California Cling Peach Advisory

Board 2015 Annual Report

Project Titles: Regional Testing of New Cling Peach Selections

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Objectives:

A. Continue the evaluation of UCD Experimentals currently in regional trials, particularly those in the *Dixon-Andross* and *Halford-Corona* season. Determine appropriate disposition of the most promising selections currently in regional testing, particularly *Ultra-Early#1, Early#5, Early#6 and Extra-Lates#1 through 4.*

B. Identify candidates for the next round of regional testing and establish virus-free FPS foundation nursery stock for new items and verify trueness-to-type of advanced selections already in Foundation Plant Services (FPS). Work with processors and growers in defining and testing fruit and tree characteristics required for effective mechanical and once-over harvesting.

C. Continue the low-volume high-throughput fruit-sample processing at the new UCD Pilot Plant. Expand grower/processor opportunities to evaluate raw & processed UCD Experimentals.

2015 Summary

The recently released *Kader* variety, ripening between *Carson* and *Andross*, represents the 1st of a new series of UCD processing peach cultivars, selected for traditional high productivity and processing quality with the additional advantages of improved fruit brown-rot resistance and the capacity of ripe fruit to hold on the tree for a week or more without loss in quality, thus allowing the potential for once-over and mechanical harvest. *Early#5*, a companion selection to *Kader*, ripening with, to just after *Andross* and possessing similar qualities as *Kader* is currently being considered for patenting and release. Although many regional test plantings of UCD advanced selections have been lost with the recent wave of general orchard removals, the initial test plantings have generated sufficient industry interest in this selection that over 11,000 new trees have been nursery propagated in 2015 for renewed grower and processor evaluation. A comprehensive assessment of the 6+ years of available production data for *Early#5* documents exceptional tree productivity and fruit quality without the serious red-pit-staining and associated fragments which plague *Andross*. Fruit readily hold on the tree for a week or more, allowing greater harvest flexibility for grower and processor. *Early*#6, a third advanced selection with similar characteristics but ripening approximately one week before *Andross* and so in the targeted *Dixon* period, continues to look promising but will require additional regional testing. Evaluation updates based on 2015 performance are provided for remaining Ultra-Early, Late, and Extra-Late advanced selections, as well as the Compact tree size selections. In addition to producing more compact trees to facilitate harvest, the gene controlling the compact trait also suppresses aggressive epicormic watersprout' growth, thus allowing dramatic reductions in summer and winter pruning.

Introduction

Because of the requirements for longer orchard productivity and production efficiency for processed compared to fresh-market fruit, new varieties need to be thoroughly tested in the different production regions and under the range of environment/cultural conditions anticipated for commercial production. This is necessary to identify the most promising selections for release to growers as well as to detect any deficiencies prior to large-scale commercial plantings. During the last several years, over 5,500 trees of UCD processing peach selections have been planted in regional evaluation blocks to accelerate the evaluation and release of improved varieties to the California industry. Regional testing data has expedited the release of *Extra-Early#1* in 2014-15 as the variety *Kader* which provides California growers with a productive, high processing-quality and improved brown rot resistant variety with the desired harvest time between *Carson* and <u>*Andross*</u>. Other UCD Experimentals currently in extended regional trials include *Extra-Early#2, Early#4, Early#5, Late#2, Extra- Late#1, Extra-Late#2 and Extra-Late#3, with* a smaller number of trees of *Ultra-Early#2, Ultra- Early#3, Ultra-Early#4, Late#3, Late#4,* and *Extra-Late#3*. [Regional selection designations are based on the *Maturity period* -followed by a number indicating sequence of release for grower testing]. More recently, we initiated regional test plantings of *Ultra-Early#1, Early*#6, *Extra- Late#4, Extra-Late#5, Extra-Late#6,* and *Extra-Late#7* which represent genetically novel selections developed to facilitate mechanical harvest. A genetically controlled more compact tree architecture (resulting in final tree sizes of ½ to 2/3 of standard) for facilitating mechanical orchard management (thin/prune/harvest) is also now in production at Sacramento and San Joaquin Valley grower trials. Over 1,200 additional *Early* to *Extra-Late* selections have been planted since 2010-14, particularly *Early#5 & Early#6* which show promise as high processing quality, firm and productive cultivars in the *Dixon-Andross* time period, *Late#4* which shows promise as a mid-season mechanically harvestable cultivar, and *Ultra-Early#1* which, because of its very early harvest and improved fruit brown rot resistance, is being tested under both organic and standard management. Many of these earlier UCD experimental plantings were lost when growers removed their cling peach orchards with the recent economic downturn. While early performance data was often collected prior to orchard removal, the loss puts greater importance on evaluations of new test plantings. In addition, the next generation of advanced processing peach breeding selections combining high productivity, improve disease resistance and improved harvest ability as well as greater environmental stability (owing to its derivation from multiple genetic sources) is now being selected for the next round of regional testing

Progress: 2015

As presented in the Introduction and more thoroughly documented in the in accompanying 2015 Processing Peach Variety Development Annual Report, the California processing peach industry has moved into an era of changing production and consumption demands while largely dependent on traditional cultivars developed from a very narrow initial germplasm. Recognizing that the traditional breeding germplasm of the 1990s was deficient to meet even basic traditional needs (such as replacement varieties in the *Dixon* harvest season), a major objective of our breeding program has been to identify, introgress, and fully incorporate the often more exotic germplasm having the potential for meeting these needs. The Cling Peach Variety Development Project has subsequently been developed as the engine to develop new and practical genetic solutions to current and emerging California cling production needs. Because of the complex genetic interactions in any new variety, thorough testing is required in all anticipated production environments before they can be confidently recommended to growers. The goal of the Regional Testing Project is work closely with growers and processors to oversee these regional evaluations, including a careful assessment of canning quality using standard industry equipment and procedures but under the more controlled conditions allowed at the UCD Mondavi pilot processing plant. We are currently in a transition period where the 1st generation of breeding selections that was advanced to regional testing is being carefully examined for their merit for further advancement to patenting and release as new varieties. At the same time, the next generation of breeding selections, many of which incorporate some of the newer genetic options developed over the past decade, have been selected for advancement to grower testing.

Promising Extra-Early to Early selections in Regional Testing

The 1st generation of regional testing selections has targeted replacements in the Dixon-Andross season, replacements in the Halford-Starn season, as well as early and late season-extension. In the Extra-Late season, *Lilleland*, released as a *Halford* alternative, is seeing increasing grower interest. Advanced selections *Extra-Late #4* through *7*, while showing good fruit and tree quality, extend the harvest season later than *Corona*, which currently does not appear to be a processor priority. Most remaining promising selections ripen in the Extra-Early to Early Season. Table 1 presents averages of data collected over the 3 years of the RosBreed-1 project. *UltraEarly#1*, while consistently demonstrating exceptional fruit size, firmness, soluble solids and desirable Brix/TA ratio, ripens up to 2 weeks before Loadel which has been too early for processor use (though the increasing plantings of *Ceres-Carson* may change this). *UltraEarly#1* also possesses good levels of fruit brown rot resistance and is currently being tested in organic production for canned peaches. [The very early harvest season allows processor runs before non-organic peaches contaminate the lines. The more gold-yellow flesh color of *UltraEarly#1, (*see a* value in Table 1) enhances the color appeal of the peach while it's very early harvest does not risk mixing with the paler colored varieties such as Loadel]. Updated regional information for this item is summarized in Appendix A.

