California Cling Peach Advisory Board

2013 Annual Report

Project Titles:	Regional Testing of New Cling Peach Selections
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Objectives:

A. Finalize requirements for the patenting and release of *Extra-Early #1*, and possibly *Extra-Late#1* and *Ultra-Early #1*. Establish virus-free and verified true-to-type foundation nursery stock of these items for use by California nurseries for establishing propagation mother blocks

B. Continue the evaluation of more recent UCD Experimentals currently in regional trials, particularly those in the Dixon-Andross and Halford-Corona season. Work with processors and growers in defining and testing fruit and tree characteristics required for effective mechanical or once-over harvesting.

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

2013 Summary

The breeding program is in the final stages of patenting and release of *Extra-Early #1* with the expectation that budwood will be available to nurseries this coming propagation season. *Extra-Early #1* harvest just after Carson and because of its good on-tree fruit-holding ability, can be harvested into the *Dixon-Bowen* season. This UCD selection has demonstrated good fruit and tree qualities over a 10 year evaluation period, including freedom from red staining of the pit, a low proportion of split pits, and improved resistance to fruit brown rot and flesh browning. The exceptional fruit-sizing capacity of 'Extra-Early #1''combined with good fruit eating quality and firmness allow interior and otherwise slower-growing fruit to continue to size with delayed harvest, further contributing to a high yield potential. Foundation virus-tested trees of this genotype presently being maintained at FPS under the designation 'Extra-Early #1'. UCD advanced selection *Extra-Late#1*, a *Starn-Corona* season variety is the next candidate for patenting and release and we expect to move forward with this item by late 2014 if all fruit and tree characteristics continue to look promising. Other advanced selections which continue to look very promising include *Early#5, Early#6* and *Extra-Lates#5,6&7*. In order to encourage effective commercialization of the early season extension selection *Ultra-Early#1* as well as the modified tree structure selections *Compact 2* and *Compact 3,* special arrangements are being considered with growers willing to make the effort to adapt these novel tree types to California conditions. Over 100 advanced UCD selections were evaluated and processed at the new UCD Mondavi processing pilot plant on the UCD campus in addition to the over 400 initial and intermediate selections from the main breeding program, representing a sizable

increase from the 166 selections evaluated and processed in 2012, and demonstrating progress in pursuing low-cost high-throughput fruit-sample processing at the new facility**.**

Regional Testing of New Cling Peach Selections: 2013.

The primary goal of the Regional Testing program is the evaluation of suitability of breeding program selections for the different processing peach production areas, as well as final processing quality. For regional adaptability, over 5000 trees have been propagated and planted in grower and University research blocks in the major production areas of the Sacramento and San Joaquin valleys. While a number of these plantings have recently been lost with grower decisions to remove entire orchards, sufficient test plantings remain to assess general regional adaptability. To evaluate processing quality, selections were processed and canned at the new UCD Mondavi Processing Pilot Plant on the UCD campus. In addition to grower plantings, a large number of breeding selections are also test processed at the Mondavi facility. The recent breeding program emphasis for more extensive field plantings (in order to increase our likelihood of identifying the elite but rare individuals having all tree and fruit traits required for commercial success -see the 2013 annual report), has resulted in over 30,000 individual seedlings evaluated in 2013 from breeding program plots with an additional >3000 clonal propagations of 15 advanced selections evaluated at regional plantings. In 2013, over 500 selections were processed and evaluated at the UCD Mondavi plant with approximately 100 samples from regional test plots and the remainder from the breeding program representing a sizable increase from 166 selections processed in 2012. To increase selection intensity required to manage these larger populations a more rigorous initial screening was applied. For example, selections maintaining on-tree firmness for at least two weeks following the full ripe date were advanced to processing evaluations (provided they also maintain good qualities in other important fruit and tree characteristics). While quickly eliminating large proportion of the breeding population from further assessment, we found this approach improves our selection efficiency for fruit firmness and quality and postharvest stability, and greatly facilitates a longer term goal of once-over harvest to facilitate hand or machine harvest in the future. The distribution of fruit flesh firmness for breeding selections harvested at 0, 1, 2 and 3 weeks after tree ripe are presented in figure 1. (Some selections targeting other traits such as brown rot resistance or improved phtyonutrient content were still harvested at ripe or shortly thereafter, particularly if they are being considered as parents for future crosses). Even at 3 weeks after tree-ripe stage, sufficient fruit firmness remained in enough individuals to allow effective selection for this and other fruit quality traits, supporting this element of our high through-put selection strategy. (Samples presented later in this report as well as in the annual report on Cling Peach Variety Development demonstrate the successful recovery of good quality for other targeted traits as well). Following 2013 evaluations, selection *Extra-Early 1* was recommended for patenting and release and following University review is currently in the early stages of that process. UCD selection *Extra-Late* 1 is also in the final stages of consideration for release as is the nontraditional season-extension selection *Ultra-Early 1*. A summary of these and other promising advanced selections follow.

