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

Continuing Project: Year 10 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, and Deb Mathews.
B. To collaborate with other researchers worldwide in evaluating and exchanging promising plant material.
C. To collaborate with Dr. Douhan 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 and others as requested.
E. To maintain and improve the CAS variety block and the *Persea* germplasm block located at the UC South Coast Research and Extension Center.
F. To insure the timely and effective dissemination of information developed from this research program.

Summary

Program Overview and Synopsis

A formal avocado variety breeding program has existed at the University of California for several decades. The first controlled selections were made in 1937 by J. W. Lesley at UC Riverside, and in 1939 by W.E. Lammerts at UCLA (Lammerts, 1943). Dr. Art Schroeder, was also active in the selection of promising material in the 1930's and 1940's and participated in several plant exploration trips to Central America. In the 1950's the UC hired Dr. Royce

Bringhurst (UCLA) to develop new avocado varieties. He was followed after a short tenure by Dr. Bob Bergh (UC, Riverside) in 1956 who worked on the development of new varieties until his retirement in the early 1990's. Gray Martin, carried on Dr. Bergh's work upon his retirement and was supervised by Dr. Guy Witney briefly in 1994 through 1996. Dr. Mary Lu Arpaia assumed full responsibility for the program in 1997. She has been assisted by Mr. David Stottlemyer (1996 – 2006) and by Mr. Eric Focht (2005 –present).

Dr. Bergh outlined the general breeding objectives for the California industry (Bergh, 1976; Table 1). With these objectives in mind, we have continued our program to search for improved varieties. The goal of the current program is to produce new avocado varieties, superior to 'Hass' in consistent production and fruit size. These new selections also must have Postharvest fruit quality equal or better than Hass: uniform fruit ripening, sensitivity to chilling injury and most importantly eating quality. Although it would be ideal to identify new varieties that have long harvest seasons, we will not necessarily eliminate promising material that have a more limited on-tree storage life or maturity season as compared to Hass.

Table 1. Avocado breeding objectives (Bergh, 1976).

Fruit quality	
Medium size	Thick ovate shape
Uniformity	Pulp
Skin	Proper softening
Medium thickness	Appetizing color
Readily peelable	Absence of fibers
Insect, disease resistance	Pleasing flavor
Free from blemishes	Long shelf life
Attractive color	Slow oxidation
Long tree storage	Chilling tolerance
Seed	High oil content
Small	High nutritional value
Tight in its cavity	
Shoot qualities	
Upright to slightly spreading habit	Tolerant of chlorosis
Easy to propagate	Tolerant of other stresses
Strong grower	Short fruit maturation period
Tolerant of pests and diseases	Precocious
Tolerant of wind	Regular bearing
Tolerant of cold	Wide adaptability
Tolerant of heat	Heavy bearer
Tolerant of salinity	

This project aims to help maintain and enhance the California avocado industry by introducing consistently heavier producing, high-quality avocado varieties, better pollinizer varieties, and to test improved rootstock hybrids. The goals of this project will be achieved through continued evaluation of new material generated through traditional selection techniques, collaboration with Dr. Clegg and others as they develop refined techniques to increase the efficiency of selection and introduction of new material from other breeding and selection programs. Increasing the genetic diversity of varieties cultivated in California will decrease the risk of major pest and disease invasions on a susceptible monoculture.

Since 1996 our activities have focused in 6 general areas.

1. Material from the Bergh Breeding Program

The selections listed in Table 2 were ones selected (along with the already released 'Lamb Hass' and 'SirPrize') by Dr. Bergh and Mr. Martin in the early 1990's. In 2003, 2 of the selections, 3-29-5 (GEM) and the N4 (-) 5 (Harvest) were patented and commercially released. Field evaluation of these varieties has been conducted in trials established throughout California. Limited Postharvest evaluation has also been carried out. As of 2006 we have discontinued the field trials with these selections. At this time we do not plan to release any additional varieties from this cohort due to results from both field and Postharvest evaluations. There is a chance that the BL516 (Marvel) may be released if in the final results of the DeBusschere trial proves it noteworthy as a pollinizer variety (further information on our evaluation of these varieties can be found in previous reports).

2. Development of new varieties

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), J. Chaparro (Univ. of Florida, Gainesville) and A. W. Whiley (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. Table 3 summarizes the number of seedlings that we have planted since 2000 at UC South Coast REC from "open-pollinated" sources.

Table 2. UC Avocado Varieties* Evaluated from Bergh Program.

	Date of cross	Date planted in Field	First Evaluation	First Fruit Test at SCREC	Flower type	Season	Fruit Description	Tree Shape
BL667 (Nobel)	1983	Spring 1985	May 1991	May 1993	B	mid-late Hass	Hass-like	Upright semi-compact
BL516 (Marvel)	1983	Spring 1985	May 1991	June 1994	B	mid-Hass	small Hass	Upright semi-compact
3-29-5 (GEM)	1984	Spring 1986	April 1991	May 1995	A	mid-late Hass	smooth Hass	Mod. spreading
N4 (-) 5 (Harvest)	1984	Spring 1986	May 1993	June 1996	A	late Hass	Hass	Upright
5-552	1984	Spring 1986	Dec. 1990	Aug 1994	B	late Hass	small Reed (green)	-
5-186	1984	Spring 1986	May 1992	July 1995	A	late Hass	green-skin Hass	-

*Parentage of all material: open pollinated 'Gwen' seedlings (as is the 'Lamb Hass').