With the recent release of the *Kader* processing peach variety targeting the harvest season between *Carson* and *Andross* (i.e. the *Dixon* variety gap), the next breeding objective is to provide an alternative variety for *Andross*. *Early# 5* has been test-planted over the last 6 years as a promising new variety at this harvest time. While most of these regional evaluation plots were lost when growers pulled out entire orchards during the economic downturn, the limited data remaining appeared sufficiently promising to promote considerable grower and processor interest. In 2015, 11,000 new trees, primarily of *Early#5*, were propagated by cooperating nurseries for regional grower plantings in 2016. In addition, data from remaining evaluation plots, including previous evaluation years, have been compiled, analyzed, and summarized below as a primer to possible formal patenting an industry release in 2016 or 2017.

Table 1. Fruit quality data averaged over the 3 years of the RosBreed-1 evaluations, for promising advanced selections in the Extra-Early and Early maturity season and which are currently undergoing regional testing. Standard cultivars are included for reference. The variety *Kader* (highlighted in gold) was released in 2014-15 being previously tested as ExtraEarly#1 (Figure 1). [Intermediate shading identifies varieties released earlier in this program while light shading identifies previous UCD releases. Promising advanced selections are highlighted in yellow.]

Selection	Seed Parent	Pollen Parent	Blush	CIELAB color- a*	Red in pit	Harvest	pH	Brix	Brix/TA	TA	Fruit width (mm)	Fruit length (mm)	Fruit cheek width (mm)	Fruit weight (g)	Flesh firm. (lbs.)
UltraEarly#1	NJC83	Conserva485	1	17.22	-	11-Jul	3.88	12.80	19.88	0.64	779.24	790.78	762.18	284.49	8.1
Loadel	Lovell	OP	1	5.65	-	16-Jul	3.85	8.00	16.81	0.48	671.38	684.94	643.38	183.74	8.3
Carson	Leader	Maxine		4.97	-	23-Jul	4.04	7.50	17.05	0.44	583.69	548.64	580.25	219.48	8.2
Dee-Six	Dix,4A-4	Dix,#3	1	8.07	-	29-Jul	4.14	10.00	22.32	0.45	651.75	669.41	617.09	226.82	7.3
Kader	Ross	R1-1	3	6.98	-	29-Jul	3.98	12.50	25.67	0.49	723.77	657.67	659.26	332.74	7.2
Early#6	Woltemade	ExtraLate#2	1	5.03	-	29-Jul	3.81	10.80	19.85	0.54	700.71	693.79	761.97	237.94	7.7
Compact#2	Compact#1	Self	3	11.42	-	29-Jul	3.82	10.30	17.67	0.58	772.68	674.48	826.99	307.22	7.7
Dixon	Australian Muir	Orange Cling	4	6.07	+	29-Jul	4.06	12.30	30.22	0.41	769.97	763.35	719.71	226.42	5.6
Goodwin	DrDavis	11_11_37	2	9.07	-	3-Aug	3.85	12.70	22.56	0.56	728.08	706.53	720.79	236.20	9.4
Andross	Fortuna	Dix_5A_1	1	6.87	+	10-Aug	4.09	12.40	30.54	0.41	788.19	784.22	674.54	332.22	6.5
Early#5	Loadel	UltraEarly#3	2	11.99	-	11-Aug	3.77	11.50	20.80	0.55	709.42	583.21	669.15	235.68	7.2
Klampt	Dixon	Wiser	1	5.43	-	12-Aug	3.87	10.70	21.57	0.50	830.48	874.03	704.69	353.12	5.9
Ross	D_30_3E	GH_8_14	3	5.27	-	13-Aug	3.82	10.80	22.45	0.48	719.72	707.10	645.08	236.02	9.2
DrDavis	D25_9E	G40_5E	2	7.17	-	19-Aug	3.85	11.80	22.35	0.53	743.07	740.33	729.54	320.00	8.2

Early#5 ripens with, to just after *Andross,* and possesses fruit and tree characteristics similar to the variety *Ross* (Table 1, Figure 1). Fruit are similar to *Ross* in size though slightly more oblate in shape and with less red-blush. Fruit are typically firmer than *Andross* (Table 1, Figure 3) with some softening occurring on shoulders and at the suture as the fruit become overripe. Fruit tend to hang well on tree without significant loss in quality though pit cavities will gain some reddening by 10-14 days after full-ripe. In hotter regions such as the southern San Joaquin, some fruit flesh may develop a reddish stain when 5+ d overripe (as in the 2013