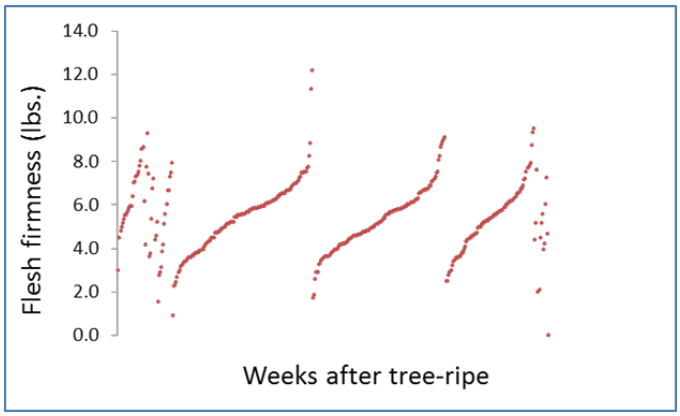


Figure 1. Distributions of fruit flesh firmness of 2003 breeding selections harvested at 0, 1, 2 and 3 weeks after tree-ripe stage**.**

Extra Early#1.

A long-term objective of the UCD processing peach breeding program is the development of replacements for the 'Early' maturity season varieties '*Dixon'* and '*Andross'*, and the 'Late' season varieties '*Halford', Starn* and *Corona. Dixon*, which was introduced in 1956, produced very high yields which made it a popular variety for growers. Fruit flesh was a desirable yellow-gold but with the pit often showing a pink to red color from the formation of red anthocyanins. However, this red color oxidizes to brown when canned, resulting in an undesirable fruit color as well as an undesirable brown staining of canned syrup. The red stained fruit stone or endocarp is also more susceptible to breakage resulting in pit fragments being left with the fruit flesh at processing. As result of these problems, processors have for many years refused to buy 'Dixon' fruit from growers. The variety is no longer commercially planted, though no replacement variety presently exists (Fig. 2). Since the early 1990s, many thousands of seedlings of processing peach have been developed and evaluated at UCD and *Extra-Early#1'and* the recently released 'Andross' replacement 'cv. '*Goodwin'*, and the 'Halford' replacement cv. *Lilleland* are products of this breeding effort. Originally designated as 90,9-116, this selection is the result of a controlled cross with the UC processing peach variety '*Ross'* as the female (seed) parent and the UC processing peach breeding line 'R1-1'as the male (pollen) parent (Fig. 2). UCD 90,9-116was first selected in the mid-1990s based on its good fruit and tree qualities, its freedom from red staining of the pit in processed flesh, and the desirable 'Dixon' ripening time and was propagated to regional test plantings at Winters (Wolfskill Experimental Orchards) and Davis, California, as well as at the Kearney Agricultural Center at Parlier, California. Based on promising results, additional, grower evaluation plots were established in

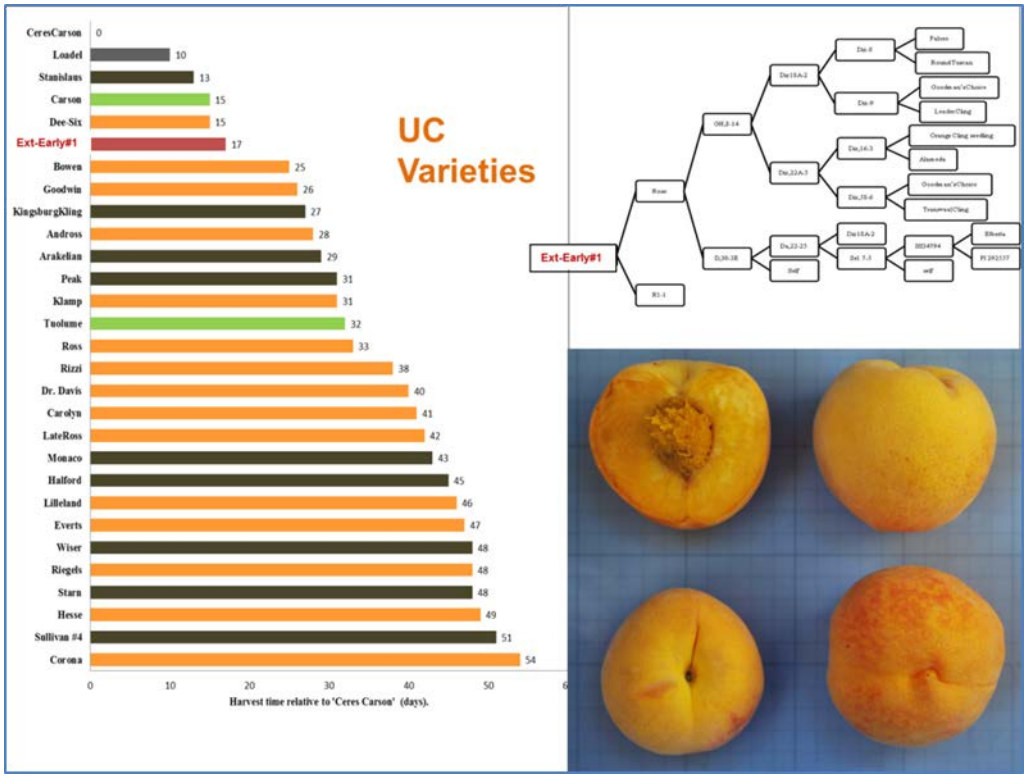


Figure 2. [Left] Maturity sequence of California processing peach varieties. The new cultivar Extra-Early #1 ripens between cv. Carson and cv. Bowen in the gap left by the loss of the cultivar Dixon. (Numbers indicate average ripening time (d) after cv. Ceres Carson. Orange bars are UC releases; green- private breeder releases, remainder are chance grower selections). [Top-right] lineage of Extra-Early#1. [Bottom-right] Highly thinned tree-ripe fruit of Extra-Early#1 on 1 cm grid.