Table 3. Open pollinated seedlings from varying maternal sources planted at the UC South Coast Research and Extension Center from 2000 to Spring 2006 as well as anticipated plantings for Fall 2006 and 2007.

Year Planted	5-552	5-Star	Bacon	BL1058	GEM	Green Gold	Gwen	Harvest	Lamb Hass	Marvel	Nobel	Murietta Green	SirPrize	XX3	Total Planted
2000*	32				39		14		5	90	37				217
2002					91				20	75	51				237
2003					41		55			50	25				171
2004	30				42		55			61	48				238
2005			3		99		23		60	60	73		36	11	341
2006					54	1	25	14	29	19	37		1	2	182
*2006 (Fall)***		*5*		*8*	*28*	*59*	*30*	*51*	*95*	*120*	*7*		*147*	*18*	
*2007***												*1*		*40*	
Totals* **	**62**		**3**		**375**	**1**	**184**	**14**	**146**	**359**	**274**		**37**	**13**	**1386**

Note: The "Total Planted" per year may not always add up due to some trees with lost labels where the parents are "unknown."
* 81% of these seedlings have now fruited and been evaluated. Tree removal of non-promising material will occur in Fall 2006 as well as trees which have not borne fruit.
** Numbers for 2006 and 2007 are based on the number of seeds collected. Actual trees that will be planted will be dependent on successful germination and seedling survival.
*** Totals reflect actual trees planted through 2005.

Table 4. 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 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.

Of the trees planted in 2000 and 2001, 211 have produced fruit and have been evaluated. Twelve seedlings have been selected for further evaluation. Seven of these have been topworked onto Duke7 rootstock at UC South Coast REC, and are also being propagated onto clonal rootstock material for further field evaluations. The remaining ones have been selected during the current cycle and will be propagated in the upcoming year. Two of these selections were selected for their sympodial growth habit; the others were selected mainly on the basis of flavor and/or maturity season. In addition to the 12 seedlings selected for further evaluation, one seedling has been selected to be further propagated as a “seed parent”. This variety will be propagated in Field 4 to increase the quality of the genetic pool; due to its elongated shape, however, it will not

be considered for commercial development. This selection has been made in accordance with the suggestions of Dr. Jose Chaparro. This makes for a total of thirteen selections from fruit evaluated in 2005 and 2006.

In the second approach we have taken the more traditional approach of Dr. Bergh by establishing isolation plots in various locations. Table 4 lists the location, year established and selections in each isolation block. The potential parents were selected under consultation with Dr. Bergh. A total of 379 seedlings have been thus far planted out from the isolation blocks (Table 5).

Table 5. Seedlings from isolation blocks that are (or will be) planted at the UC South Coast Research and Extension Center from 2000 to Spring 2006 as well as anticipated plantings for Fall 2006 and 2007.

Year Planted	GEM x GEM	GEM x Marvel	GEM x Thille	Lamb Hass x Lamb Hass	Lamb Hass x Nobel	Lamb Hass x Reed	Marvel x GEM	Nobel x Lamb Hass	Reed x Lamb Hass	Reed x Stewart	Thille x GEM	Total planted
2003											15	15
2004		6										6
2005		113	179				12					304
2006		2	50			1	1					54
*2006 (Fall)***		*1*	*151*	*60*						*1*	*99*	
*2007***	*108*	*120*	*8*	*130*	*300*	*125*	*140*	*2*	*94*	*30*	*110*	
Totals***		**121**	**229**			**1**	**13**				**15**	**379**

Note: The "Total Planted" per year may not always add up due to some trees with lost labels where the parents are "unknown."

* 81% of these seedlings have now fruited and been evaluated. Tree removal of non-promising material will occur in Fall 2006 as well as trees which have not borne fruit.

** Numbers for 2006 and 2007 are based on the number of seeds collected. Actual trees that will be planted will be dependent on successful germination and seedling survival.

*** Totals reflect actual trees planted through 2005.

In June 2005, we asked Dr. Uri Lavi (fruit breeder including avocado from the Volcani Institute in Israel) and Dr. Jose Chaparro (citrus and stone fruit breeder from the University of Florida, Gainesville) to review our progress over the last 6 years. They made many useful suggestions for improvement of the program and helped us in developing strategies for the future. A summary of the key outcomes of this audit are attached.

Our activities thus far in fiscal year 2005-2006 in this area can be summarized as follows:

1. **Implementation of the recommendations of Drs. Jose Chaparro (University of Florida) and Dr. Uri Lavi.** Following the audit of the breeding program we have implemented many of the suggestions offered by Drs. Chaparro and Lavi to streamline the breeding program and increase efficiencies.