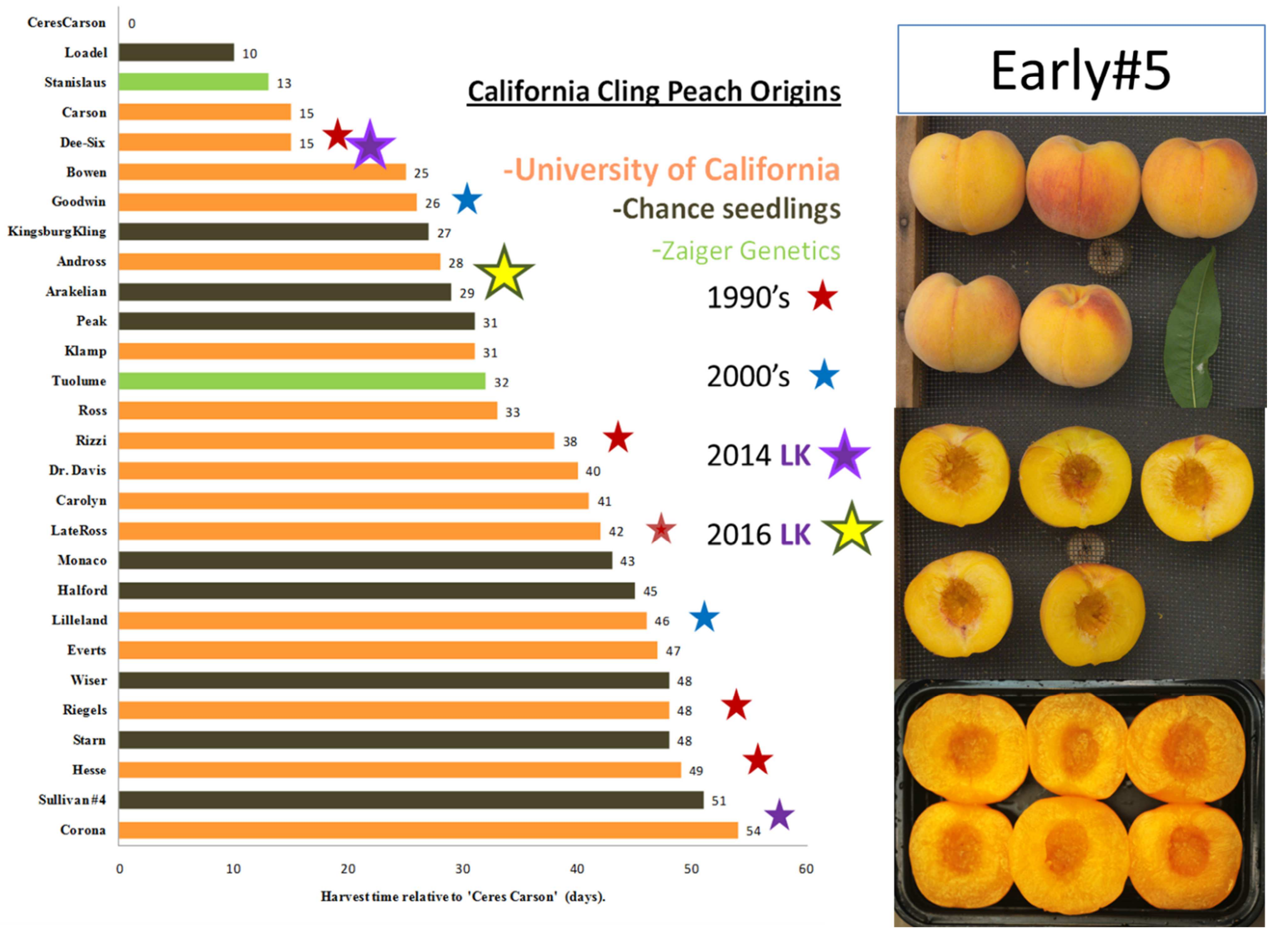


Figure 1. Top-Left: Harvest season of *Early#5* (gold star) relative to other commercial processing peach varieties, showing its ripening with to just after *Andross*. (Because fruit of Early#5 hold on the tree well after full-ripe, harvest may be delayed until *Ross* season allowing growers and processes more harvest flexibility). [Gold bars designate other varieties released by the UC program, black bars represent chance grower selections and green bars are varieties released by private breeders].

Top-Right: Raw fruit of *Early#5* at the tree ripe stage and peach halves processed in 2015 (bottom).

Right: Lineage of *Early#5*.

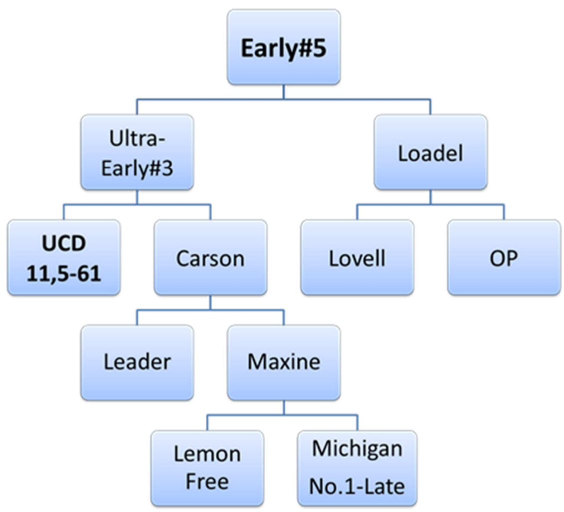


image in Figure 2). Some brown-rot has been observed in regional trials. Flesh has also shown low bruising/browning potential in recent tests, a characteristic which has been verified recently in work and Dr. Barrett's lab. Fruit readily hold on the tree for one to 2 weeks after initial tree ripe allowing greater flexibility in grower and processor harvest (Figure 3). Fruit size well, requiring less thinning than other varieties such as *Loadel*, though under-thinned fruit will develop to a moderate final size rather than the distinctly larger fruit observed in varieties such as *Dr. Davis*. Trees are hardy with yields comparable to and typically larger than *Andross* (within the limited trial data analyzed to date). Some fruit drop has been observed, particularly if developing fruit are left in clumps and ripening is delayed for a week or more after initial tree ripe stage. Fruit process well, and the relatively small pit, combined with low incidence of pit staining and pit fragments have resulted in higher case yields than *Andross*. Some pit fragments and split-pits have been observed (~3%) but consistently less than *Andross* and other accessions ripening at this very vulnerable time period

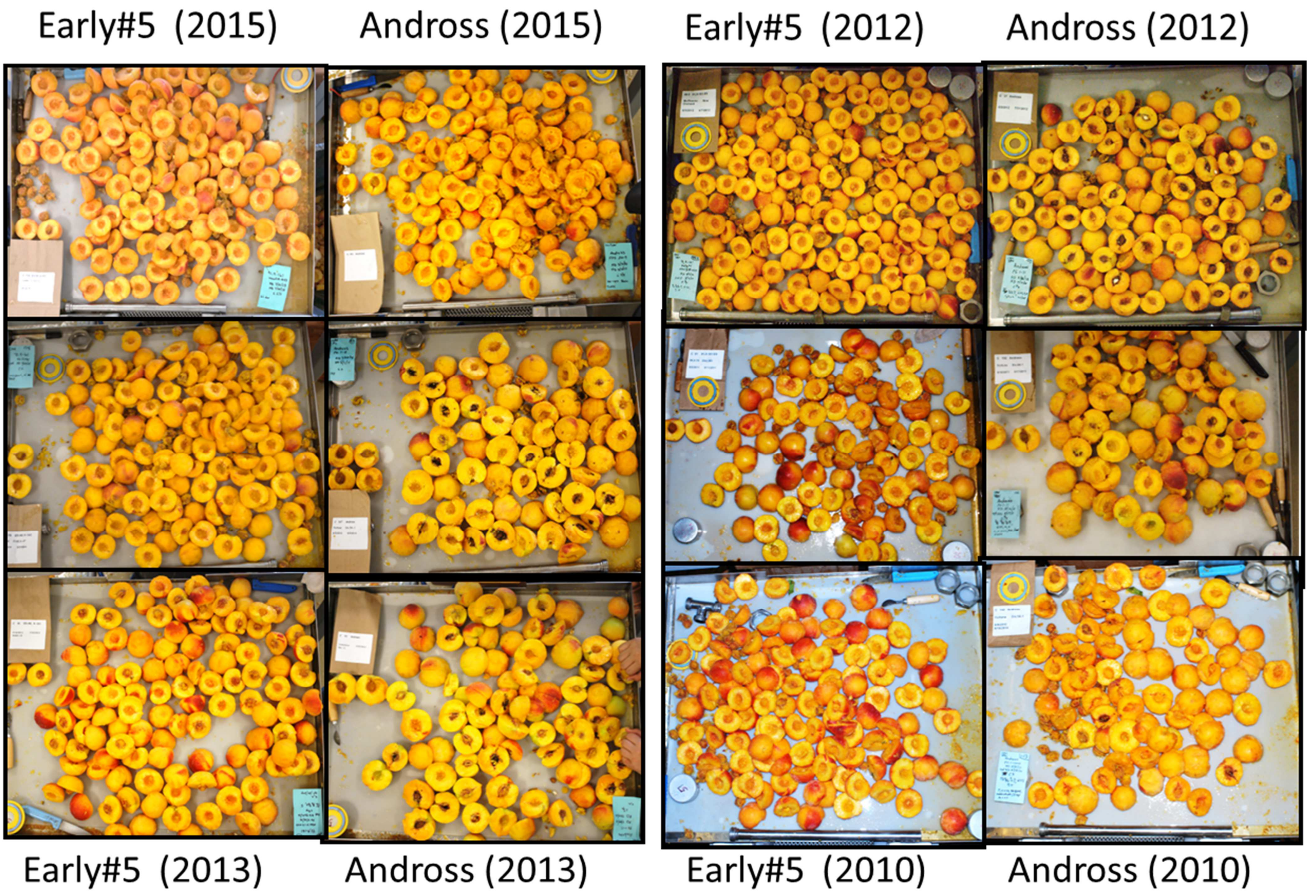
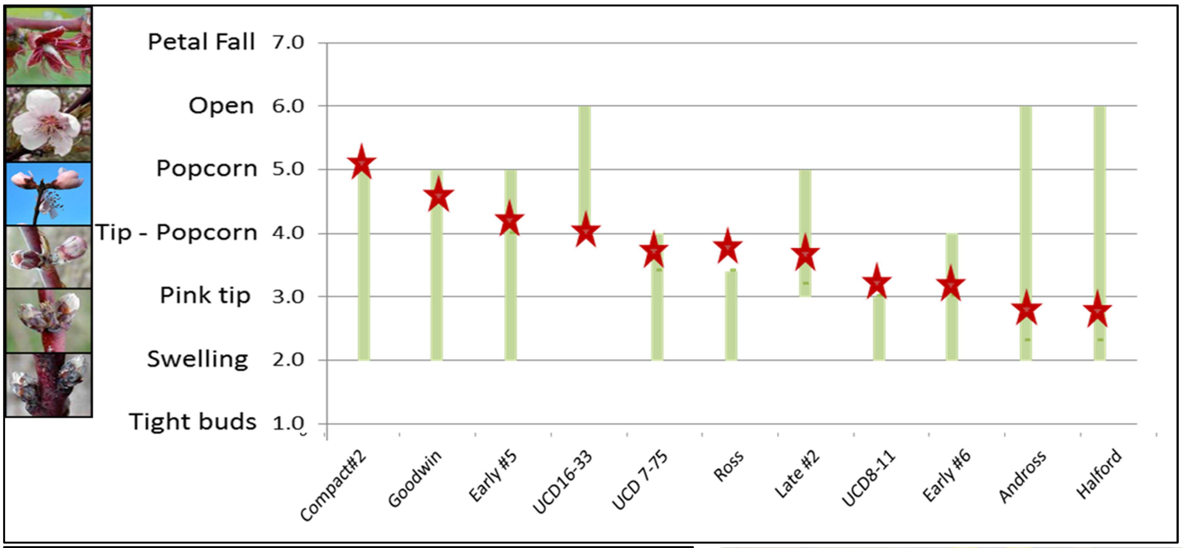
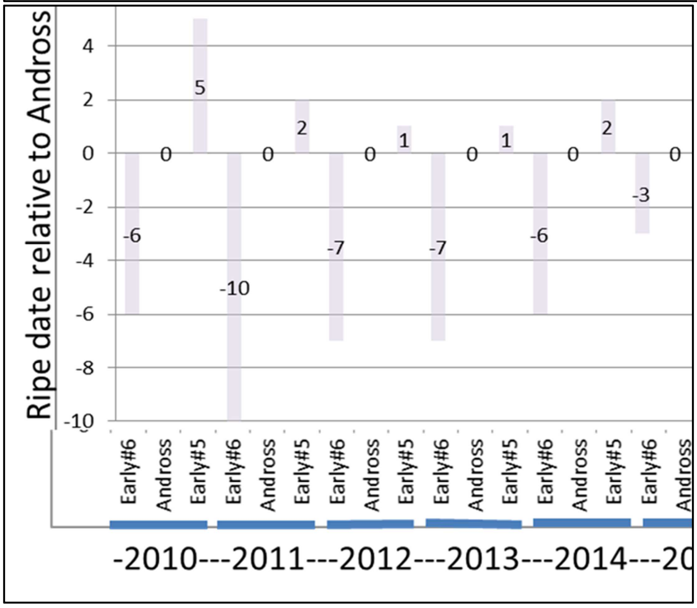


