

Enhancement of Avocado Productivity. Plant improvement - selection and evaluation of improved varieties and rootstocks

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The goal of the avocado scion breeding program is 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. This is achieved through identification of material which is less prone to alternate bearing and more tolerant to adverse environmental conditions. Additionally identifying varieties with a more upright tree structure will assist in high density tree management schemes. The goals of this project will be achieved through continued evaluation of new material generated by traditional selection techniques, collaboration with other researchers as they develop refined techniques to increase the efficiency of selection and introduction of new material from other improvement programs. Increasing the genetic diversity of varieties will decrease the risk of major pest and disease invasions on a susceptible monoculture. Our progress since October 2010 is summarized below.

We envision the breeding program as a 4-Tier selection process. The bulk of our activities are based at the UC South Coast Research and Extension Center (SCREC) in Irvine where all seedlings are planted and Tier 1 and Tier 2 selections made (Figure 1). Tier 1 is the collection, germination and planting out of seedling material from maternal parents of interest due to fruit quality attributes, alternate bearing tendencies or growth habit. The seedling blocks are planted in both the Spring and Fall of each year. They are kept for approximately 6 years which allows for about 80% of the seedlings to flower and set fruit. The fruit from the seedlings are collected and evaluated for eating quality, appearance and seasonality. If the seedling produces fruit with desirable characteristics it is then passed on to Tier 2.

All Tier 2 selections are currently being topworked onto Duke 7 rootstocks in Field 4. We also have a maternal breeding stock in Field 4. As per the 2005 recommendations of Dr. Chaparro (University of Florida, plant breeder of citrus and stone fruit), the Field 4 planting serves a two-fold purpose of providing pollen for cross pollination with our seed-producing trees while allowing us to closely monitor selections of interest for fruit production, quality, seasonality (dry weight samples are collected every 4 to 6 weeks), flower type, growth habit and other favorable features. Varieties topworked in this planting include both released and unreleased material from previous breeding programs and the public domain. We have 4 to 5 trees of each Tier 2 selection in Field 4 to allow us to have multiple opportunities to observe the selection's performance in the field. With multiple trees per selection we are also able to conduct preliminary postharvest and sensory evaluations.

Tier 3 plantings are designed to be plantings of material that is deemed of interest after the Tier 2 evaluation. Currently we have 4 sites where we are testing this material; San Diego County, Orange County, Ventura County and Tulare County and are currently using Dusa as the rootstock at all sites. We are also planting Hass trees with the Tier 3 selections in order to adequately compare our selections to the industry standard. Each selection is replicated 4 times in the planting. Each replicate consists of 3 trees per selection for a total of 12 trees. These are planted in a randomized block

design. We intend, for the sake of space to only plant one replicate of Hass in years 2 and 3 but then will plant 4 replicates in year 4 when we re-evaluate the rootstock to be used. We will repeat this cycle as the years progress. We will collect data (individual tree) on yield and tree vigor. We will collect pooled data from each replicate on flowering, maturity and postharvest quality. We will need to collect data on the Tier 3 selections for 6 to 7 years, at which time the hope is that commercial release of good performing selections is possible. Commercial release is considered to be Tier 4 in the program.

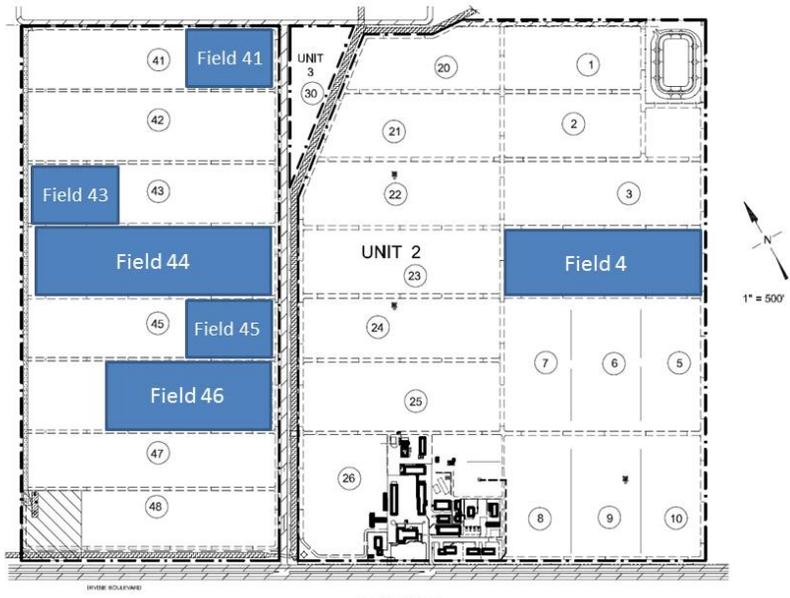


Figure 1. Map of UC South Coast Research and Extension Center in Irvine, CA, the site of the majority of our activities. We have seedlings in Tier 1 evaluation in Fields 44, 45 and 46. Tier 2 activity is centered in Field 4. Tier 3 plantings are located in Field 41. The Variety Collection is located on the east side of Field 44. The Persea collection is located on the west side of Field 43.

