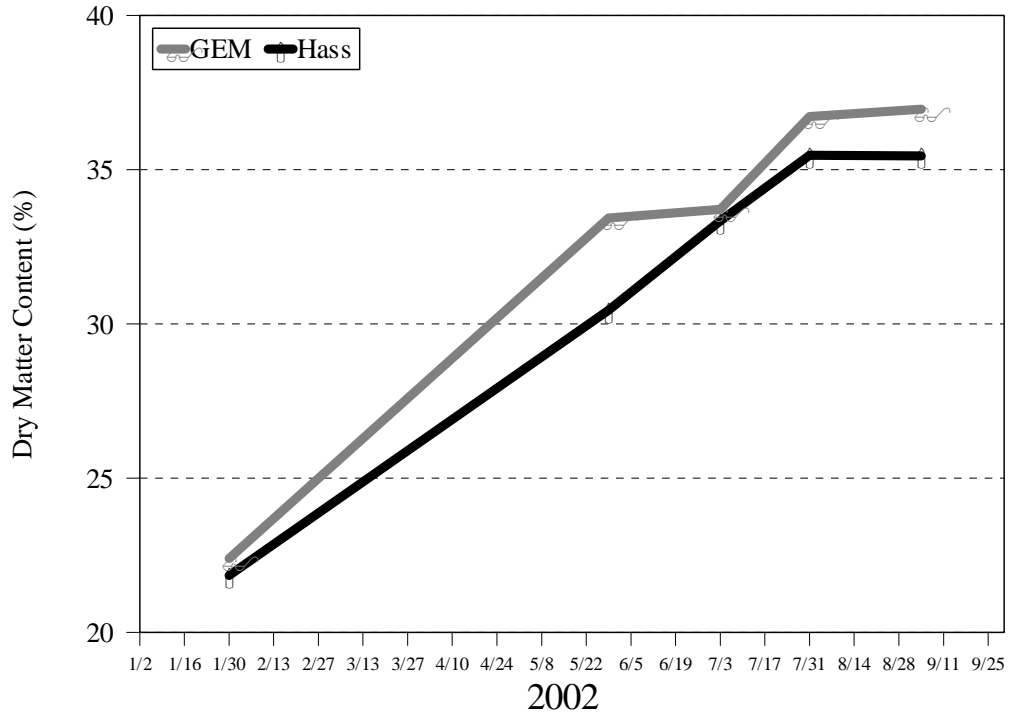


Figure 6. Comparison of changes in dry matter (%) for 'GEM' harvested during the 2000, 2001 and 2002 maturity seasons. Data collected from the Righetti Ranch site near San Luis Obispo.

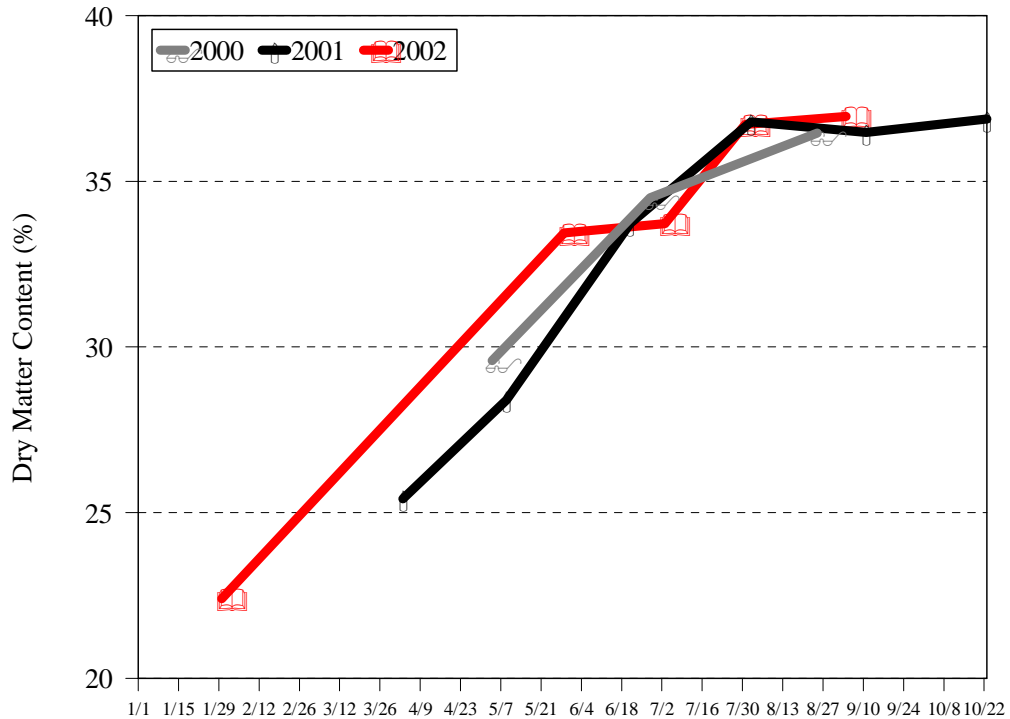


Figure 7. Comparison of percent bloom for 'Hass' and 'Nobel' from February through May 2002 at the UC South Coast Research and Extension Center, Irvine, Ca.