2004 for this selection in the Sacramento and San Joaquin Valleys of California under the designation of 'Extra-Early #1'. Field evaluations through 2013 confirm earlier established desirable characteristics and indicate substantial commercial potential for the new variety. Sacramento Valley grower yields in 2011 and 2012 were above 15T/H for both years, being comparable to adjacently planted 'Early'-season 'Andross' variety and consistently 1 T/H above adjacent 'Extra-Early' season

Fig. 3. *Extra-Early#1* fruit following mechanical pitting and prior to lye- peeling and canning. Left image shows 2012 fruit at 10d passed tree-ripe stage while images at right is from tree-ripe 2013 harvest. (Color differences result primarily from different lighting, i.e. camera flash used in 2012, ambient light in 2013).

cv. Carson while displaying desirable fruit quality (Table 1, Figure 3). Tree-ripe fruit of this selection also demonstrate capacity to maintain good quality for over 1 week on-the-tree (Table 4) allowing delayed harvest and economically efficient once-over harvest including mechanical-harvest rather than multiple hand-harvests practiced for current varieties. Improved resistance to Monilinia fruit brown rot (Table 2) and resistance to flesh browning/bruising (Table 3) also contribute to very good delayed-harvest and post-harvest quality. The exceptional fruit-sizing capacity of 'Extra-Early #1''combined with good fruit eating quality and firmness (Table 1) allow interior and otherwise slower-growing fruit to continue to size with delayed harvest, further contributing to a high yield potential.

Wood of the new variety has been subjected to the virus indexing program of Foundation Plant Service (FPS), University of California at Davis, CA. All indices have proven to be negative for viruses for Foundation trees of this genotype presently being maintained at FPMS under the designation 'Extra-Early #1'.

The 'Extra-Early #1' peach is primarily a nonmelting clingstone peach that would be grown and sold as a processing fruit though because of its very good fruit size and fresh-eating quality would have some limited potential as a fresh market fruit.

Table 1. Fruit characteristics of the *Extra-Early #1* peach relative to commercial standards. (Average of 3 years from fruit randomly collected from 8 6-year-old trees planted at Davis, CA research plots which were heavily thinned to less than 1 fruit per 50cm bearing shoot to minimize competition effect).

Item	CIELAB color a*	CIELAB color b*	CIELAB color L*	Brix	TA	Brix/TA	pH	Fruit weight (g)	Fruit flesh firmness (lbs)	Maturity (d after Loadel)	Red in pit
Loadel	5.7 a	48.6 ab	70.8 a	8.0 a	0.5 ab	16.8	3.8 a	183.7 a	6.1 ab	0	(-)
Carson	5.0 a	50.8 b	71.5 a	7.5 a	0.4 a	17.0	4.0 a	219.5 ab	5.2 ab	5.3	(-)
ExtraEarly#1	7.0 ab	45.0 ab	77.2 ab	12.5 c	0.5 ab	25.7	4.0 a	332.7 bc	6.9 b	7.2	(-)
Dixon	6.1 ab	41.4 a	76.4 ab	12.3 c	0.4 a	30.2	4.1 a	226.4 ab	4.4 a	10.6	(+)
Goodwin	9.1 b	44 a	75.5 ab	12.7 c	0.6 b	22.6	3.9 a	236.2 ab	7.8 bc	15.9	(-)
Andross	6.9 ab	45.9 ab	78.1 ab	12.4 c	0.4 a	30.5	4.1 a	332.2 bc	7.5 bc	17.7	(+)
Klampt	5.4 a	46 ab	78.7 ab	10.7 ab	0.5 ab	21.6	3.9 a	353.1 c	5.4 ab	20.3	(-)
Ross	5.3 a	43.3 a	79.7 b	10.8 ab	0.5 ab	22.5	3.8 a	236.1 ab	8.2 c	23.8	(-)
DrDavis	7.2 ab	45.5 ab	78.8 ab	11.8 abc	0.5 ab	22.3	3.9 a	320.1 ab	5.8 ab	28.4	(-)

Table 2. Fruit Brown-rot disease scores following controlled lab inoculations and incubations. (3 year average).

Genotype	Lesion Diameter (mm)	Proportion Infected	Disease Severity
Carson	16.25	0.90	9.5
ExtraEarly#1	8.60	0.60	5.2
Goodwin	11.22	0.83	5.8
Andross	14.0	0.67	9.3
Ross	21.53	0.90	16.9
Dr.Davis	14.6	0.44	6.1

Table 3. Polyphenol oxidase (PPO) and associated fruit flesh bruising/browning following controlled lab incubations. (from 2013 Techakanon Thesis data).

Genotype	Flesh browning (CIE L* value - % loss over 12h)	PPO activity (mAbs/min)
Carson	0.04	156
ExtraEarly#1	0.03	178
Dixon	0.41	242
Goodwin	0.22	20
Andross	0.40	383
Ross	0.35	193

Table 4. Fruit flesh firmness (lbs.) at tree-ripe stage and 7 d after tree-ripe. (Firmness below 6 lbs. is considered too soft for canning).