2. **Seeds for new selections.** We have been collecting seed material from open-pollinated flowers from cultivars of maternal interest. These are grown and then planted out at South Coast REC. We will collect open pollinated seeds for this current funding cycle from promising varieties in the breeding program which will be planted out later this year. Seeds will be collected from the following varieties: BL516 ('Marvel'), BL667 ('Nobel'), 'GEM', 'Gwen', 'Lamb Hass', 'Green Gold', 'XX3' and 'Murrieta Green'. We also collected 378 seed from the isolation blocks at UCR: 'Thille' x 'GEM' and BL516 x 'GEM'. Seven hundred-eight-nine fruit from the isolation blocks at the Nakamura Ranch have also been collected. The 'Hass' is not being used as a parent in these blocks based on discussions with Dr. B. Bergh who related his experience with 'Hass'.

3. **Fruit evaluations of new selections.** The new selections from the breeding program have continued yielding fruit for evaluation this year. So far, 373 fruit have been evaluated representing 291 different selections. If trees have multiple fruit, they are being sampled over a period of time so the dry weight values can be tracked. Fruit of interest are also being photographed during the evaluation process. Since November 2005 we have identified 7 new selections for further evaluation.

4. **Dry weights.** Percent dry weights have been calculated on all the above varieties using the "coring" method of fruit sampling.

5. **Continued evaluation of material in Field 46.** Although most of the evaluation effort has gone into the most promising unreleased varieties, avocado selections from field 46 at SCREC continue to be evaluated.

6. **Space for new selections.** There is room in Field 46 for a large number of new seedlings to be planted out. There are 4 rows of older germplasm material that are currently being moved and propagated elsewhere; Once their continued propagation is assured, they will be removed for further seedling plantings. We have continued to plant out new selections in Field 44 and have made arrangements with SCREC for further space to be cleared for possible planting later this year. In addition, we will begin to remove the earliest of our new selections (planted 1999) as they are determined to have no value as a potential future variety or parent. This removal will begin as soon as we are assured of the propagation of the varieties of interest.

7. **Overseas cooperation.** We have answered several questions regarding exchange of material with potential overseas cooperators but no arrangements have been finalized thus far this year. In particular we are interested in 3 varieties from Westfalia Technological Services (WTS) in South Africa and an Israeli variety encountered on our trip to South Africa in August of this year. WTS has expressed an interest in BL516.

8. **Introduction of new plant material.** In March 2003 we imported budwood from 2 new 'Hass-like' selections from Chile, 'Andes 3' and 'Andes 4'. This material was planted in the heritage collection this spring. In addition, the 'Puebla', also received from Chile has been planted. Furthermore, we have added 2 'Lula' and 2 'Carmen Mendez' (Carmen Hass) trees to the heritage block this spring.

9. **Study of abnormal ovule development in SirPrize flowers.** When Dr. Gad Ish Am visited California in 2004 he noted that abnormal ovule development in many 'SirPrize' flowers. A study is currently continuing to investigate possible temperature effects on "extraovary"

ovule development in 'SirPrize' flowers. For comparison, buds have been collected from various 'SirPrize', 'Hass' sites in Ventura, Orange and Tulare Counties. Temperature data is continuously recorded year-round at each site. The results from this year's study will be compared to samples collected the previous year.

10. **Field 4 at SCREC.** We have begun plans to convert Field 4 in order to produce seed from good parentage for the creation of new selections as suggested in the 2005 audit. This is an ongoing project that will likely take several years to complete and involves the removal of older trees in combination with a mix of replanting and topworking of different germplasm into the field.
11. **Sunblotch Testing.** Leaf samples were collected from fields 44 and 46 at SCREC. Of the 84 trees tested since 11/1/05, none have tested positive. Last year we began to institute a more aggressive policy to contain sunblotch; we now remove the negative or untested trees adjacent to a positive tree. Sunblotch testing has been completed on all trees in the heritage block (field 44) with one positive tree being removed in 2004; there have been no reoccurrences in this field since. New additions to the collection are tested prior to planting or grafting into the field.
12. **Carmen Mendez Evaluation**. We have begun to compare the spring and flora loca flowering cycles of 'Carmen Mendez' with that of regular 'Hass'.

3. Maintenance of the CAS Germplasm Plot at UC South Coast REC

We have slowly revitalized this plot and conducted sunblotch testing of interesting material. New selections have been added when possible. Budwood of non-protected material is distributed when requested. The XX3, a 'Murietta Green' selection by Dr. Bergh was released for backyard growers in 2002.

We also make selections in our heritage collection available to nurseries. Since November 2005, we have supplied over 4,550 budsticks to various nurseries for the following varieties: 'Edranol', 'Mexicola', '3/11', 'Lamb Hass', 'XX3' and 'Colin V33'.