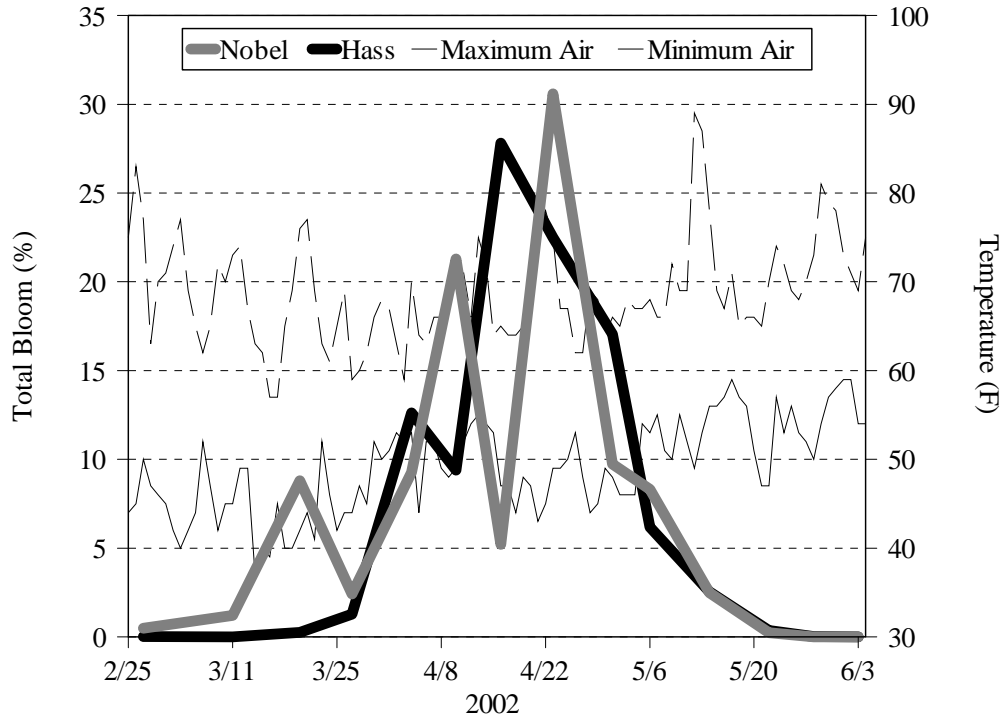


Figure 8. Comparison of percent bloom for 'Hass' and 'Marvel' from February through May 2002 at the UC South Coast Research and Extension Center, Irvine, Ca.

