California Cling Peach Advisory Board
2020 Annual Report

Project Titles:	Regional Testing of New Cling Peach Selections
Project Leaders:	Tom Gradziel
Cooperating Personnel:	A. Dhaddey, S. Marchand, A. Fletcher, C. Crisosto, J. Hasey and R. Duncan
Location:	Dept. of Plant Sciences, Univ. of California, Davis

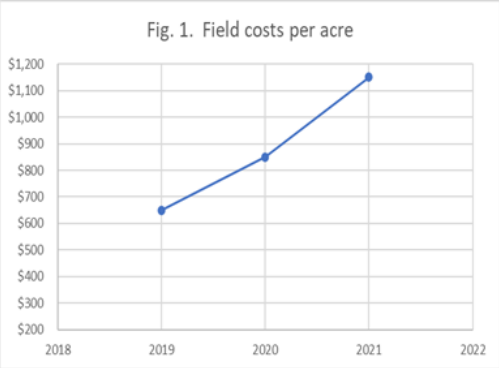
Summary

Despite COVID19 restrictions, advanced UCD processing peach selections were evaluated in regional plots in Marysville, Yuba, Solano, Yolo, and Stanislaus counties. Restrictions did limit access to the UCD pilot plant cannery (primarily due to social distancing rules) to about half our normal cannery sessions but we were still able to process and evaluate over130 advanced selections and breeding lines. Recently released UCD varieties Kader and Vilmos continued to show good promise in regional plantings. Advanced selections Ultra-Early-1 and Early-6 also continue to show promise and are on track for industry release. Most remaining regional plots are evaluating UCD selections in the Extra-Early and Early harvest seasons. The next round of regional trials will continue this focus while expanding to address evolving industry and University practices. Future industry practices will require consistent fruit quality and productivity with reduced inputs, particularly labor and agrochemicals. University support will depend upon how the breeding program is continued following the current breeding phase. Minimizing labor and agrochemicals inputs at the UCD breeding program level will be required to allow a smoother transition to the next breeding phase and will also ensure that UCD evaluation and selection criteria are consistent with the emerging realities in grower orchards and processing plants. Consequently, as with the Variety Development report, the focus will be in the context of the coming convergence of major transitions, within a) the processing peach industry, b) the UCD breeding program, and c) University field support.

Industry needs. While California produces a consistent, high quality and relatively low-cost processing peach product, it is rapidly losing access to traditional inputs including time-proven agrochemicals, water, and labor. As detailed in previous annual reports, the UCD Processing Peach Breeding Program has developed an exceptionally rich California-adapted breeding germplasm that appears to contain traits which could contribute to solving current and future industry challenges.

University support. As presented in the Variety Development report and Figure 1, University support of field-based research continues to erode on several levels, including decreasing University support coming to the program, with increasing program responsibilities to cover rising field and lab expenses.

Program transition. I currently anticipate 5 to 7 years until retirement. As with the Variety Development program, three aspects of regional evaluation need to be addressed: output (assessment of recently released varieties), 'in-transits' (remaining selections undergoing regional trials) and inputs (the next cycle of grower/processor regional testing).



Progress.

As with the Variety Development Program, the challenge is to increase the quality and quantity of output but with reduced inputs. To achieve this, we have increasingly mechanized UCD breeding orchards, including annual tree hedging and mechanical flower thinning. As explained in the Variety Development report, this mechanization has actually improved our efficiency, consistency and accuracy for evaluating the very large number of seedlings and selections making up the breeding populations. This is because when mechanically hedging and thinning our orchards, we deliberately over-thin. While reducing final tree yield, this ensures that individual fruit will express their full genetic potential in size, soluble solids, and color since fruit-to-fruit competition is largely eliminated. However, mechanization also makes us dependent on grower trials for yield assessment including the proportion of rejects. A major breeding focus in the last decade has been breeding and regionally testing improved varieties for the Extra-Early and Early harvest seasons. Because the harvest times of breeding progeny populations can often vary beyond those of the breeding parents, the program has also accumulated a series of promising selections in the Late to Extra-Late harvest seasons. For example, figure 2 shows a UCD breeding selection with high productivity of good processing quality fruit ripening with Corona. Should these advanced selections also be considered in the next round of regional testing?