Tier 1 Activities

Seed collection and germination. In 2009 we contracted seed propagation/germination to Farm ACW in Fallbrook. This change was necessitated by overall poor germination rates in the SCREC greenhouse, which was likely due to high temperatures in late spring and summer. The SCREC greenhouse is still used to germinate small numbers of SCREC seed and also to hold germinated seedlings from ACW until they are planted in 1 gallon citrus sleeves. Seed germination rates are close to 100% as a result of this new arrangement.

Each year we collect seed material from open-pollinated flowers from cultivars of maternal interest as well as the remaining isolation plots at UC Riverside. These are germinated and then planted out at SCREC. Our seed sources this year were varied, more so in the past, reflecting the suggestions made during our previous audit of the breeding program. We harvested just over 900 seed in total in 2011. We collected 280 seed from the UCR isolation blocks as well as 250 seed from 5 different Tier 2/3 selections. Seeds were also collected from material in the Field 4 maternal block (Sir Prize, Lamb Hass, Gwen, GEM, Lamb Hass) as well as more diverse and unrelated material such as Pinkerton, Ardith, Reed, Jan Boyce, Green Gold and Kona Sharwil among others. We will have approximately 1000 seedlings to be planted in the field in Spring 2012 (this includes some carryover from the Fall 2009 seed collection).

Seedling evaluation. The seedling plantings from the breeding program have continued yielding fruit for evaluation this year. Fruit yields for 2012 look promising with many trees that have not borne fruit previously with fruit. This is the fourth year we have seen fruit on seedlings planted in 2003 through 2006. We also had several seedlings from material planted in 2007 and 2008 bear fruit. We are following our plan of removing seedlings once they reach 5 to 6 years of age, both to make more room

in the field for new seedlings and also under the idea that we want to select precocious material. Therefore we are in the process of removing seedling material planted in 2004-2005.

Eric Focht (Staff Research Associate) has made 3 selections for 2011 and these have been topworked into Field 4 for Tier 2 evaluation. We have topworked 5 trees of each selection onto Duke 7 rootstock. We have also grafted a few trees in the older section of Field 4 to produce additional fruit for sensory and postharvest evaluation. In addition, he is closely following another 4 selections in the seedling population. If these trees produce sufficient fruit, they are sampled for dry weight and fruit quality approximately every 4 to 6 weeks over the season. Fruit of interest are also being photographed during the evaluation process. Percent dry weights are sampled using the CDFA approved coring method of fruit sampling.

Tier 2 Activities

We are using Field 4 at the South Coast REC for our Tier 2 evaluations. Many of the newest selections located in Field 4 have been propagated for further evaluation and these trees are entering full production.

An informal 'take home' fruit evaluation system was developed that makes use of volunteer evaluators from within the UCR community. Preliminary results were used to select material for the initial Tier 3 plantings. During the current funding cycle we also conducted 3 sensory evaluations at the UC Kearney Agricultural Center's sensory lab in Parlier, CA. Table 1 provides the dry matter data for each of the selections used in the sensory test. We did individual dry weight tests for 5 fruit per selection per test. Note that the '464918-99' selection had a higher maturity value than Hass at the time of the February evaluation. We typically observe this for this selection. It was also rated in the February tasting higher than Hass (Table 2). In general, none of the selections were well liked in the February tasting when the dry matter was relatively low (Table 1). With regard to the overall sensory results, note that the various selections are generally liked to the same degree as Hass (Table 2). We also conducted preliminary postharvest evaluations on this material with results similar to the performance of Hass with the exception of one variety (465518-99) which showed increased susceptibility to internal disorders in one of the 2 tests for which it was included. We plan to repeat these evaluations in the upcoming funding cycle.

Table 1. Harvest dry weight of fruit used in UC Kearney Agricultural Center sensory evaluations in 2011.

	Description (ripe color; maternal parent)	Harvest Dry Weight (%)		
		February	June	August
Hass	Purple Black/Black	23.9 b	30.8 b	36.0 a
Carmen Hass	Purple Black/Black when ripe	24.2 b		
GEM	Black when ripe; Gwen		26.0 d	36.7 a
Lamb Hass	Purple Black/Black; Gwen			28.3 c
464918-99	Purple Black/Black; BL516	28.5 a	36.3 a	
465202-99	Purple Black/Black; Lamb Hass	21.4 c	26.5 cd	28.8 c
465418-99	Dk Green/Purple Black; BL516	24.2 b	31.1 b	36.9 a
465512-99	Black; GEM	19.3 c		
465518-99	Purple Black; BL516	24.0 b	29.2 bc	33.1 b

Mean separation at the 0.05 probability level using LSD.