Selection	Ave. firmness at Tree Ripe	STD	Ave. firmness at Tree Ripe + 7d	STD
Extra-Early#1	7.7	2.8	6.8	1.6
Dixon	6.3	2.0	4.9	0.8

Although fruit ripens between *Carson* and *Goodwin* (approximately the same time as the old *Dixon* variety) because it maintains good fruit integrity on the tree following the full-ripe stage, and can be harvested to *Andross* season. Fruit weight under conditions of heavy flower thinning is among the largest of the *Extra-Early* and *Early* selections tested (Table 1). This indicates an aggressive compensatory-sizing (very similar to *Andross*) which should facilitate consistently high grower yields. Fruit Brix (averaging 12.9) is also amongst the highest for these maturity seasons) and Brix/TA ratio is above the desired level of 20. *Extra-Early#1* has consistently shown good levels of fruit brown rot resistance (Table 2) and is being used as a parent for this trait. Fruit are generally symmetrical; though occasionally show some cheek asymmetry similar to *Goodwin* with which it shares some lineage (but does not show a similar tendency for split-pits). Flesh color is golden-yellow, also similar to *Goodwin* and also occasionally showing traces of green on shoulders. Flesh shows good firmness as well as low bruising/browning potential (Fig. 3, table Table 3). Skin is yellow-gold with up to 80% showing stippled red blush. Fruit drop, split pits, and pit fragments were low in 2006-20013 evaluations with some drop at KAC plantings in 2009 & 2010. Fruit are similar in size and shape to the *Dixon* cultivar but without the red-pit staining and excessive pit fragments associated with *Dixon*. Some slight pink discoloration of in pit cavities was observed in some overripe 2008, 2009 & 2010 samples but was lost with cooking. Early 2004 KAC test plantings of this selection included a few atypical trees which ripened 4-5 days after most trees in the selection, suggesting that some variability in maturity time may be present. Subsequent test

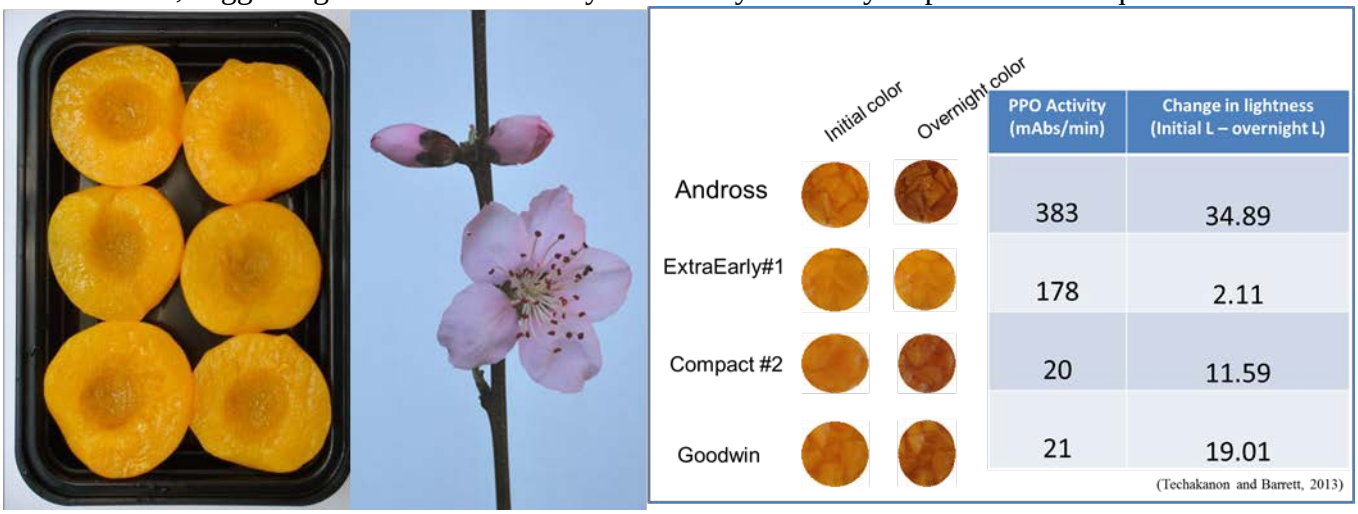


Fig. 4. Cut-out sample of *Extra-Early#1* fruit (left) and flower and bud (center). Right: Dr. Barrett's lab has shown low flesh browning in *Extra-Early#1* relative to commercial standards while maintaining moderate PPO levels believed desired for Monilinia brown-rot resistance.

plantings, including all grower test plantings, were propagated from individual Foundation trees established at FPS in virus-free isolation blocks. No deviations from fruit ripening time were observed in either FPS or propagated trees suggesting that off-types were the result of propagation error. Patenting regulations discourage the publishing of the final variety name until the patenting process has been completed. It is expected that this will occur in time for spring 2014 nursery propagations and that the variety will be named after a recently deceased UCD Department of Pomology Post-harvest Biologist who had dedicated his career to improving California processed and fresh fruit quality.