An additional benefit of our long-term focus on applied breeding is that the resultant large populations of genetically diverse, fruit-bearing trees has made the UCD breeding program a particularly desirable partner in SCRI-type projects because these projects usually require demonstrated applied/field-based activities before funding consideration. In 2020 we were successful in securing funding as part of a Clemson University-based SCRI project for breeding improved peach rootstock with oak root fungus resistance. These funds will essentially match/augment cling peach industry funds for Variety Development over the next few years.

Breeding program outputs.

Recently Released Selections

Kader

The Kader processing peach variety targets the harvest season between Carson and Andross (i.e. the harvest gap left by the loss of the Dixon variety to California growers). Fruit samples of Kader collected in 2020 regional evaluation trials continued to show good-quality fruit including the ability of the fruit to hold on the tree for one week or more after developing to the full-ripe stage. There was one report of a few trees in recently planted Kader orchards which ripened later than expected, and while this could be the result of environmental influences or propagation errors, it needs to be monitored because the variety Ross, which was the seed parent to Kader has a tendency to throw later-harvesting budsports (such as Late Ross) and this trait could be transmitted to progeny. [Virus-free and verified true-to-type propagation sources of this cultivar have been established and are presently being maintained at the Foundation Plant Services foundation orchards at Davis, California, and the use of these foundation trees to establish nursery propagation blocks should minimize the occurrence of off-types in tree propagation].

Kader's improved resistance to Monilinia fruit brown-rot and resistance to flesh browning/bruising also contribute to good harvest and post-harvest quality, even when fruit left on the tree for a week or more after the tree-ripe stage. It's good fruit-sizing capacity 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. Fruit weight under conditions of heavy flower thinning is among the largest of the Extra- Early and Early selections tested. This indicates an aggressive compensatory-sizing (similar to Andross) which should facilitate consistently high grower yields. Fruit Brix (averaging 12.9) is also amongst the highest for this maturity seasons) and Brix/TA ratio is above the desired level of 20. Fruit are generally symmetrical; though occasionally show some cheek asymmetry similar to Goodwin with which it shares some lineage (though Kader does not show a similar tendency for split-pits even under the higher temperatures of 2020). Flesh color is golden-yellow, also similar to Goodwin. Skin is yellow-gold with up to 80% showing stippled red blush. Because of the high June/July temperatures just before and during ripening, fruit samples from some northern test sites showed a more extensive and darker red blush with some slight pink staining of the flesh though the fruit pit remained unstained (lower image above). Fruit drop also increased in heat stressed sites though split pits, and pit fragments remained low.

Vilmos

Vilmos ripens with, to just after *Andross*, and possesses fruit and tree characteristics similar to the variety *Ross*. Fruit are similar to *Ross* in size though slightly more oblate in shape and with less red-blush. Despite the unusually high June/July, 2020 temperatures in Sacramento Valley test plots, Vilmos fruit, including fruit pits remained largely clean with only a slight hint of pink in some pits as well as some flesh adjacent to highly blushed skin areas, (despite a more intensive blush in the skin). We previously observed that in hotter regions such as the southern San Joaquin, some Vilmos fruit flesh may develop a reddish stain when 5+ days overripe. Some brown-rot has been observed in regional trials including in 2020. Flesh has shown low bruising/browning potential and fruit readily hold on the tree for 10 days or more after initial tree-ripe even under these higher temperatures allowing greater flexibility in grower and processor harvest. Fruit size well, requiring less thinning than other varieties such as Loadel, though over-thinned fruit will develop only to a medium to medium-large size rather than the distinctly larger fruit observed in varieties such as *Kader* and Dr. *Davis* when over-thinned. Trees are hardy with yields comparable to Andross. 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 and this was observed in some blocks in 2020. Fruit process well, and the relatively small pit, combined with low incidence of pit-staining and pit fragments can result in higher case yields than *Andross*. Some pit fragments and split-pits have been observed (~4%) but consistently less than *Andross* and other accessions ripening at this very vulnerable time period. Virus-free and true-to-type vegetative sources of this cultivar have also been established at the Foundation Plant Services foundation orchards at Davis, California.