Based on the sensory results from this year, we are in the process of revamping our sensory evaluation activities at UC Riverside. We plan, rather than during the informal testing as previously described, to do monthly tastings similar to those conducted at the UC Kearney Agricultural Center.

Overall status of selections of interest. During the current funding cycle, we selected an additional 3 seedlings for further evaluation as Tier 2 selections. Based on further evaluation, we have also dropped 1 selection from the Tier 2 program although we have retained it as a maternal seed parent. Entering the 2011-12 funding cycle we have 13 selections in Tier 2 evaluation.

Table 2. Mean hedonic score (1-9 scale where 1 = dislike extremely; 5 = neither like or dislike; 9 = like extremely) for sensory evaluations conducted at the UC Kearney Agricultural Center in 2011.

	February		June		August			
	Weeks @ 41°F		Weeks @ 41°F		Weeks @ 41°F			
	0		0	4	0	4		
Hass	4.8	bc	6.6	a	6.3	6.8	ab	6.9
Carmen Hass	5.6	ab	-	-	-	-	-	-
GEM	-		5.9	b	5.9	6.4	ab	5.9
Lamb Hass	-		-	-	-	5.6	c	6.0
464918-99	6.2	a	6.8	a	6.2	-		-
465202-99	4.8	bc	6.6	a	6.5	6.2	bc	6.5
465418-99	5.2	abc	6.4	ab	6.0	6.1	bc	6.2
465512-99	3.4	d	-	-	-	-		-
465518-99	4.2	cd	7.0	a	-	7.0	a	6.2
<i>Probability</i>	<i>0.0002</i>		<i>0.0240</i>		<i>0.7200</i>	<i>0.008</i>		<i>0.3250</i>

Mean separation at the 0.05 probability level using LSD.

Tier 3 activities

In Spring 2011 we planted the first Tier 3 plantings. The trials are located in San Diego county (Farm ACW), Orange County (UCSCREC), Ventura county (Brokaw Ranch, Santa Paula) and Tulare county (UC Lindcove Research and Extension Center). All trees are on Dusa clonal rootstock. For the 2011 planting we had 5 selections: ‘Hass’ (the control), 465518-99, 465418-99, ‘Flavia’ and ‘Eugenin’. The latter two selections are Hass-like selections from Chile that are here under test agreement. We installed weather stations at each site in order to monitor temperature, relative humidity, irradiation, rainfall and wind speed. Figure 2 shows an example of the comparative data between the sites from mid-August to mid-September 2011. The data shows for this time period that the Lindcove site as the warmest and the Santa Paula site as the coolest. Relative humidity was also the lowest at the Lindcove site.

We will have 1 new selection to be planted in 2012 and plan to have another selection to be planted in 2013. After this time we hope to have 2 to 3 selections per year as the Tier 2 evaluations will have more material from which to select.

Introduction of new plant material

We have not introduced any new material this year.