Extra-Late#1

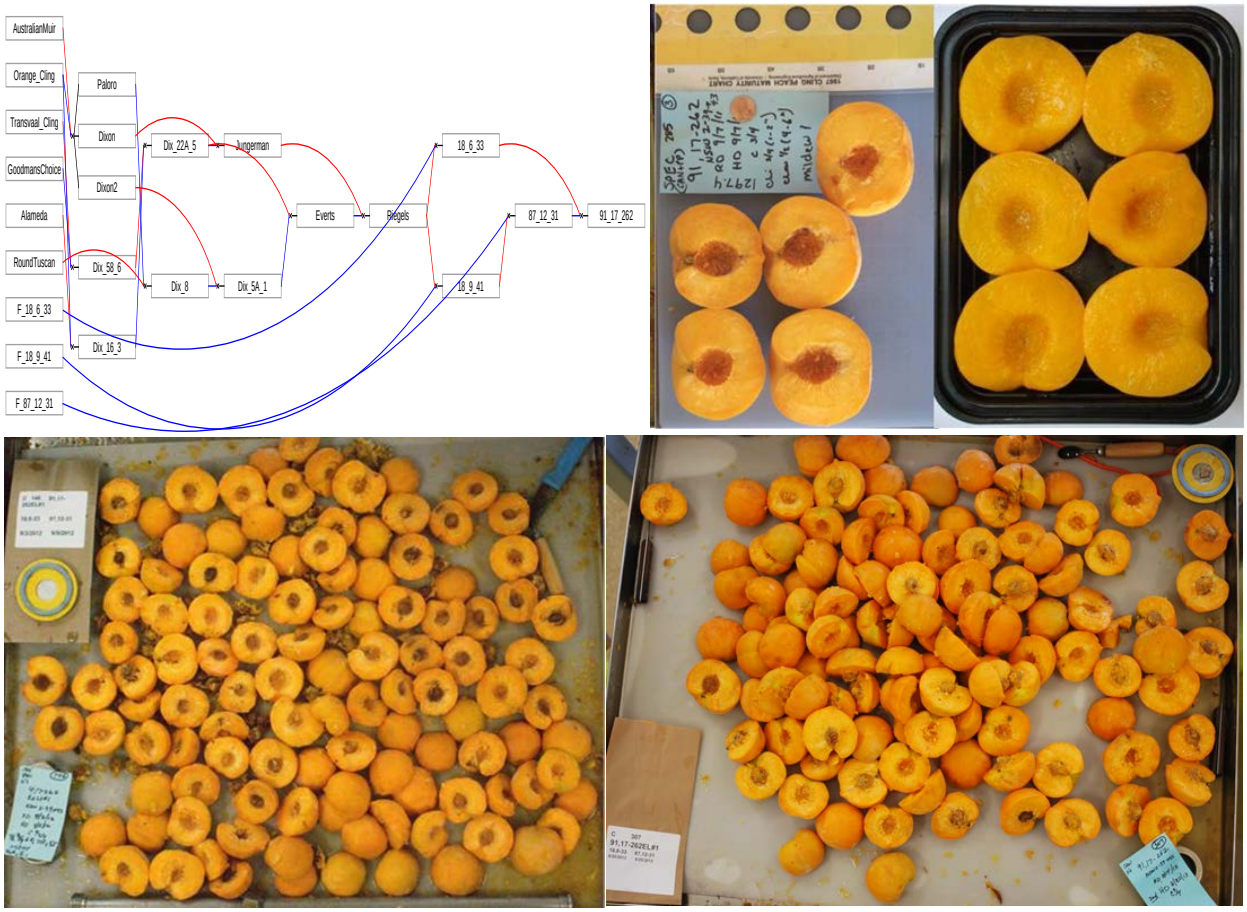


Fig. 5. *Extra- Late#1* lineage (top-left); heavily thinned fruit (top-center); processed fruit (top-right); bottom-left image shows 2012 fruit at 5d passed tree-ripe stage while bottom-right show tree-ripe fruit from 2013 harvest.

[UCD breeding designation 91,17-262]. *Extra-Late#1* is currently the next candidate for patenting and release and we expect to move forward with this item by late 2014 if all fruit and tree characteristics continue to look promising. Fruit ripen in the targeted *Starn-Corona* season. Fruit are medium to large in size with a moderately small pit contributing to improve processing case-yield. Flesh color is uniform yellow-gold to orange-gold with associated higher

levels pro-vitamin A and antioxidant compounds. In some years flesh color can approach that of *Hesse*. Skin color is a uniform yellow-gold, also without red pigmentation. Fruit are firm with a three year average of 8.3 lbs. Extra-Late#1 consistently maintained better flesh firmness and texture than the adjacent *Halford* and *Corona* in regional test-plantings. Pit cavities are generally free from split pits and fragments. Fruit flesh show low flesh-browning potential which has been confirmed by laboratory and biochemical studies in Dr. Barrett's lab (Figure 5). Slight bruising of fruit and flesh browning was observed in overripe 2009, 2011, and 2013 samples. Some fruit drop as well as field brown- rot infected fruit were observed in 2008, 2009 and 2011. Unlike 4th-generation Extra-Late#4-7 selections, Extra-Late#1 shows only moderate levels of the long-keeper post-ripening fruit integrity trait and fruit brown-rot resistance (comparable to *Halford*) but relatively high levels Monilinia flower blight resistance.