<u>Selections currently in transition</u>

Early#6

Despite the unusually high June/July, 2020 temperatures that affected nearby varieties Kader and Vilmos and despite having a harvest date between these varieties, Early#6 appeared to show no adverse effects but rather continued to show good yields of uniform fruit size shape and quality. This is partly because Early#6 has a gene for suppressing all red anthocyanin production in the fruit. The high 2020 temperatures did seem to somewhat accelerate the last phase of Early#6 fruit ripening, which can sometimes seem frustratingly slow since fruit normally size late in the ripening process. The anticipated patenting and release has been delayed due to COVID as well as the recently increased requirements of Plant Science Department variety release protocols.

Bred as 9,12-155, Early-6 represents 3rd-generation germplasm, being an advanced breeding selection developed from Californian and South African germplasm (Wolvamade) combining the distinct stay-ripe potentials of Wolvamade and UCD-Late#4 with a more traditional golden-yellow flesh color and a ripening time within the crucial Dixon-Andross gap. So far, this selection has consistently shown superior fruit color as well as harvest- and post- harvest firmness along with good cropping potential over a multi-year test period. Fruit can maintain integrity and quality 14 days or more after tree-ripe (stay-ripe trait) allowing delayed or once-over harvest. Good levels of fruit brown-rot resistance have also been achieved as demonstrated in both lab and field evaluations, and it also demonstrates moderate levels of resistance to Monilinia flower blight. Bloom time also remains relatively concentrated even in years of low winter chill resulting in more uniform fruit ripening times. This combination of traits makes it a promising varietal-type for addressing anticipated changes in the growing climate over the next decades. Fruit is medium large, uniformly round and firm, even when overripe. Fruit remain free of red blush on the skin with no red staining of the fruit pit-cavity even up to two weeks beyond the full-ripe date. Pit-cavity is medium and somewhat ragged. Fruit weight following heavy thinning was moderately large (238g), being similar to Ross though somewhat smaller than Kader. Trees have been upright and consistently productive.

Ogawa.

Currently being tested as *Ultra-Early#1*, this selection is derived from a combination of Brazilian (*Conserva485*) with probable Eastern European (*NJC5102893*) peach germplasm from the Rutgers University breeding program of Dr. Fred Hough which was terminated in the 1980s. The initial New Jersey parent expressed unusual sections of stem necrosis which we determined to be possibly epigenetic rather than disease in origin. A series of clonal-source selections during the 1990's (based on the Noninfectious-Bud-Failure elimination strategies developed for almond) has eliminated all trace of this condition in all subsequent UCD and regional grower trees. *Ultra-Early#1* combines very good size and cropping potential for its 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 as more resources become available, as would occur when the crop is over-thinned or due to early fruit loss from weather, disease, etc.). The aggressive fruit sizing compensates by making remaining fruit and so final yield larger. *Ultra-Early#1* has also shown resistance to fruit brown-rot and has been an important parent for conferring fruit brown-rot resistance as well as early maturity, good fruit size and firmness The 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 grower trials for organic production of processed product because it allows the product to be processed in the cannery 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 color). High temperatures during fruit development (as occurred in 2020) can result in irregularly shaped fruit. While this would discourage its use for processing peach-halves, most very early processing peach fruit is diced with some slicing, neither of which seem to present a problem for this time-period based on processor discussions. The potential for good fruit production and quality as well as good fruit brown-rot resistance in a very early processing peach variety offers the opportunity for both season-extension and expansion of organic production. Because both of these options are inherently risky, it has been decided to release this selection under the name *Ogawa* but without patenting to make it more accessible to the industry for grower/processor experimentation. Clean foundation stock has been provided to FPS and we are now awaiting certification for trueness-to-type and freedom from viruses prior to continuing its release.

Inputs: new regional testing candidates by season.

Extra-Early

Carson harvest season.