4. Maintenance of Persea species collection

We continue to maintain a small species collection at UC South Coast REC that was planted by Dr. Rainer Scora in the late 1980's and early 90's.

5. Rootstock and pollinizer evaluation

We have conducted a number of rootstock trials at UC South Coast REC. These trials are planted out under non-root rot conditions in order to evaluate the productivity of 'Hass' as influenced by rootstock. Figure 1 presents the 10 year yield data for the original rootstock trial using 8 clonal rootstocks. Note that rootstock greatly influence cumulative productivity. The results of this trial have been summarized and we anticipate publication of these results in late 2006 or 2007 (Mickelbart et al., In press).

In 1999 we established a new rootstock trial at UC South Coast REC. This trial includes both 'Hass' and 'Lamb Hass' on several interesting rootstocks from the Menge program (Day*, Duke 7*, Dusa, Evstro*, G755A, Parida, Spencer, Thomas*, Toro Canyon*, and Zentmyer; * = 'Lamb Hass'). We also have 1 row of 'Carmen Mendez' on Toro Canyon for evaluation of that variety. Table 6 presents the cumulative yield data collected thus far (2003-2006) for the 'Hass' variety. Figure 2 illustrates that 2006 is the first year with appreciable yield from this trial, however one can also observe that that the tendency towards alternate bearing is also being expressed.

Figure 1. Cumulative yield of 'Hass' on 8 clonal rootstocks from 1986 – 1996 planted at the UC South Coast Research and Extension Center in Irvine, CA.

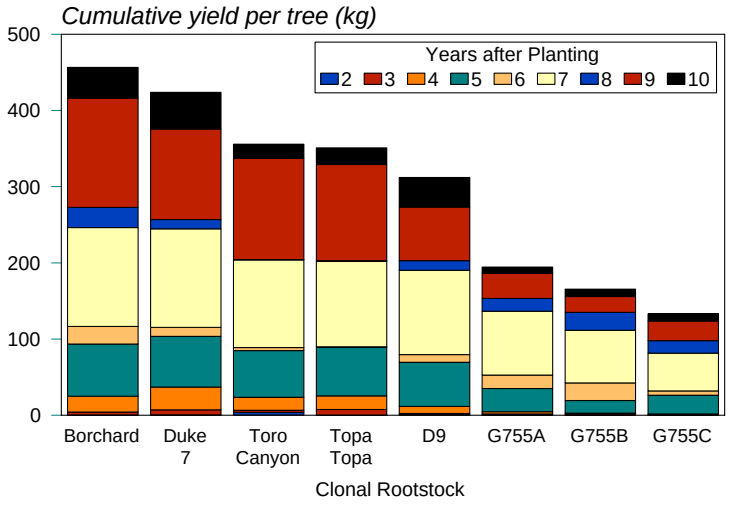
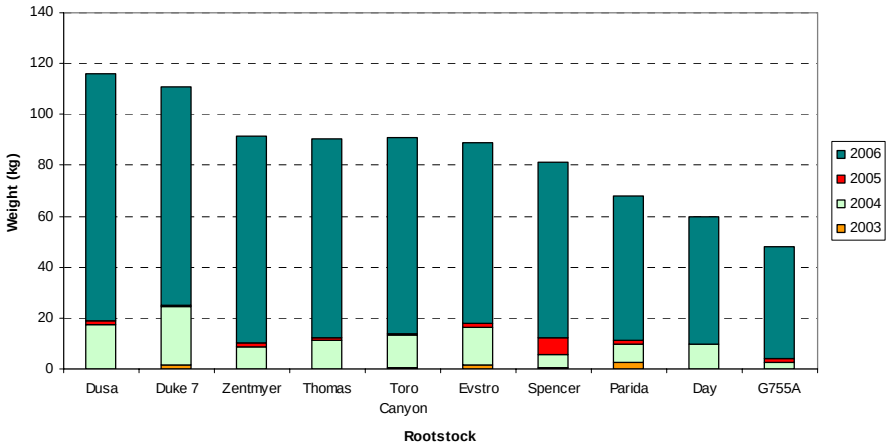


Table 6. Cumulative data (2003-2006) for Hass on selected rootstocks. Data from UC South Coast Research and Extension Center, Irvine CA. Trees were planted in 1999 in a randomized block design with 20 replicates. Mean separation by LSD, P<0.05.

Rootstock	Cumulative Weight (kg)		Cumulative Fruit Count		Average Fruit Weight (g)	
Dusa	116.36	a	523.72	a	220.33	bc
Duke 7	110.67	ab	466.68	ab	250.36	ab
Zentmyer	93.18	abc	404.70	ab	231.04	bc
Thomas	91.90	abc	390.33	ab	238.81	abc
Toro Canyon	91.62	abc	410.85	ab	224.94	bc
Evstro	89.53	bc	430.55	ab	224.49	bc
Spencer	81.28	cd	402.53	ab	202.63	c
Parida	68.10	cde	351.74	b	194.90	c
Day	59.74	de	230.53	c	271.60	a
G755A	49.01	e	212.75	c	233.78	bc

Figure 2. Data from Hass rootstock trial at UC South Coast Research and Extension Center, Irvine CA. A. Cumulative yield. B. Cumulative fruit count. C. Average fruit size of Hass as influenced by rootstock (2003-2006).