Figure 2. Tree-ripe fruit samples of *Early*#5 and adjacently planted *Andross* prior to processing at the UCD Mondavi pilot plant. Six consecutive years are shown, ranging from 2010 at bottom right to 2015 at top left.

Early#5 resulted from a cross between *Loadel* and *Ultra-Early#3* (Figure 1) which had largely traditional parents with the exception of UCD11,5-61 whose origins remain uncertain. Molecular markers analysis suggests that UCD 11, 5-61 represents a distinct





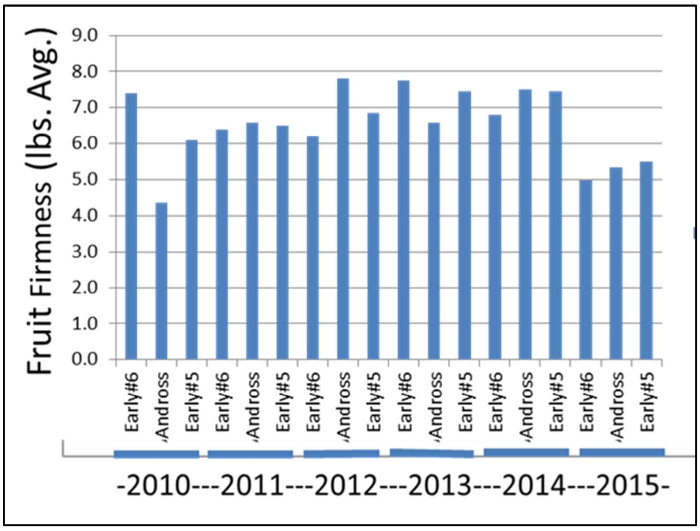


Figure 3. **Top**: low chill flowering performance of *Early#5* relative to other varieties and selections.
Center left: Ripe Date of Early5 and Early6 relative to *Andross* for the past 6 years.
Center right: Raw fruit of Early#5 at the tree ripe stage (top) and harvested 2 weeks after the full ripe stage (bottom) from 2013 crop.
Right: fruit firmness at tree ripe for Early5 and Early6 versus Andross during the past 6 years.

germplasm, and it is also unique in that it's fruit maintain quality on the tree for up to 10 days after tree ripe, which appears to be the source for the 'long-keeper' quality of *Early*#5.

Early#5 is also among the advanced UCD items under selection for tolerance to erratic winter chill conditions. Winter bud-chilling is a complex phenomenon, involving cold temperatures below and warm temperatures above changeable thresholds, which can be enhanced by periods of fog and corrupted by periods of midwinter heat, thus making selection indicators difficult to identify. For over 15 years, the UCD breeding program has monitored and made selections based upon the final outcome: the final density viable flower buds as well as the timing and duration of the viable bloom. The 2014/15 winter bloom was among the most erratic in recent history resulting in low flower density and a prolonged blooming period for many varieties, which in turn, resulted in widely different fruit development and so ripening times within the same tree. The red star In Figure 3 gives the viable flower bud density (0-none, 5-very high), while the vertical bar denotes the range in bud state at the time of evaluation (February 22, 2015). High viable bud densities with relatively uniform bud development (concentrated vertical bars) are most desirable. Flower bud-concentration and the concentrated-development phase for the UCD selections shown, document significant improvements when compared to standard varieties such as *Andross* and *Halford* (Figure 3). [Similar results were obtained in 2013/14, which was another low-chill year].

With the anticipated release of *Early*#5 in the near future, *Early*#6 advances to the next UCD selection with sufficient data to justify consideration for release. *Early*#6 ripens approximately one week before *Andross* (Figure 3), which positions it squarely in the desirable Dixon gap (Figure 1) and would culminate the release of several new varieties covering this important harvest season. *Early6* is derived from South African germplasm and represents an even greater deviation from traditional material then *Early5* with preliminary regional testing showing good fruit size, color, firmness and cropping potential. An updated discussion of Early6 is presented in Appendix A.