11,23-61. Fruit have a desirable golden-yellow flesh color and good fruit size and uniformity for the season. Ripening in the *Carson* harvest season, this advanced selection is a selfed progeny of 90,11-3 which has plant introduction PI292557 in its lineage. Ripe fruit are firm and have a moderate red blush covering approximately 60-80% the surface. Overripe fruit can develop a slight pink staining of the inner flesh though this cooks out with processing. Fruit quality and firmness are maintained up to 2 weeks following tree ripe. Despite harvesting after tree-ripe, fruit process well, producing a good quality product. This selection shows good field resistance to fruit brown-rot though testing using controlled inoculations in laboratory conditions have not yet been made. In 2018, this selection showed good performance despite being in an evaluation block that suffered from frost damage.

11,12-122. Representing a newer, third-generation selection, this processing peach combines traditional with the South African *stay-ripe* sources, producing firm fruit of good quality. Tree is vigorous and productive, producing abundant fruit with yellow to golden-yellow flesh color. Fruit firmness is very good at harvest and is maintained for up to 2 weeks after initial tree-ripe phase. The unusually high temperatures in 2020 resulted in more over-ripe fruit showing browning and water-soaking of the flesh. Pit cavity is relatively small but can show some slight red-pigmentation following warmer spring temperatures though this routinely cooks out. Similarly, there is some tendency for the inner flesh at the pit to retain some greenish color even when the remainder of the fruit is full- ripe, though this tends to also cook-out with processing. Fruit show a red to scarlet blush over approximately 30% of the skin surface. Tree can produce fruit of good size though interior fruit may be more irregular in size. Some pit-splits have been observed on over-thinned trees.

Dixon harvest season.

11,23-81. Representing a 3rd generation breeding selection, this genotype resulted from Dr. Davis crossed with a hybrid between PI292557 progeny and advanced selection *UltraEarly*-1. The tree is productive and produces fruit of good size and firmness. Fruit quality and firmness are maintained up to 2 weeks after tree-ripe. Fruit show good field resistance to fruit brown-rot which has been verified in laboratory studies in the Bostock lab [Both the *Dr. Davis* seed parent and *UltraEarly-1* have been identified as dependable sources of brown-rot disease resistance with putative molecular markers being developed for this source]. Irregular fruit sizing has been observed in some years such as 2016 and 2019. A slight but distinctive pink staining of the fruit pit cavities was seen in the higher temperatures of 2020 as well as an increased number of split-pits.

11,23-110. Resulting from a cross between more traditional parents, this selection combines firmness with good fruit color at this critical harvest period. Fruit is medium to large in size with a uniform yellow to yellow-gold color. Fruit is more susceptible to bruising than other selections in this category and fruit brown rot has been observed in the field but this item has yet to be tested in controlled laboratory conditions. Pits are clean of any red pigmentation even in overripe fruit or after prolonged heat as occurred in 2020. Consistent fruit sizing remains a concern as does a greater susceptibility to flesh browning after fruit damage.

11,2-84. This selection resulted from a cross between the very firm but small selection 2000,9-79 with *Ultra-Early- 1* resulting in improved firmness and size. Fruit color is a desirable golden-yellow and fruit tend to be large with moderate small pit though fruit shape can sometimes be a bit irregular, reminiscent of its Ultra-Early-1 parent.. Fruit have inherited good firmness at tree-ripe and in many years will maintain this firmness for a week or more. Fruit also show a lower tendency to bruise and show low fruit brown rot disease in the field. In some years, such as 2016 and 2019, over-ripe fruit tend to soften in the outer flesh resulting in pit or-cup bruising during processing. Split pits were concern in 2019, though the fruit remained relatively free in previous years as well as 2020.

05,10-223. Resulting from a cross between Dr. Davis and almond derived breeding lines, this selection produces fruit of good firmness and size. Interestingly, molecular data showed that the almond parent contributed an important gene for fruit size that was present in ancient peaches but was lost during subsequent domestication and breeding. Fruit sizing tendency is such that over-thinned fruit can continue to size up to harvest resulting in larger

fruit that compensate for the smaller crop load. While fruit tend to have good firmness that is maintained for a week or more after tree-ripe, large fruit that sized-up late achieve this by significant water uptake making those fruit more susceptible to rapid softening after tree-ripe. Fruit have a good golden-yellow flesh color with clean pits though some slight staining will be apparent in some years in overripe fruit including 2020. Fruit are moderately resistant to flesh-bruising but becoming less so in overripe fruit.