A.



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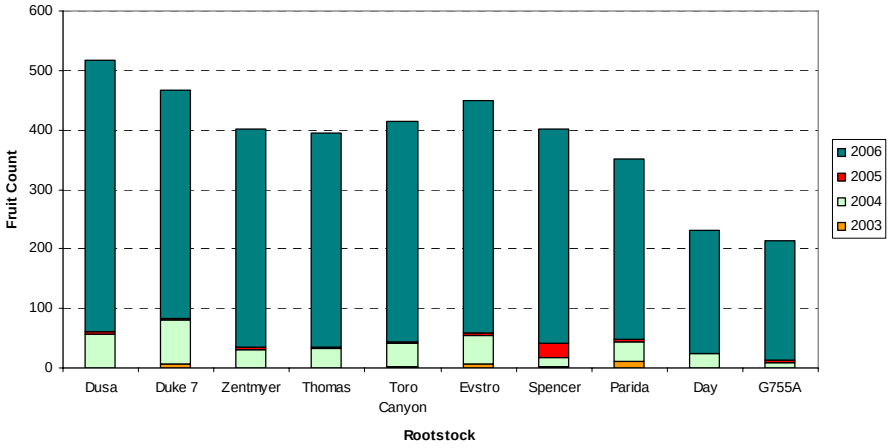

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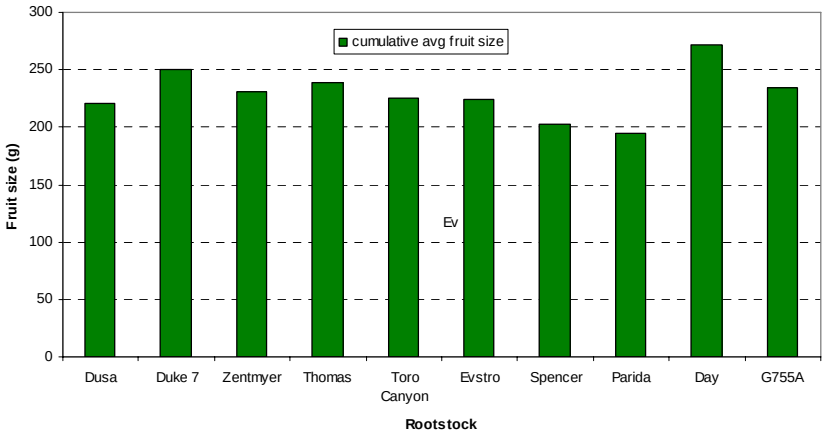


We have 'Lamb Hass' on 5 rootstocks as indicated above. Table 7 presents the cumulative yield data thus far for the 'Lamb Hass' portion of the trial. There was no significant difference between rootstocks with regard to cumulative weight, fruit count or average fruit size. Figure 3 presents the same type of data for the 'Lamb Hass' as presented in Figure 2. Note again the alternate bearing tendency between 2004, 2005 and 2006.

Table 7. Cumulative data (2003-2006) for Lamb Hass on selected rootstocks. Data from UC South Coast Research and Extension Center, Irvine CA. Trees were planted in 1999 in a randomized block design with 20 replicates. Mean separation by LSD, P<0.05.

Rootstock	Cumulative Weight (kg)		Cumulative Fruit Count		Average Fruit Weight (g)	
Evstro	111.98	n.s.	409.47	n.s.	271.69	n.s.
Duke 7	100.17		387.06		259.96	
Toro Canyon	99.16		371.95		268.99	
Thomas	98.38		366.74		296.53	
Day	90.06		328.00		281.70	