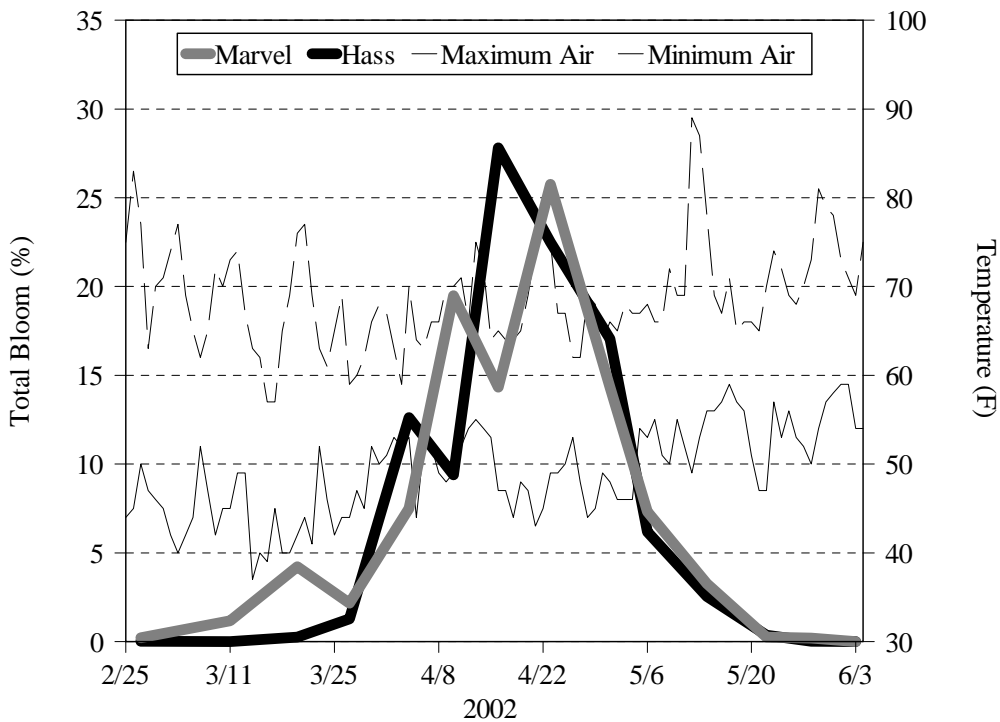


Figure 9. Comparison of percent bloom for 'Hass' and 'GEM' from February through May 2002 at the South Coast Research and Extension Center, Irvine, Ca.

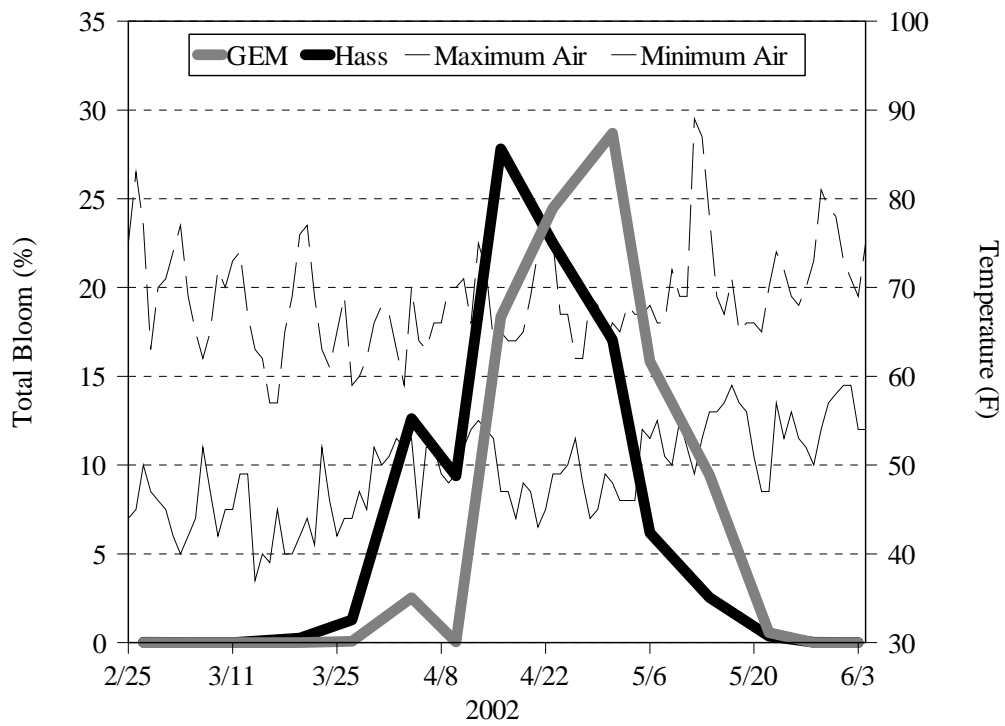


Figure 10. Comparison of percent bloom for 'Hass' and 'Harvest' from February through May 2002 at the South Coast Research and Extension Center, Irvine, Ca.