Bowen harvest time.

10,21-450. Despite being a progeny from Late season selection *Wolvamade* (South Africa) and *Extra-Late-2* as grandparents, this selection ripens with *Bowen*. (It is not unusual for more exotic germplasm to shift ripening time beyond that of either parent. This was essentially how the Dixon gap was targeted: *Early-6* with its Dixon harvest time, has a similar lineage. This transgressive harvest shifting has been one of our core strategies for targeting the otherwise challenging Carson-Andross maturity time). As with *Early-6*, the fruit show a desirable golden yellow flesh and skin color without blush. Also similar to *Early-6*, fruit have very good firmness at tree ripe that is maintained to over 2 weeks post-ripe. Fruit are uniform in size though not as large as previously described selections in this group. Some fruit bruising is observed on fruit harvested longer than 2 weeks post-ripe, though a 2 week delay represents a rather strong selection pressure since commercial delays would not be expected to be this long. This selection also demonstrates good bloom consistency with variable winter chill as well as a delayed flowering by almost a week which allowed it to escape frost damage in some of our 2018 plots. Flesh color in fruit held on the tree for 2 weeks or more will develop a yellow-gold to more pronounced gold color. Fruit show good resistance to flesh bruising and fruit brown rot both in the field and after controlled lab inoculations. As with *Early-6*, fruit achieve only a moderate final size with much of that growth in the final weeks/days of ripening, yet like Early-6 yields are good and fruit quality is consistently very good, with uniform in size shape and color and low defects.

10,21-186. Resulting from a cross between traditional and introgressed breeding selections, having 04,4-155 as a great grandparent. {Breeding line 04,4-155 is one of the few traditional peach genotypes showing potential for prolonged processing quality after the tree-ripe stage (*stay-ripe*)}. Fruit show good productivity though fruit size can be variable, particularly in young trees. Fruit show low to moderate levels of red blush with some red imprinting observed in fruit pits, though this consistently cooks out with processing. Fruit demonstrate good firmness at harvest and good processing firmness is similarly maintained for

two weeks or more after the tree-ripe stage. The image at left shows 10,21-186 fruit harvested on September 6, 2020 despite ripening with Bowen. Fruit also show good resistance to bruising in the field. The tree is productive, upright and vigorous and shows good general resistance/tolerance to field pests and diseases.

11,23-147. A sister line to 11,17-150 and also having 00,16-92 as a grandparent. Pubescence or fuzz on this and other selections derived from 00,16-92 appears denser and more compact with better resistance to fruit brown rot as well as improved lye-peeling ability. Fruit show moderate size and good firmness but greater susceptibility to flesh bruising when overripe. As with other 00,16-92 breeding selections, epidermis and fruit pit are free from any red pigmentation, even in overripe fruit. Fruit have good firmness at maturity which is maintained for a week or more in the field, though softening and bruising can occur rather rapidly after that time.

<u>Early.</u>

Andross harvest time.

12,6-294. The result of hybridization between advanced selection Extra Late-2 and almond-derived breeding selection 2008-57-35 producing fruit with good size and quality as well as the ability to hold on the tree for a week or more. Skin has approximately 30% blush though the fruit pit remain largely free of any red pigmentation. Some slight red tinting is apparent in overripe fruit but this cooked out with processing. Pits are relatively small resulting in greater case yields. Fruit are also generally uniform in size, shape and color. Flesh is more susceptible to bruising though response to fruit brown rot has not been observed in the field and not yet tested under controlled laboratory conditions.

Klampt harvest time.

15,5-106. Also an example of an advanced generation selection. Fruit are of good size with an unusually high firmness. Color is uniform and bright with no red staining of flesh or the pit cavity even in overripe fruit. Skin is a golden yellow with no evidence of red blush. Good processing quality is retained up to 14 days after the tree-ripe stage. Low fruit brown rot has been observed in the field but this item has not been tested under laboratory conditions. Fruit are more susceptible to bruising from both physical damage as well as cold injury.