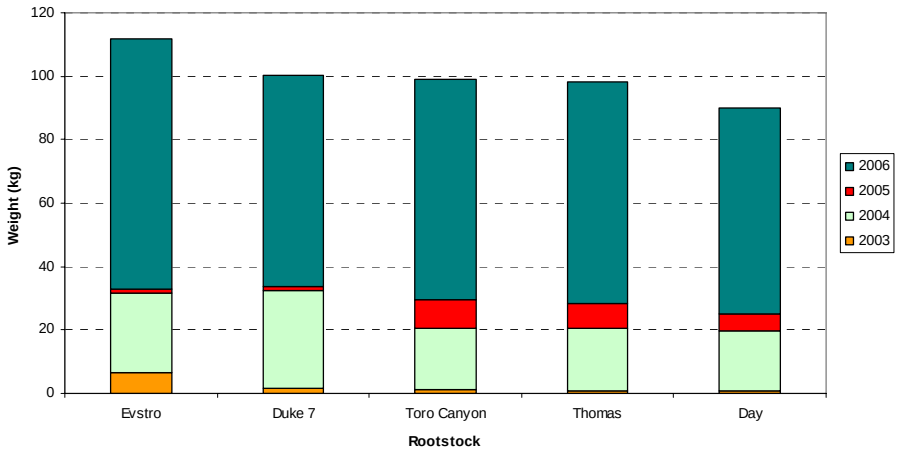
We have also done a preliminary analysis of the rootstock – scion interactions in this trial. When the data is combined for 'Hass' and 'Lamb Hass' for the 5 rootstocks shared in this trial we see that thus far there is a significant difference between the two varieties in terms of cumulative yield (88.6 kg per tree for 'Hass' vs. 100.0 kg/tree for 'Lamb Hass', P<0.01), and average fruit size (242 g for 'Hass' vs 276 g for 'Lamb Hass', P<0.001). There were no significant differences detected in cumulative fruit number (386 fruit for 'Hass' and 373 fruit for 'Lamb Hass'). In terms of the impact of rootstock on yield when looking at the combined data, yield for both varieties is significantly less on the Day rootstock (74.5 kg/tree) as compared to the Duke 7 (105.6 kg/tree), Evstro (100.5 kg/tree), Thomas (95.5 kg/tree), and the Toro Canyon (95.4 kg/tree). Rootstock also significantly impacted cumulative fruit count. Again fruit numbers of both varieties were less on the Day rootstock (P<0.001). Rootstock did not have a significant impact on average fruit size when compared across the 2 varieties.

We have also introduced salinity tolerant rootstock material from Israel and this material is currently being evaluated as part of the rootstock program through Dr. Greg Douhan and Dr. David Crowley.

DeBusschere Pollinizer Plot. The 'Hass' trees in this trial were planted in 1998 and the pollinizer trees in July 1999. We harvested the DeBusschere Pollinizer plot March 20-23, 2006. We collected one week prior to harvest, 8 'Hass' fruit (6.98 oz average size) from each pollinizer row (6 replications). Dry weight was determined for each fruit (a special thanks to Donella Boreham and her staff from the Avocado Inspection Service). We also measured the length and width of each fruit and seed as well as the fruit and seed weight. We also rated the color of the seed coat. Table 8 presents the results of the dry weight measurements and compares the 2006 data with the data collected in previous years. Although differences were once again detected in 'Hass' dry matter relative to the nearest pollinizer variety; these differences are not consistent across years. We also noted that seed coat color varied significantly across the plot and is roughly in line with dry matter, that is, the higher the dry matter the darker the average seed coat color.

Figure 3. Data from Lamb Hass rootstock trial at UC South Coast Research and Extension Center, Irvine CA. A. Cumulative yield. B. Cumulative fruit count. C. Average fruit size of Lamb Hass as influenced by rootstock (2003-2006).

A.



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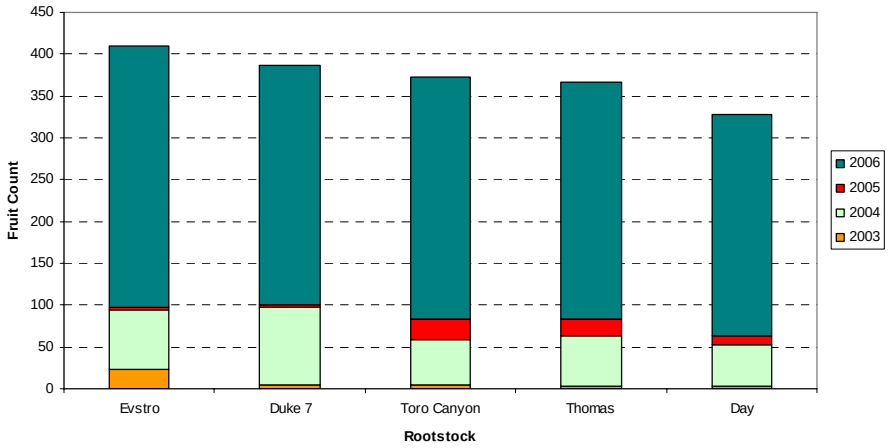

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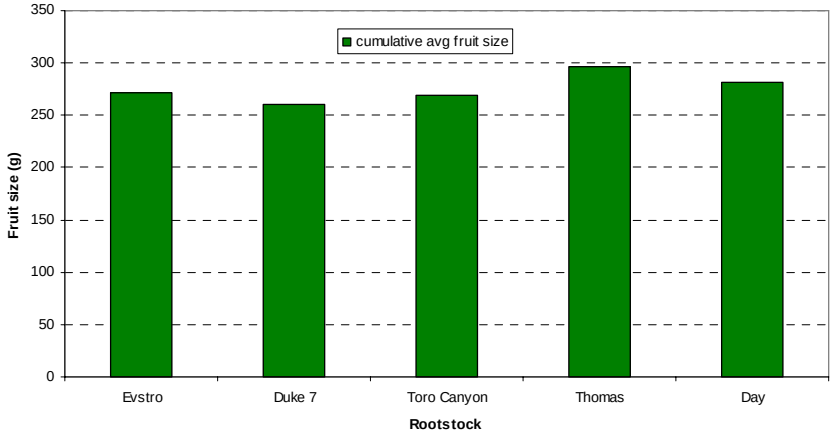

Table 8. Average 'Hass' dry weight (%) for 2004, 2005 and 2006. Fruit harvested in April in 2004 and 2005 and in March for 2006 from the pollinizer rows. Seed coat color also reported for 2006 using a scale of 1-5 (1=white; 3=brown; 5=black). Mean separation by LSD, P<0.05.