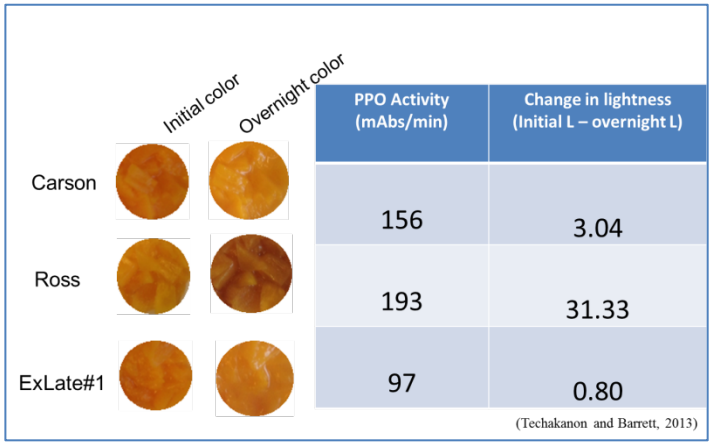


Figure 5. Very low flesh browning in Extra-Late#1 relative to commercial standards while maintaining moderate PPO levels believed desired for Monilinia brown-rot resistance.

Ultra-Early#1

[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 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 and 2013 annual Variety Development reports). However, because it is so early, it matures before most processing plants open. The exception was the Kingsburg DelMonte plant, which when closed essentially orphaned this variety which has potential for early season extension. Because the current production environment does not seem conducive for a variety that is this early, we are currently considering special growing arrangements with interested growers to encourage its commercial production (possibly as organic because of its inherent resistance) for ultimate evaluation of larger-scale processing potential.

Fig. 6. *Ultra-Early#1*: lineage (top-left); heavily thinned fruit (top-center); processed fruit (top-right); bottom-left: 2012 fruit at 10d passed tree-ripe, and bottom right are 2013 fruit from tree-ripe harvest. Note a tendency for irregular fruit shape and some beaking at fruit tip.

Early #6

[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 show no red blush on the skin and, more importantly, no red

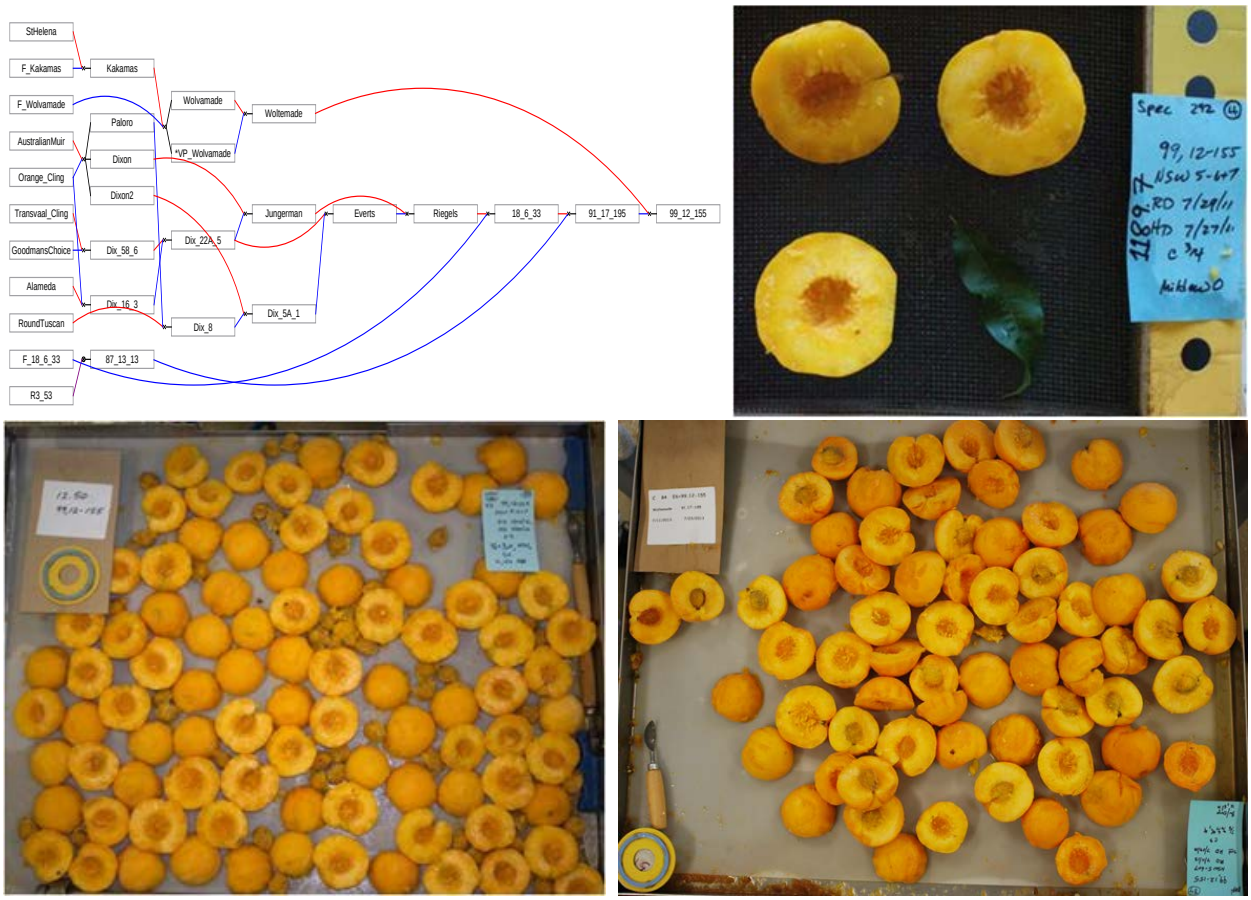
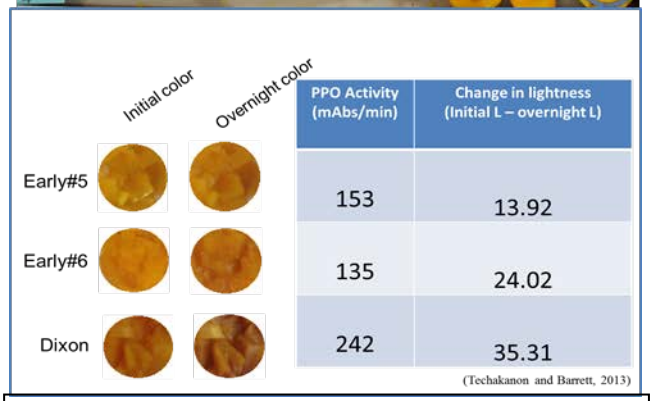