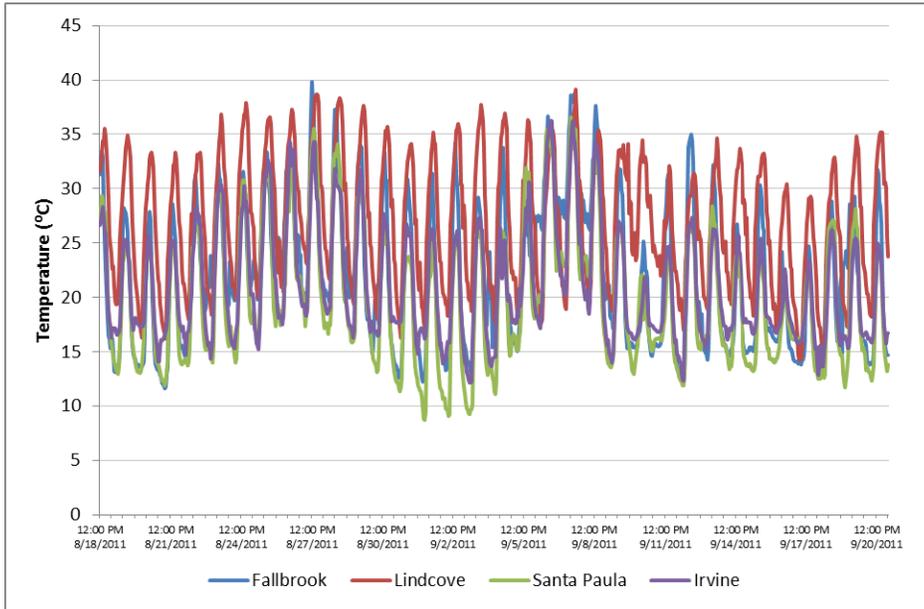
Sunblotch Testing

Leaf samples continue to be collected on a routine basis from Fields 4, 44 and 46 at SCREC. Indexing is done by Dr. Deb Mathews in the UCR Department of Plant Pathology and Microbiology. We found one positive selection this year (Hass on Duke 7, Field 46). This tree was removed. New additions to our collection are tested prior to planting or grafting at SCREC. Our current focus in testing is to screen all new selection seedling plantings using batch sampling. In Fall 2011 we also initiated sampling (using the batch method) the windrows which surround the various fields we are assigned. Thus far, no positives have been identified.

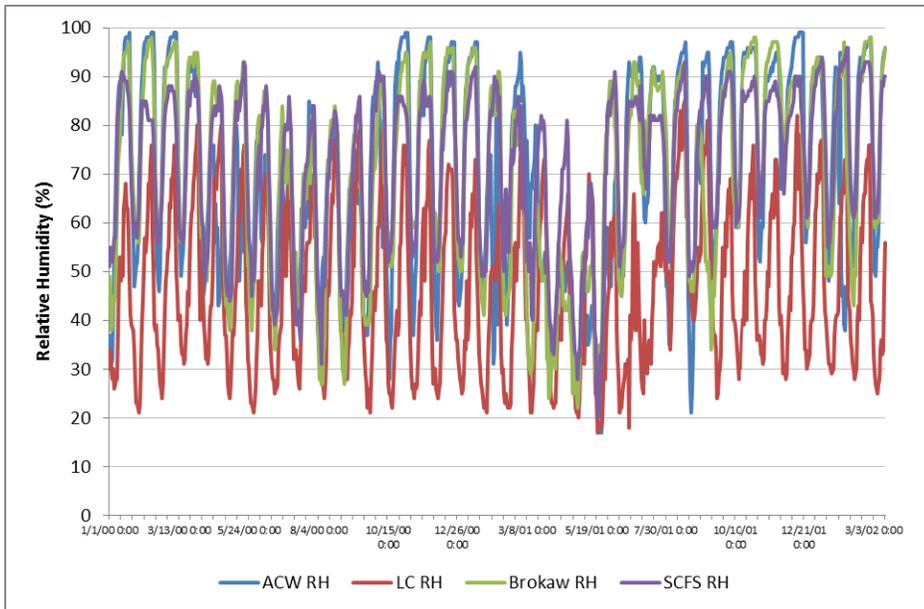
Variety Rootstock Trial

We previously reported that trees had been ordered for a new scion/rootstock trial with Brokaw Nursery in February 2010 with anticipated planting date of April 2011. The trees unfortunately were not ready for planting this spring. Rather, the trees are being repropagated for a Spring 2012 planting. This new trial will be located in Ventura County. The scions to be included in this trial are ‘Hass’, ‘Carmen Mendez’, ‘Lamb Hass’, ‘Gem’ and ‘Reed’. The rootstocks to be used for the trial were compiled in consultation with Greg Douhan and Larry Rose and include Dusa, Duke 7, RO.O6 (a promising

experimental rootstock from South Africa), Zentmyer, Uzi, Steddom, Brandon, Eddie and Anita. The latter 6 rootstocks are from the UCR rootstock program.



A.



B.

Figure 2. Weather data from August 18, 2011 through September 20, 2011 at the 4 Tier 3 evaluation sites. A. Temperature (°C). B. Relative Humidity (%)

Heritage varieties for nurseries: We make selections in our heritage collection available to nurseries. Due to cost increases in labor and water, we continue the process of moving any and all heritage and other varieties of interest out of Field 46 and into our germplasm collection in Field 44. In the future, our germplasm collection will be more geographically concentrated and thus more easily managed.

Collaboration with Domestic Researchers. We again provided sections of wood, or ‘bolts’ from our *Persea* relatives collection to Dr. Jorge Peña of the University of Florida in Homestead, FL as part of his host preference studies for the Ambrosia Beetle, the vector of Laurel Wilt, a lethal disease affecting members of the Lauraceae in the Southeastern US.

Overseas co-operation. We have answered several questions regarding exchange of material with potential overseas cooperators but currently nothing is in progress.

Website, e-mail and other outreach activities. Mr. David Stottlemyer has continued to assist us in maintaining our website, www.ucavo.ucr.edu. We are, however, currently assessing on how best to improve the website. We may contract with UCR web programmers to improve the site. We continue to answer e-mails from California growers as well as those outside the state and US on general questions. We have had several visitors to SCREC this last year to view our progress as well.