Pollinizer	2004	2005	2006	
	Dry weight (%)	Dry weight (%)	Dry weight (%)	Seed coat color (1-5)
Bacon	25.34 ab	27.42 abc	26.68 ab	2.83 a
Ettinger	25.30 abc	26.44 bc	24.70 c	1.94 b
Fuerte	24.80 bc	27.30 abc	24.26 c	1.98 b
Harvest	24.95 bc	28.06 ab	27.44 a	2.85 a
Marvel	24.45 c	25.88 c	25.05 bc	2.38 ab
Nobel	26.20 a	28.72 a	26.95 ab	3.13 a
SirPrize	24.94 bc	26.90 abc	25.20 bc	2.54 ab
Zutano	26.08 a	25.92 c	24.49 c	2.38 ab

Tables 9 and 10 presents data collected in all years for the fruit length/width ratio and the seed length/width ratio, respectively. Table 8 presents the seed to fruit ratio for 2005 and 2006. No large differences were noted this year in fruit or seed length/width ratios, although the fruit this year tended to be slightly more round (lower ratio values) than in 2005. A large difference between 2005 and 2006 can be noted in relative seed size. The relative proportion of the total fruit weight accounted for by the seed increased substantially this year across the entire plot. A weakness of this study has been our inability to test for parentage of the 'Hass' fruit but the data from Dr. Davenport's project should help us to interpret these results.

Table 9. Average 'Hass' fruit length/width ratio for 2004, 2005 and 2006. Fruit harvested in April in 2004 and 2005 and in March for 2006 from the pollinizer rows. Mean separation by LSD, P<0.05 (n.s. = not significant).

Closest Pollinizer	2004	2005	2006
Bacon	1.29 n.s.	1.45 ab	1.41 a
Ettinger	1.37	1.47 ab	1.34 b
Fuerte	1.39	1.52 a	1.39 ab
Harvest	1.45	1.49 ab	1.38 ab
Marvel	1.40	1.47 ab	1.35 ab
Nobel	1.43	1.50 ab	1.40 ab
SirPrize	1.37	1.42 b	1.35 ab
Zutano	1.37	1.46 ab	1.35 ab

The overall yield this year was substantially higher as compared to 2005 and range between 95 to 284 fruit per tree regardless of distance from the pollinizer source. Figures 4 and 5 utilize data from 2002 through 2006. We have dropped the yield data from 2001 since only 3 of the 6 field replications were harvested that year. Figure 3 shows the average yield (fruit number per tree)

for 2006 as a function of pollinizer source and distance from the pollinizer. You will note that 'Hass' near the 'Fuerte' variety currently has the highest yields, followed closely by 'Hass' planted near 'Ettinger'. Figure 4 presents the cumulative yield data as expressed by fruit number for 2002-2006. Clearly, proximity to a pollinizer has an impact on cumulative yield. We plan to collect a final year of yield data and fruit data in 2007.

Table 10. Average 'Hass' seed length/width ratio for 2004, 2005 and 2006. Fruit harvested in April in 2004 and 2005 and in March for 2006 from the pollinizer rows. Mean separation by LSD, P<0.05.

Closest Pollinizer	2004	2005	2006
Bacon	1.13 bc	1.13 b	1.14 a
Ettinger	1.11 c	1.15 ab	1.10 ab
Fuerte	1.19 a	1.20 a	1.13 a
Harvest	1.18 ab	1.19 a	1.12 ab
Marvel	1.14 bc	1.16 ab	1.10 ab
Nobel	1.15 abc	1.17 ab	1.13 ab
SirPrize	1.15 bc	1.10 b	1.09 b
Zutano	1.11 c	1.13 b	1.09 b