Fig. 7. *Early#6* lineage (top-left), heavily thinned 2012 fruit (top-right) while bottom shows standard thinned-fruit from 2012 harvested at tree ripe stage (left image) and 2013 harvested at 2 weeks after tree ripe stage (right image).

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. See also 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 significantly smaller than *ExtraEarly-1*. This suggests it may be at a compensatory-sizing yield disadvantage relative to *ExtraEarly-1* when trees are over thinned (or early crop loss from frost, disease, etc.). However, because *Early-6* harvest between *ExtraEarly-1* and *Andross* it may complement these varieties.

Early#5.

[UCD breeding designation 90,9-161]. Early#5 is an older selection dating from the mid-1990s. Derived primarily from more traditional California breeding lineages, E*arly5* represented one of the few traditional seedling progeny which matured during the *Dixon-Andross* gap. Fruit ripens with to just after *Andross*. Fruit are medium large, being somewhat larger than *Early#6* or *Goodwin*. The pit cavity is larger with a somewhat ragged appearance. Some pit fragments and split pits have been observed (~3%) but consistently less than Andross. Flesh color is a golden yellow, similar to Andross with a golden yellow skin with up to 30% red blush. Fruit are firmer than Andross 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 (Fig. 8) though pit cavities will gain a 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. Some fruit drop and brown rot have been observed at 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 (Figure 8). Because of its consistent good quality and maturity time, this item has been gaining more attention during the last few years.



	PPO Activity (mAbs/min)	Change in lightness (Initial L – overnight L)
Early#5	153	13.92
Early#6	135	24.02
Dixon	242	35.31

(Techakanon and Barrett, 2013)

Fig.8. Early#5 harvested at one week (top) and two weeks (middle) after tree ripe. Bottom: Low flesh browning relative to *Dixon* standard while maintaining PPO levels leave desirable for Monilinia brown rot resistance. (Note the relatively higher browning numbers for Early #6 despite its tendency for bright yellow-gold flesh color in both raw and processed samples.

Compact#2 and Compact#3.

Fig. 9. ***Compact#2*** **–**Top Row, left to right: 2012 and 2013 harvested at 5 days after tree-ripe, 2013 harvest at 2 weeks after tree-ripe. ***Compact#3***: –Bottom Row, left to right: 2012 harvested at ~7 days after tree-ripe, 2013 harvest at tree-ripe and 1 week after tree-ripe from a Modesto area grower test plot.

Compact#2

[UCD breeding designations 99,6-292]. The trees are productive and compact, being approximately 1/2 to 2/3 standard height (see 2010-11 Annual Reports for detailed data on tree architectures for the Compact series). Thus, while expressing high levels of 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 figure 9). Fruit are medium 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 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 (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 preharvest 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 higher 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. Trees are very productive with relatively little blind wood (which is often a problem with compact types), 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 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, and good size and color will also contribute to improved processing efficiencies. Commercialization would thus require considerable grower contributions in the area of field production. To encourage such grower innovation we are considering the development the 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*).

Extra Lates#4-7

[UCD breeding designation F8,5-147,-156,-166 &-171]. The F8-series breeding lineages originated from a peach by almond interspecies cross and, consequently, have been the source of many novel traits not found within the traditional peach germplasm. These include the only known source for plum-pox virus resistance in peach, independent sources of brown rot resistance, promising sources of mildew and leaf curl resistance, and an independent source of the long-keeper trait. Because the advanced selections are the product of many generations of backcrossing to peach, it remains uncertain for some of these traits whether they are the consequence of genes from almond, a unique almond by peach genomic interaction, or latent peach genes which have been expressed in this genetic/genomic background. Because of the unique background, greater potential exist for unanticipated and undesired consequences. For this reason, the selections are undergoing more rigorous regional testing than typical. In addition, while combining high levels of fruit quality and disease resistance and exceptional levels of on-tree post-ripe holding ability (*Long-Keeper* trait),