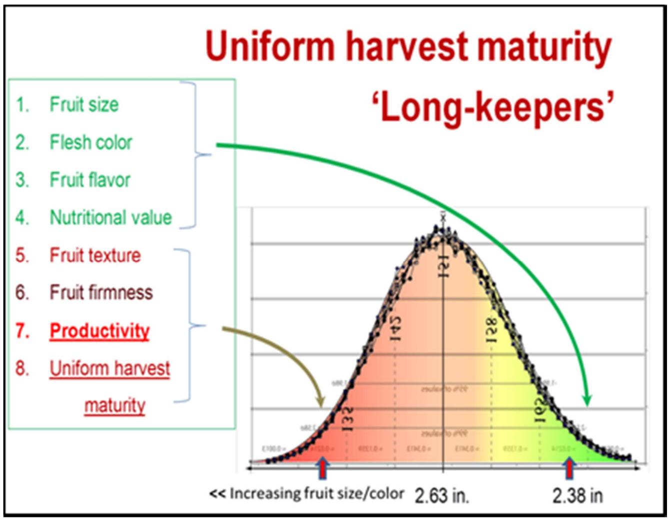


Figure 4. Plot showing potential improvements in overall fruit quality and productivity with the long-keeper trait. Normal curve shows the expected distribution of fruit sizes at a typical harvest time. Harvesting at this time avoids loss of quality in the 1st to ripen fruit from over-ripening, but may leave 5% or more of the crop under-ripe. Allowing increase time on the tree provides time for the immature fruit to ripen (increasing quality and yield) as well as most remaining fruit to finish ripening and sizing (again increasing quality and yield). [Maturation time moves from right to left on the plot].

Evaluations of new and advanced UCD breeding selections.

Over 300 selections were evaluated for harvest and postharvest fruit quality at the UCD Mondavi pilot plant in 2015, with approximately half of the samples further evaluated for processing quality. A summary of the most promising of these selections is provided in Table 2 with sample images from the January, 2016 cut-out evaluations provided in Figure 5. Harvest dates for items ranged from early July to early September, indicating good opportunities for harvest season extension if/when desired by the industry. To facilitate a greater grower capability for uniform, once-over harvest, strong breeding pressure has been directed towards this trait. Despite delays of harvest of up to 21 days after the initial fruit full-ripe development, fruit of good color and firmness (Table 2) as well as good processed appearance, including

Table 2. Summary data for promising selections from the 2015 fruit processing and subsequent cutout. Items include Advanced Selections currently in regional testing as well as new breeding selections identified as candidates for future regional testing.

No.	Selection	Seed Parent	Pollen Parent	Origin	Firm. Avg.	Firm. STD	Ripe	Harv.	Dif	Firm in Can
19	Ultra-Early#1	NJC5102893	Conserva485	Brazil	5.1	0.9	1-Jul	13-Jul	12	+
45	Compact#2	F10E22-59	Self	Compact	3.3	0.8	2-Jul	12-Jul	10	+
49	2011,4-88	05,20-118	Self	P. scoparia	4.0	1.9	1-Jul	14-Jul	13	+
58	91,12-54	Andross	Kakamas	South Africa	4.5	0.8	13-Jul	13-Jul	0	
84	2011,10-260	05,10-133	Spec/Can	Brazil	5.9	0.9	7-Jul	22-Jul	15	+
92	2011,23-149	06,1-20	clone	Traditional	5.3	1.1	7-Jul	22-Jul	15	
95	2011,6-260	07,9-101	Self	Almond	5.1	1.1	7-Jul	22-Jul	15	+
134	2010,13-80	05,27-232	Self	Early#5	6.2	1.0	18-Jul	5-Aug	18	+
136	2010,13-197	05,28-96	Self	Exotic	5.0	1.3	18-Jul	5-Aug	18	++
137	2010,21-280	18,8-23	02,6-300	CrimsonLady	4.4	1.6	18-Jul	5-Aug	18	
143	2010,5-210	Dr D	97,7-79	Almond	6.3	0.8	11-Jul	1-Aug	21	+
146	2010,8-310	99,12-155	Self	South Africa	3.0	2.0	15-Jul	1-Aug	17	+
156	2011,11-233	07,10-245	Self	Almond	5.0	1.1	15-Jul	1-Aug	17	+
179	Andross			Traditional	2.2	1.2	1-Aug	1-Aug	0	
181	Ross	D,30-3E	GH,8-14	Exotic	3.4	0.7	3-Aug	3-Aug	0	+
226	2011,10-83	07,7-187	Self	Almond	5.7	1.8	27-Jul	17-Aug	21	+
270	97,7-79	91,14-46	Self	Traditional	5.6	2.1	12-Aug	12-Aug	0	
290	2010,10-130	Riegels	04,4-155	Traditional	4.0	0.9	14-Aug	31-Aug	17	
308	00,16-133	F8,5-147	Self	Almond	5.7	0.9	18-Aug	28-Aug	10	+
320	2011,22-233	05,31-132	OP	Exotic	4.6	1.4	14-Aug	1-Sep	18	+