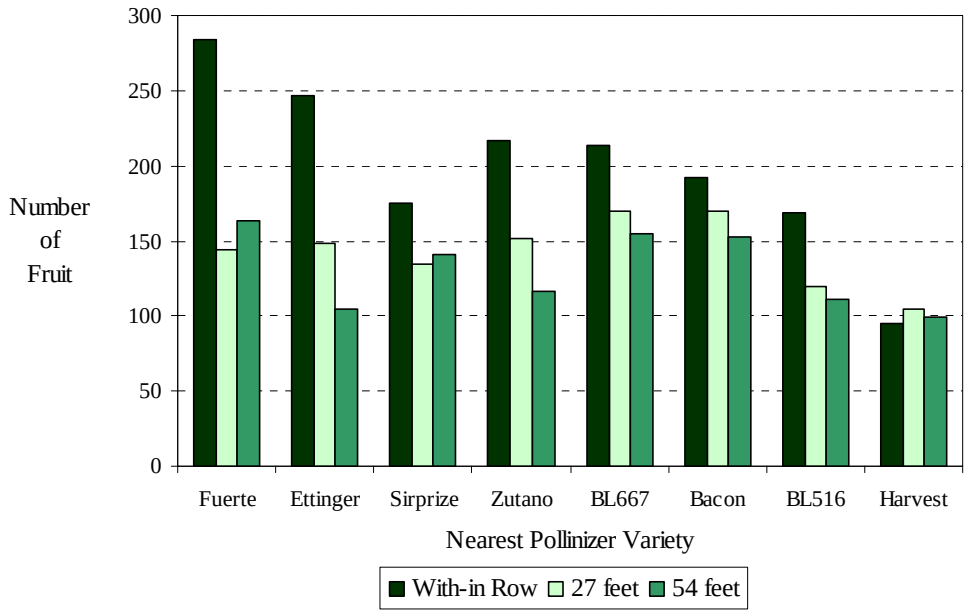

Figure 4. The average number of 'Hass' fruit per tree as a function of distance from a pollinizer variety. Fruit harvested in March 2006 from the DeBusschere pollinizer plot near Oxnard, CA.

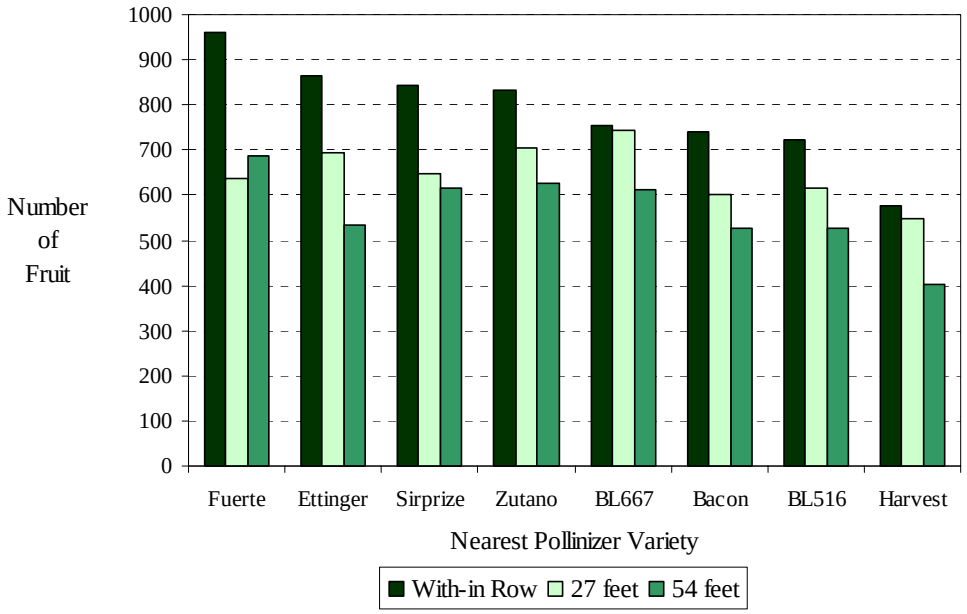

Figure 5. The average cumulative number of 'Hass' fruit per tree as a function of distance from a pollinizer variety. Fruit harvested in March 2006 from the DeBusschere pollinizer plot near Oxnard, CA.

6. Outreach Activities

These can be summarized into 3 general areas:

1. **Web Site.** The web site continues to be updated and changed on a periodic basis.
2. **Answered Email.** We have received and answered numerous email requests for information on avocados since November 1, 2005. These range from specific questions regarding avocado germplasm to questions from avocado enthusiasts worldwide.
3. **Visit to South Africa, August 2006.** In August of 2006, M. L. Arpaia (as the 2006 Hans Merensky Fellow), E. Focht, G. Douhan and W. Tucker (UC, Office of Technology Transfer) visited South Africa as guests of Westfalia Technological Services (WTS). The purpose of this visit was to exchange information pertaining to both rootstock and scion development. From this programs perspective, the trip re-enforced the long standing relationships of this program with that of WTS. We expect to initiate a budwood exchange program so that as interesting material is identified in both countries the other can benefit from that development.
4. **Other Outreach Activities.** We have given several presentations of data collected from this trial, as requested. This has included several field tours as well as oral presentations to grower groups and visitors to the field station.

Planned Activities for Remainder of Fiscal Year:

1. In additions to the planting of 236 new seedling selections at SCREC in May 2006, we plan to plant approximately 300 new additional seedlings in October 2006.
2. Further propagation of varieties of interest from our new selections' seedlings. Promising selections will be topworked, grafted onto Duke 7 clonal rootstock or rooted using the etiolation method.
3. Further collection of seed to provide a total of more than 1,500 seeds in 2006 for the new selections.

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