Fig. 10. *ExtraLate#6* and *ExtraLate#7* fruit harvested at tree-ripe stage from a Modesto area grower test plot.

these selections represent a highly experimental 'whole-genome' approach to cultivar development which may at some specific genetic background exhibit unanticipated problems. Response to-date from long-term regional grower testing, however, has been positive with no significant problems observed. Other atypical aspects of these breeding selections are a flowering time is approximately 4 days earlier than even *Ross,* and moderate vigor trees which tend to be productive with minimum thinning. Selection *Extra-Late-6* (Figure 10) has displayed evidence of resistance to the plum pox virus (sharka disease) in tests with collaborators in Spain and more recently (2013) in France. Fruit of all selections ripen in the targeted *Starn-Corona* season. Fruit are of good quality with a good (on-tree, *Long Keeper*) holding of 4 weeks or more, allowing delayed or once-over harvest if desired. Fruit also displayed good cold storage potential (8 plus weeks) relative to traditional cultivars. Fruit is uniform and symmetrical, has high soluble-solids, is medium in size and with a small, clean pit cavity. Fruit flesh is firm and easily pitted, but occasionally maintains a greenish tinge when processed which can give the canned fruit a more orange hue though not as dark as the South African variety *Kakamas.* Fruit color is yellow-gold with no red pigmentation in the pit-cavity, flesh or skin. Pit cavity is medium large and somewhat ragged. Middle mesocarp flesh is particularly firm which is maintained post-ripe and postharvest. [We are currently working with Dr. Barrett's group to better characterize these observed textural differences including their value to increase processing efficiency]. *Extra Late#4*, *ExtraLate#5* and *ExtraLate#7* showed similar characteristics though have not been tested for plum-pox resistance. Extra Late#4 and ExtraLate#6 appear to be the most productive while Extra Late#4 and ExtraLate#7 have the largest potential fruit size, though the differences are relatively small. Some fruit drop observed in the selections in the field in 2007, 2009 and 2011. FPS virus-free foundation stock has been developed for *Extra Late#4*, *ExtraLate#6* and *ExtraLate#7* to provide clean foundation stock to California nurseries if released. *ExtraLate#5* stock was found to be infected with Prunus Necrotic Ringspot virus and it has not yet been decided as to whether to make the effort to attempt to clean it.

Fig. 11. *ExtraLate#7* and *ExtraLate#7* fruit harvested at tree-ripe stage from a Modesto area grower test plot.

Recent Publications:

1. Gradziel. T.M. 2012. Classical genetics and traditional breeding. In: A. G. Abbott & C. Kole (eds.). Genetics, Genomics and Breeding of Stone Fruits. Science Publishers,, Plymouth. pg. 22-53.
2. Prabhu Dhanapal, A., Pedro J Martínez-García, Thomas M Gradziel, and Carlos H Crisosto. 2012. First genetic linkage map of chilling injury susceptibility in peach (Prunus persica (L.) Batsch) fruit with SSR and SNP markers. Journal of Plant Science & Molecular Breeding Pg1-12. http://www.hoajonline.com/journals/jpsmb/content/pdf/3.pd
3. Martínez-García P., Peace C., Parfitt D., Ogundiwin E., Fresnedo-Ramírez J., Dandekar A., Gradziel T., Crisosto C. 2012. Influence of year and genetic factors on chilling injury susceptibility in peach (Prunus persica (L.) Batsch). Euphytica: 185:267-280. DOI: 10.1007/s10681-011-0572-1
4. Gradziel, T.M. & Martínez-Gómez, P. 2013, Almond Breeding. Plant Breeding Reviews 37:207-258.
5. Martínez-García P., Fresnedo-Ramírez J., Parfitt D., Gradziel T., Crisosto C. 2013. Effect prediction of identified SNPs linked to fruit quality and chilling injury in peach [Prunus persica (L.) Batsch]. Plant Molecular Biology: 81:161–174. DOI 10.1007/s11103-012-9989-8.
6. Rahemi, A., Fatahi, R., Ebadi, A., Taghavi, T., Hassani, D., Gradziel, T., Folta, K. & Chaparro, J. 2012. Genetic diversity of some wild almonds and related Prunus species revealed by SSR and EST-SSR molecular markers. Plant Systematics and Evolution, 298: 173-192.
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9. Fresnedo-Ramírez J., Martínez-García P., Parfitt D., Crisosto C. Gradziel T. 2013. Heterogeneity in the entire genome for three genotypes of Peach [Prunus persica (L.) Batsch] as distinguished from sequence analysis of genomic variants. BMC Genomics. 2013 Nov 1;14(1):750.
10. Martinez Garcia, P.J., Dan E. Parfitt; Richard M. Bostock; Jonathan Fresnedo-Ramirez; Alejandra Vazquez-Lobo; Ebenezer Ogundiwin; Thomas M. Gradziel; Carlos H. Crisosto. (2013). Application of Genomic and Quantitative Genetic Tools to Identify Candidate Resistance Genes for Brown Rot Resistance in Peach. PLOS ONE.
11. Frett, T., K. Kasic, J. Clark, D. Byrne, T. Gradziel and C. Crisosto. 2013. Standardized phenotyping for fruit quality in peach [Prunus persica (L.) Batsch]. J. American Pomological Society. 66:214-219