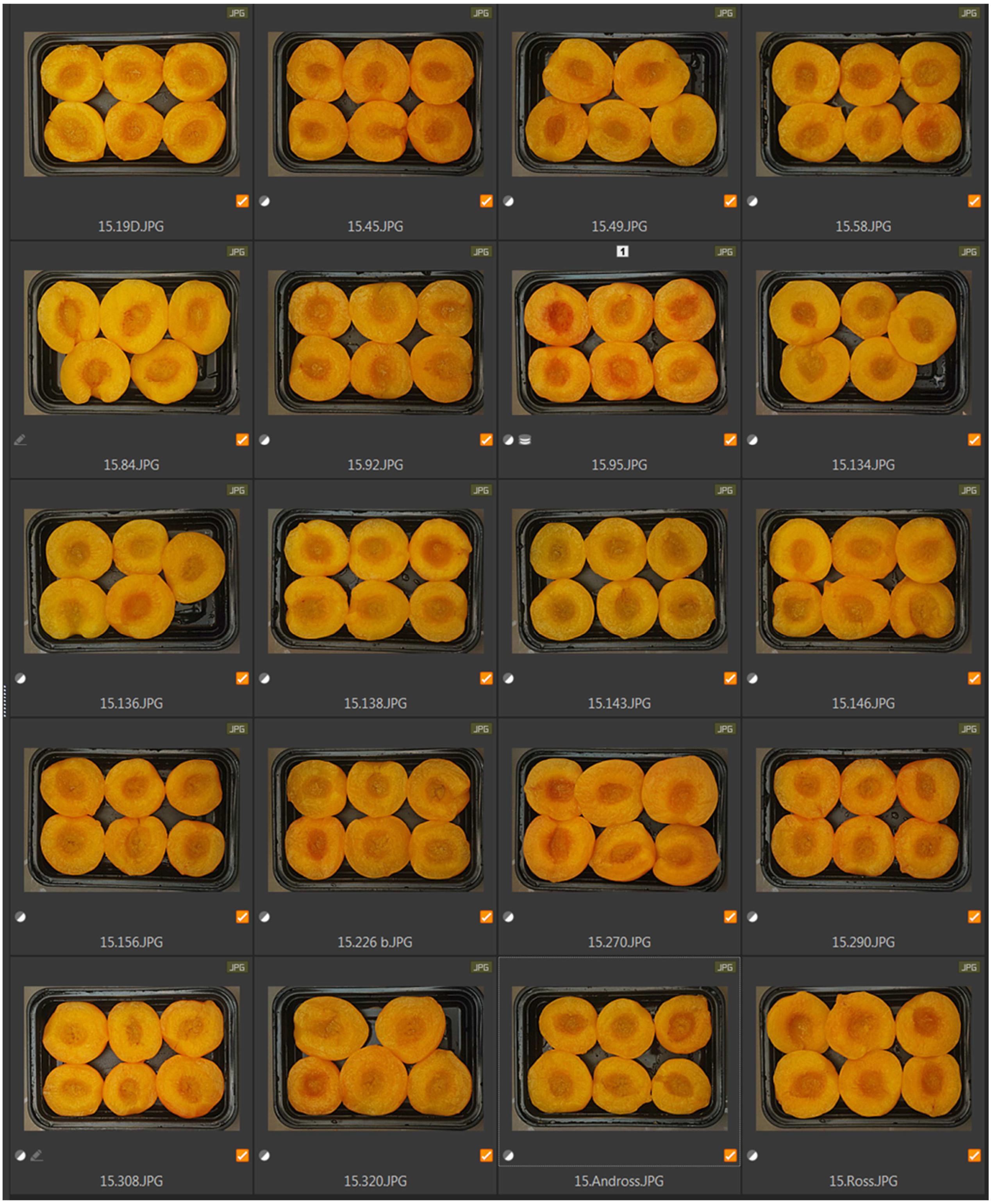


Fig. 5. Promising advanced selections from the 2015 canning quality evaluations. *Andross* and *Ross* are included at the bottom right for comparison.

freedom from pit fragments and red pit staining (Figure 5 and Table 2) were obtained. Advanced selections having the capacity to hold from one to several weeks on the tree without serious deterioration of fruit quality also tend to show improvements in fruit quality and final productivity (Figure 4) as well as good post-harvest cold storage life as both appear to be associated with resistance to fruit flesh deterioration. Figure 4 plots the potential improvements in overall fruit quality and productivity utilizing the 'long-keeper' trait. The normal distribution (bell-curve) shows the expected distribution of fruit sizes at a typical harvest time. Harvesting at this time avoids loss of quality with subsequent over-ripening in in the first -to-ripen fruit, but often leads 5% or more of the crop under-ripe and of lesser quality (requiring multiple-harvest with field bin rogueing of undersized fruit). The 'long-keeper' trait allows increased time for fully-ripe fruit to remain on the tree, allowing the immature fruit to ripen (increasing overall quality and yield) as well as allowing all fruit to fully ripen and size (again increasing overall quality and yield). This capacity also facilitates once-over harvest and even mechanical harvest in times of labor shortage. As in 2014, wide diversity of germplasm donor sources is also documented with breeding lines including Brazilian and South African germplasm, peach relatives (exotics), cultivated almond and the related almond species *Prunus scoparia* and *P. argentea*. The capacity of fruit to hold on the tree after the full ripe stage without appreciable deterioration was usually associated with germplasm derived from more exotic sources, with a few exceptions which appeared to be the result from beneficial mutations in commercial germplasm (as with the 'Compact' mutation). Higher fresh fruit firmness was usually associated with higher firmness for processed fruit as measured at the cut-out, though some interesting exceptions occurred where improved process-product firmness appears to be associated with differences in the fruit flesh matrix. Recent selections identified as candidates for future regional testing come primarily from the 2010 block and 2011 Blocks, reflecting the large sizes of these blocks (approximately 10,000 seedlings in each) as well as the general high-quality of the parents and parent combining ability in these breeding progeny. The availability of large populations of breeding progeny from diverse, including interspecific germplasm, yet at advanced stages of selection for commercial fruit and tree quality demonstrated by these populations, was crucial to their selection is the dominant peach germplasm for the next round of the RosBreed molecular marker development project. The primary objectives of of RosBreed-2 testing will also focus on parameters crucial to the processing peach industry including fruit quality and firmness and disease resistance (particularly to fruit brown rot disease). The germplasm diversity contained within the current UCD breeding populations represents an extensive genetic variability and so has greater opportunity to identify genetic solutions to current and evolving production problems (as described in more detail in earlier annual reports). A greater general or overall trait diversity, however, would be detrimental to breeding program efficiency as it would improve diversity both for the presence of desired as well as undesired traits. Intensive selection for high levels of locally-adapted commercial fruit quality has concentrated desired processing quality in current advanced UCD processing peach breeding lines while still maintaining a diverse germplasm base. Diverse origins can often indicate different mechanisms towards the same goal. Thus, opportunities for even higher expression of desired traits may be achieved when the different sources are combined or 'pyramided'. For example, data in Table 4 identify geographically independent sources for the ability of fruit to maintain integrity following the full-ripe stage, and our preliminary studies indicate independent mechanisms may be involved (different tissue matrix structure from almond and different structural integrity (endoPG softening) from the Brazilian (Conserva) germplasm. Similar results have also been found for fruit brown rot resistance.

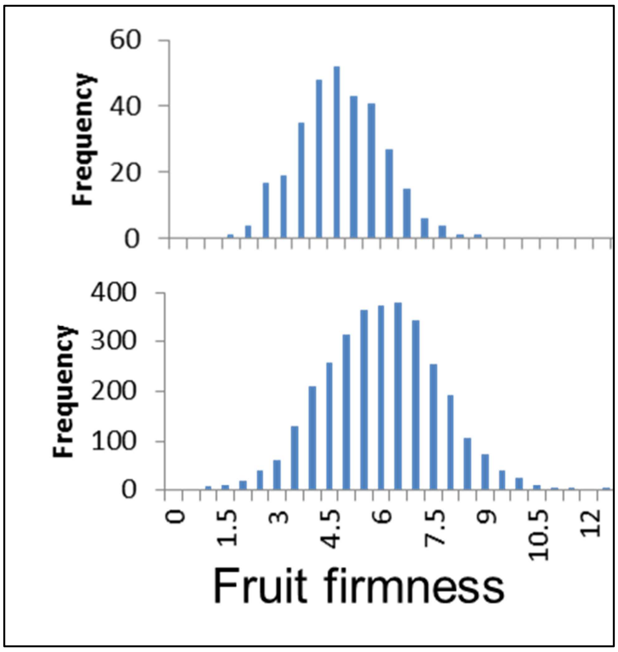


Figure 6. Frequency distribution plot for fruit firmness as measured for all fruit processed from 1995 to 2005 (bottom) as compared with fruits processed in 2015 (top). The distributions are surprisingly similar despite the fact that most fruit samples processed in 2015 were routinely harvested 2 weeks or more after the tree ripe date for that selection.

An indication of the progress that the breeding program has achieved over the past 2 decades is shown in Figure 6, which is a frequency distribution plot for fruit firmness as measured for all fruit processed from the mid-1990s to the mid 2000s (bottom) as compared with fruits samples processed in 2015 (top). The distributions are surprisingly similar despite the fact that most fruit samples processed in 2015 were routinely harvested 2 weeks or more after the tree-ripe date for that selection. [Fruit firmness is measured internally at the pit cavity in our program, as this allows a more accurate measurement of the softer inner or mesocarp tissue but results in a lower firmness score than typical for processing peach grading (which measures the firmer outside mesocarp after removing approximate 1 cm of the skin and outer flesh).]

Appendix A

Promising advanced selections currently in regional trials.