17,3-185. This recent breeding selection resulted from a cross between traditional and introduced germplasm having Early-6 as seed parent. It has produced good quality fruit with good firmness and holding ability, though additional seasons of observation are needed. Fruit flesh and pit are uniform golden-yellow with no evidence of red staining even in overripe fruit and with the occasional slight red blush in about 10% of skin surface. Fruit holds well on the tree for 10 days or more after the tree-ripe stage. Low brown-rot incidence has been observed in the field but this item has not yet been tested under laboratory conditions. Fruit also show good resistance to bruising in initial evaluations. Fruit are medium to large with similarly medium to large pit cavities which can result in a somewhat ragged appearance of halved fruits though this softens with canning. Although the pit has a distinct tip, we have so far not observed breakage or fragmentation during processing. Processed fruit are uniform bright yellow in color.

Recent Publications

1. Johnson, E.P., Preece, J.E., Aradhya, M., Gradziel, T. Rooting response of Prunus wild relative semi-hardwood cuttings to indole-3-butyric acid potassium salt (KIBA). Scientia Horticulturae, Volume 263, 15. https://doi.org/10.1016/j.scienta.2019.109144.

2. Angela S. Prudencio, Raquel Sánchez-Pérez, TM Gradziel, Pedro J. Martínez-García, Federico Dicenta, Thomas M. Gradziel and Pedro Martinez Gomez.. 2020. Genomic Designing for New Climate-Resilient Almond Varieties . In: Chittaranjan Kole (Ed.) Genomic Designing of Climate-Smart Fruit Crops. ISHS Jhlpd68505c015976.

3. Felipe Pérez de los Cobos, Pedro J Martínez-García , Agustí Romero , Xavier Miarnau, Iban Eduardo , Werner Howad, Mourad Mnejja, Federico Dicenta, Rafel Socias i Company, Maria J Rubio-Cabetas, Thomas M Gradziel, Michelle Wirthensohn , Henri Duval, Doron Holland, Pere Arús , Francisco J Vargas and Ignasi Batlle. 2021. Pedigree analysis of 220 almond genotypes reveals two world mainstream breeding lines based on only three different cultivars. Horticulture Research (2021) 8:11. https://doi.org/10.1038/s41438-020-00444-4.

4. Kourosh Vahdati, Saadat Sarikhani, Neus Aletà, Charles A. Leslie, Abhaya M. Dandekar, Mohamad Mehdi Arab, Beatriz Bielsa,, Thomas M. Gradziel, et al. . Physiological and molecular aspects of nut crops rootstock-scion interactions: current and future. (in-press).

5. Gradziel, T.M. 2020. Redomesticating Almond to Meet Emerging Food Safety Needs Frontiers in Plant Science, Volume 11, 12 June 2020. 89/fpls.2020.00778. https://doi.org/10.33

6. Gina Sideli, Ted DeJong, and Sebastian Saa. 2020. Almond Variety Program; The Continuum of Variety Development, Screening, and Evaluation. ABC Special Technical Report. 54 pages.

7. Katherine M. D'Amico-Willman, Chad E. Niederhuth, Matthew R. Willman, Thomas M. Gradziel, Wilberforce Z. Ouma, Tea Meulia, and Jonathan Fresnedo-Ramírez. (in Press)

DNA methylation status is associated with divergent exhibition of non-infectious bud failure, an age-related disorder, in twin almonds. The Plant Journal.

8. Gradziel, Thomas M. and Jonathan Fresnedo-Ramírez. (2019). Noninfectious Bud-failure As a Model for Studying Age Related Genetic Disorders in Long-Lived Perennial Plants. Journal of the American Pomological Society 73(4): 240-253 2019

9. Gradziel T, B. Lampinen and J.E. Preece. (2019). Propagation from Basal Epicormic Meristems Remediates an Aging-Related Disorder in Almond Clones. Horticulturae 2019, 5(2), 28; https://doi.org/10.3390/horticulturae5020028