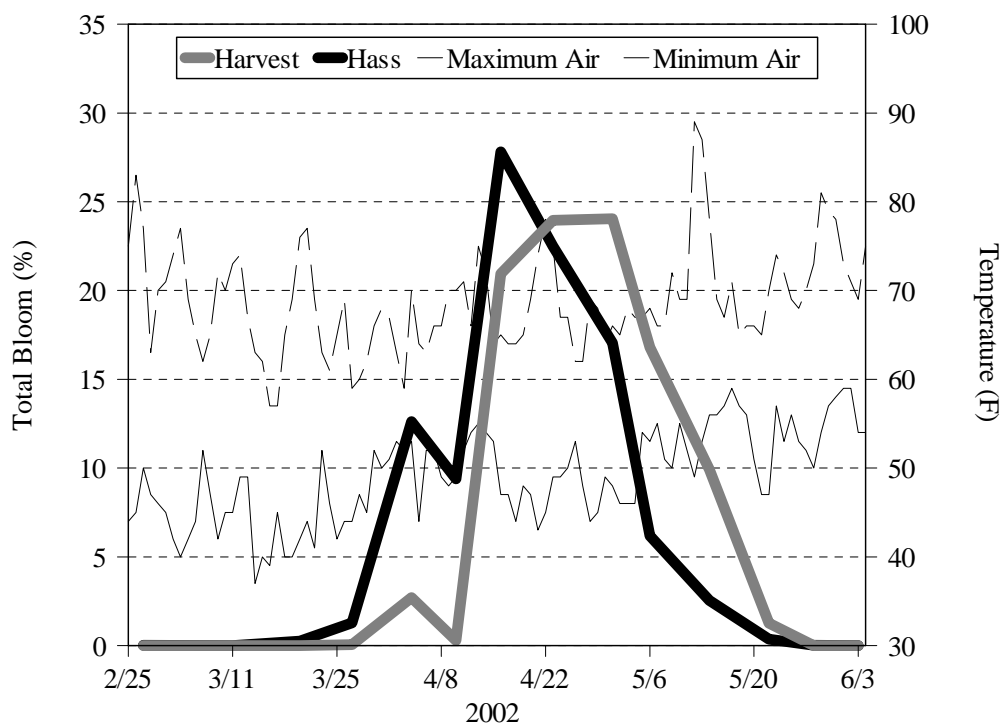


Figure 11. Comparison of percent bloom for 'Hass' and 'Lamb Hass' from February through May 2002 at the South Coast Research and Extension Center, Irvine, Ca.

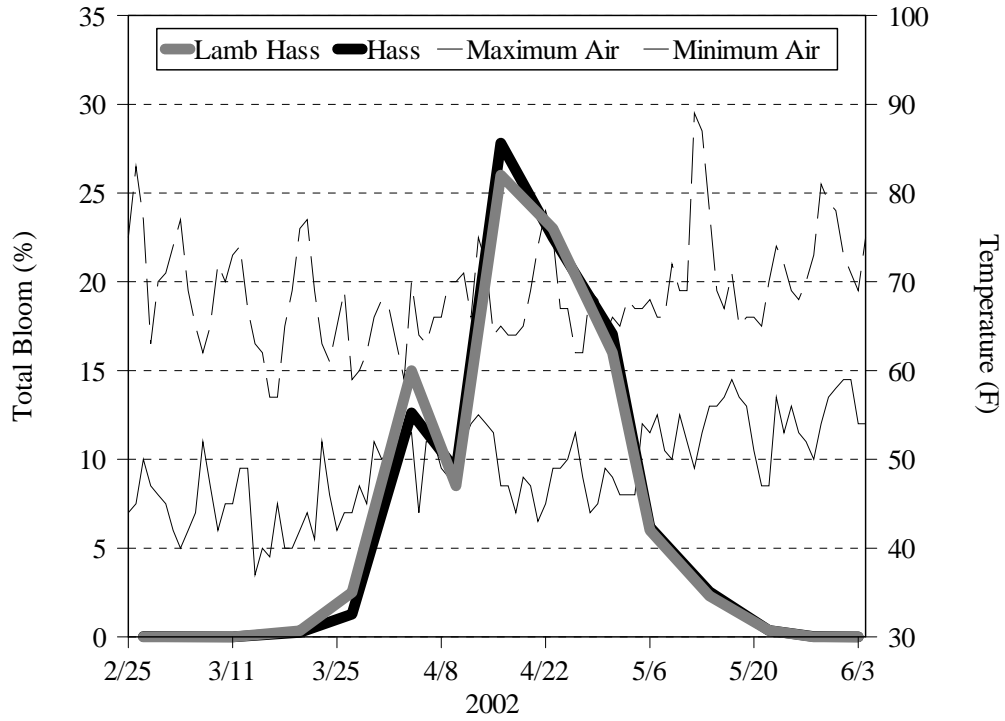


Figure 12. 'Hass' yield (fruit count) from the DeBusschere pollinizer trial in Oxnard in 2001 as influenced by pollinizer variety and distance from the pollinizer.

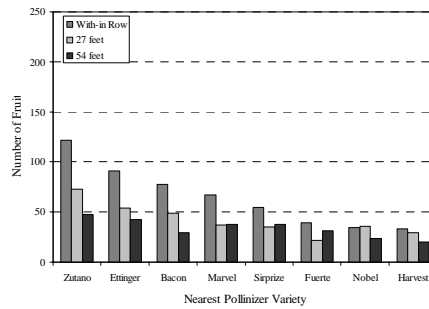


Figure 13. 'Hass' yield (fruit count) from the DeBusschere pollinizer trial in Oxnard in 2002 as influenced by pollinizer variety and distance from the pollinizer.