<u>Ultra-Early#1</u>

[UCD breeding designation D,62-193]. *Ultra-Early#1* is derived from a combination of Brazilian (*Conserva485*) and Eastern European (*NJC5102893*) peach germplasm from the Rutgers University breeding program of Dr. Fred Hough which was terminated in the late 1980's. The initial New Jersey selection expressed unusual sections of stem necrosis which we determined to be genetic rather than disease in origin. A series of clonal-source selections since the 1990's (based on the noninfectious-bud-failure elimination strategies developed in almond) has eliminated all trace of this condition in UCD and regional trial trees. *Ultra-Early#1* combines very good size and cropping potential with a very early maturity of approximately 8-12 d before *Loadel*. Despite its early maturity, this selection demonstrates exceptional compensatory-sizing capacity (i.e. the ability to aggressively size fruit

Fig. 7. *Ultra-Early#1*: lineage (top-left); heavily thinned fruit (top-center); 2015 processed fruit (top- right); bottom-left: 2012 fruit at 10d passed tree-ripe, and bottom right are 2015 fruit from tree-ripe harvest. Note a tendency for irregular fruit shape and some beaks at fruit tip.

when more resources become available, as would occur when the crop is over- thinned or early fruit loss from weather, disease, etc.). The aggressive fruit sizing compensates by making remaining fruit and so yield appreciably larger. *Ultra-Early#1* has also shown improved resistance to fruit brown rot and has been an important parent for both early maturity good fruit size and firmness and fruit brown rot. (More data presented in 2012 to 2014 annual Variety Development reports). However, because it is so early, it matures before most processing plants open. The exception was the Kingsburg Del Monte plant, which when closed may have orphaned this variety which has potential for early season extension. However it's exceptional size and yield potential for such an early season combined with its high level of brown rot resistance have made this a particularly attractive variety for organic production of processed product as it allows the product to be processed in the plant before contamination by non-organic fruit. The high orange gold flesh color of this selection would also result in a more desirable processed product without the undesirable risk of mixing with lighter colored fruit (which would result in an inconsistent canned product). Fruit in 2015 continued to show good fresh to and process quality (Table 2, Figures 5 and 7).

Early#6

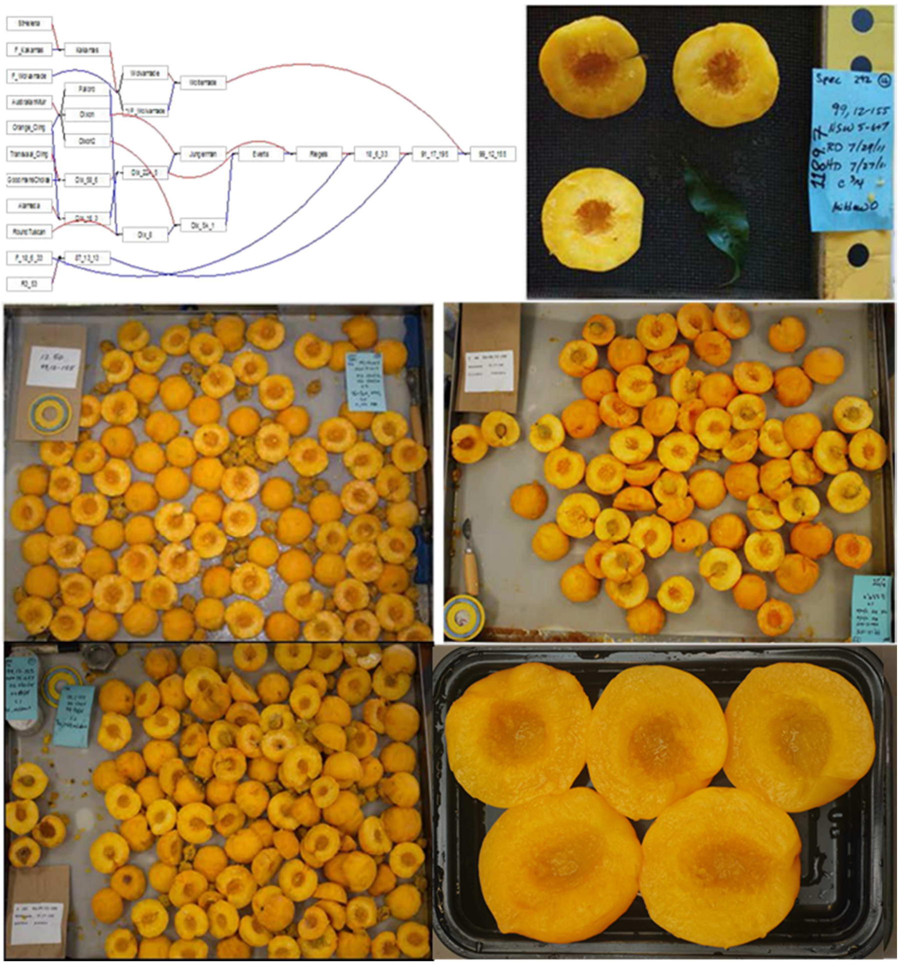


Fig. 8. *Early#6* lineage (top-left), heavily thinned 2012 fruit (top-right) middle shows standard thinned-fruit from 2012 harvested at tree ripe stage (left image) and 2013 harvested at 2 weeks after tree ripe stage (right image). Bottom: 2014 fruit harvested at 2 weeks after tree ripe stage left and processed 2015 fruit, right.

[UCD breeding designation 99,12-155]. *Early#6* is an advanced fourth-generation selection derived from South African germplasm combining the long-keeper potential of *Late#4* with a more traditional golden-yellow flesh color, and a maturity time within the crucial *Dixon-Andross* season. This selection has consistently shown superior fruit color as well as harvest- and post-harvest firmness and cropping potential over a multi-year test period. Fruit maintain integrity and quality 14 days or more after tree-ripe (*Long-Keeper* trait) allowing delayed or once-over harvest. Good levels of fruit brown rot resistance have also been achieved both in the lab and field, as well as moderate levels of resistance to Monilinia flower blight. Fruit is medium large, uniformly round and firm even when overripe. Fruit remain totally free of red blush on the skin and, more importantly, no red stain development in the fruit pit-cavity even up to two weeks beyond the full-ripe date. (This genotype may be a carrier for a gene that is thought to shut down red pigmentation during fruit development but appears distinct from the standard gene with this expression known as the ‘highlighter’ gene in that, unlike ‘highlighter’, the *Early6* maintains good raw and flesh color with processing, (Figure 8). Pit-cavity is medium to large and somewhat ragged. Fruit weight following heavy thinning was moderately large (238g) being similar to *Ross* but somewhat smaller than *ExtraEarly-1*. Because *Early-6* harvest between *ExtraEarly-1* and *Early#5* it may complement these varieties as the fruit, while medium in shape, tend to be uniform and above the minimum required size. Because of its good color, freedom from red pit and pit fragments, and good fruit integrity even after fruit developed to the full-ripe stage, this breeding line will be extensively studied in the RosBreed molecular marker project which began in 2015 and is expected to continue until 2019. *Early*#6 has shown good tolerance to low-chill winter conditions of both 2013/14 and 2014/15 as it consistently produces high densities of concentrated (i.e. at similarly uniform development stage –see Figure 3) bloom with resulting in more uniform crop development and harvest.

Fig. 9. Characteristic of compressed shoot-growth for *compact* gene. Note the lack of strong watersprout growth at the site of pruning cut.

Compact#2 and Compact#3.

The compact trait results in a tree which is ½ to 2/3 standard size. It is controlled by a single incompletely dominant gene and so can be readily transferred using traditional breeding methods. The short tree size results from reduced internode sizes so that the number of nodes and so the number of potential flowers and fruit remains unchanged. The short internode length, however, results in a higher leaf density and higher degree of shoot shading, reducing lateral branches and resulting in an increased risk of developing blind wood. The trait, which appears to be a bud sport mutation in origin, also confers better fruit flesh integrity and suppression of epicormic or water sprout shoot growth (Fig. 9). Both have potential value for processing peach improvement.

Compact#2

[UCD breeding designations 99,6-292]. The trees are productive and compact, being approximately 1/2 to 2/3 standard heights (see 2010-11 Annual Reports for detailed data on tree architectures for the Compact series). Thus, while expressing high levels of

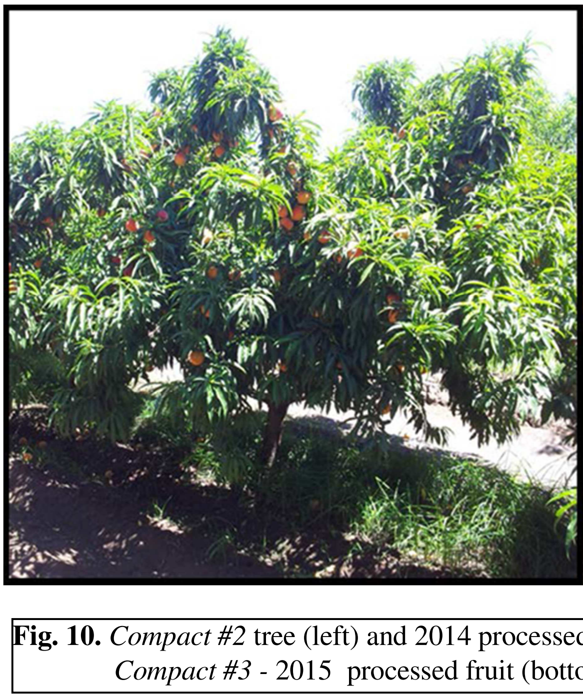


Fig. 10. *Compact #2* tree (left) and 2014 processed fruit (top-right). *Compact #3* - 2015 processed fruit (bottom-right).

fruit quality, a long-keeper type on-tree holding ability, and disease resistance, the selections will require novel management strategies to be commercially viable. *Compact#2* fruit ripen with *Dixon* and will hold on the tree until *Andross* time (see Figures 10 and 11). Fruit are medium in size, of very good quality with a good (on-tree) holding ability allowing a 1 to 2 week delay in harvest if necessary. Fruit can be only moderately firm (Table 2) but with high Brix, low bruising and moderate resistance to fruit brown rot. Fruit flesh is uniform gold to yellow-gold and is usually free of red pigmentation even when overripe (Fig. 5 and 10). Some pink in flesh was observed in pit cavities in 2008 and 2011, all of which cooked-out with processing. Skin is yellow-gold with up to 40% red blush. Trees are productive with relatively little blind-wood and low pre-harvest drop making them amenable to mechanical harvest. Some flesh bruising/browning was observed in overripe 2009-11 fruit and ~6% splits observed in 2010-11, though splitting was much lower as trees matured.

Compact#3

[UCD breeding designations 2001,18-215]. Compact#3 tree is productive and compact, being approximately 2/3 standard height (slightly larger than Compact-2, see 2010-11 annual Variety Development report. Fruit are of very good quality with a good on-tree holding ability allowing in one to two week delay in harvest if necessary. Fruit ripen with *Monaco* to *Halford* but will hold on the tree until *Corona*. Fruit flesh and skin is uniform yellow and free of red pigmentation. The fruit pit cavity is free of red-staining, though over-ripe fruit will often show a slight brown pit- imprinting, which after canning can appear as a slight pink imprinting in the pit (Fig. 10). Several taste-evaluators have noted that this color enhances the halved peach appearance (similar to frozen O'Henry halves). Trees are very productive with relatively little blind wood (which can be a problem with compact types), as well as low fruit brown rot and low-bruising, making them amenable to once-over or mechanical harvest.

The 'Compact' series (several additional compact genotypes maturing at differing time periods are in the early to mid- stages of selection) consequently offers unique opportunities for increasing both grower and processing efficiency of cling peach in California. As detailed in the 2010-11 annual reports, the trait is incompletely dominant in its genetic control and so relatively easily manipulated (placed in different maturity backgrounds). The major challenge to the Compact series is that it will require new horticultural practices (training, pruning, thinning, harvest- including the possible mechanization of all of these practices) to fully optimize its potential for decreasing California production costs. The good fruit quality in terms of firmness, color, freedom from red pit and splitting,

Fig. 11. *Compact#2* –Top Row, left to right: 2014 and 2013 harvested at 1 week after tree-ripe, 2013 harvest at 2 weeks after tree-ripe. *Compact#3*: –Bottom Row, left to right: 2014 harvested 1 week after tree-ripe, 2013 harvest at tree-ripe and 1 week after tree-ripe from a Modesto area grower test plot.

and good size and color will also contribute to improved processing efficiencies.

Commercialization would thus require considerable grower contributions in the area of field management. To encourage such grower innovation, we are considering the development of special arrangements with interested growers to provide the incentives they would require to invest in the long-term field research necessary. (Similar arrangements have been suggested for *Ultra-Early#1*). Regional test plots for this selection have also been promising with several growers indicating a desire for more extensive plantings.

Fig. 12. Visual assessment of side-by-side commercial planting of Monaco and *Compact*#3 after summer pruning. Although *Compact*#3 out-yielded *Monaco*, it required essentially no summer pruning compared to the extensive pruning with *Monaco*.

A second, potentially valuable characteristic of the compact trait is a strong suppression of aggressive ‘watersprout’ type growth following even heavy pruning. Figure 12 shows results from side-by-side commercial planting of *Monaco* and *Compact*#3 after summer pruning. Although *Compact*#3 outyielded *Monaco*, it required essentially no summer pruning compared to the extensive pruning occurring with *Monaco*. This suppression of aggressive epicormic growth may have application for routinely hedging processing peach varieties as a way to control fruit-wood renewal as well as high-density orchards. Tests are now underway in Davis and Winters, UCD plots, though grower experimentation would be more representative of commercial value.

Recent Relevant Publications

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2. Font i Forcada, C; T.M. Gradziel; C.Y. Gogorcena; M.A. Moreno. 2014. Phenotypic diversity among local Spanish and foreign peach and nectarine [Prunus persica (L.) Batsch] accessions. Euphytica 197:261–277. DOI 10.1007/s10681-014-1065-9.

3. Hanada, T; A. Watari, T. Kibe, H. Yamane, A. Wünsch, T.M. Gradziel, Y. Sasabe, H. Yaegaki, M. Yamaguchi and R. Tao. 2014. Two Novel Self-compatible S Haplotypes in Peach (Prunus persica). J. Japan. Soc. Hort. Sci. doi: 10.2503/jjshs1.CH-099.

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10. Minas IS, Font i Forcada C, Dangl GS, Gradziel TM, Dandekar AM, Crisosto CH (2015). Discovery of non-climacteric and suppressed climacteric bud sport mutations originating from a climacteric Japanese plum cultivar (*Prunus salicina* Lindl.). Frontiers in Plant Science 6:316.

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