California Cling Peach Advisory Board
2020 Annual Report

Project Title: Development of New Cling Peach Varieties

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Summary

The year 2020 has been, not surprisingly, particularly challenging. Unusually dry conditions during flowering threatened seed-set but we were able to get early supplementary irrigation, and ultimately enjoyed a relatively good season for crossing. From about 20,000 crosses we harvested over 4000 seed which have been stratified and are now being grown in the greenhouse for initial screening with field transplantation of remaining plants in 2021. As a result of COVID related University shutdowns, however, we lost about 800 hybrid seedlings of the approximately 3200 breeding seedlings from 2019 during greenhouse seed germination and early seedling growth. In the middle of the 2020 field planting season, we also lost both Pomology field managers, in Davis and the Winters Wolfskill Experiment Orchard, respectively, primarily due to administrative/budget concerns associated with COVID, while later in the year we lost our field projects manager as well as our greenhouse manager, both of whom had to leave California to take care of family members. Notwithstanding the setbacks, however, 2020 was not a bad year. We were able to get over 2400 seedlings field-planted while generating about 4000 new seed for greenhouse selection and field planting in 2021. Because of the long-term requirements for orchard crops, we were exempt from most of the University work restrictions, which allowed a relatively thorough evaluation of the approximately 22,000 seedling trees currently bearing fruit; (although restrictions at the Mondavi Pilot Plant led to biweekly sample processings rather than the weekly evaluations which had been done in the past). We were able to maintain this ‘almost normalcy’ because my relative seniority within the department allowed me to spend less time with teaching and remote committee, etc. and work more time in the field managing these unexpected transitions. In addition, we actually had more department resources available to the breeding project in 2020 because most of Plant Sciences row and field crop plantings were canceled in 2020 leaving the tree crops and some of the cereal crops as the only ongoing field operations. (We used this opportunity to update/repair equipment such as the Darwin Flower Thinner and prep fields for future plantings). This situation will change considerably in the next years , however. Consequently, the focus of this report 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. Essentially, the theme of this year’s program assessment is how can the breeding program best assist the industry as it goes through a period of dramatic changes in lieu

Table 1	Target	Planted
2015	3000	3211
2016	5000	3700
2017	8000	3027
2018	9000	3234
2019	6000	4859
2020	4000	2462
2021	3000	

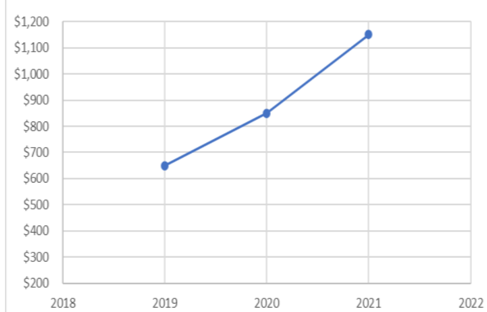
of both a) my expected retirement 5 to 7 years and b) the ongoing erosion of University support for field research.

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.

Breeding program transition. While 5 to 7 years until retirement may seem like a relatively long time, it occurs rather quickly in the context of a tree breeding program. To maximize remaining breeding effectiveness, three core aspects of the breeding program need to be optimized: ***output*** (promising advanced selections currently coming out of the variety development program), ***inputs*** (new crosses and breeding goals in anticipation of industry and breeding program needs going into the 2030s, and '***in-transits'*** (material currently in the breeding evaluation pipeline). For example, crosses made in 2019 and planted in 2020 will probably not produce sufficient fruit for evaluation until 2023/24 and items need to be evaluated for at least 3 to 4 years (2026/28) before selection and advancement to grower testing. At a minimum, eight years of regional grower testing would be desirable before official release of a variety in order to identify and rogue-out selections that, while initially showing good general promise, possess unrecognized defects such as disease susceptibility or vulnerability to pit-fragmentation, etc. which would eventually prove to be economically undesirable.

University support. University support of field-based research continues to erode on several levels. Hatch funds, provided to the University with the goal of supporting applied research have tumbled from about $30,000 when I started in the late 1980s to less than $1000 in the last fiscal year. At the same time, field charges have risen from $600 per acre only a few years ago to $1150 an acre at present with more increases anticipated (Figure 1). The Federal Marketing Orders that allow industries to support applied research have historically been untaxed (no overhead charges, etc.) but University administrators have increasingly introduced new policies to allow what are essentially levies on this funding. Finally, as with California growers and processors, the breeding program is challenged by the increasing number and complexity of restrictive regulations, but with the University being more capable and more religious in their enforcement.

Fig. 1. Field costs per acre



Breeding progress.

The breeding program is in an analogous situation to the processing peach industry, where the challenge is to increase the quality and quantity of output but with reduced inputs. In many ways, this challenge inherently improves the applicability of our research. For example, the cost of thinning, pruning and harvest had become prohibitively expensive for the breeding program because of the enormous tree-to-tree variability among our 22,000 bearing trees. To survive, we continue to increasingly mechanize, including annual hedging of trees and mechanical flower thinning (as detailed in previous annual reports). Incorporating these mechanized solutions as part of the breeding program allows us to better understand both the opportunities and constraints of this technology for solving similar problems at the much larger grower-scale. As a University-based program, we are also expected to advance science through teaching and peer-reviewed publications. This introduces both barriers and opportunities as well, that will be discussed below in the context of the three phases of the breeding program: *output, transitions,* and *inputs.*

Breeding program outputs.

The year 2020 saw a continuation in the process to patent and release the advanced breeding selection Early#6 and the unpatented release of Ultra-Early#1. Foundation trees of both selections are now in Foundation Plant Services (FPS) in the mid stages of certification for trueness-to-type and freedom from disease causing viruses. In addition, several advanced selections in the Extra-Early and Early harvest season are in regional grower testing with several additional candidates being selected for the next round of grower testing (as discussed in the Regional Testing annual report). While a more mechanized breeding program actually results in increased quality of our field data (as discussed in the next section), regional grower trials are ultimately required to accurately assess yield potential as well as possible regional deficiencies such as poor bloom resulting from insufficient regional winter chill accumulation.

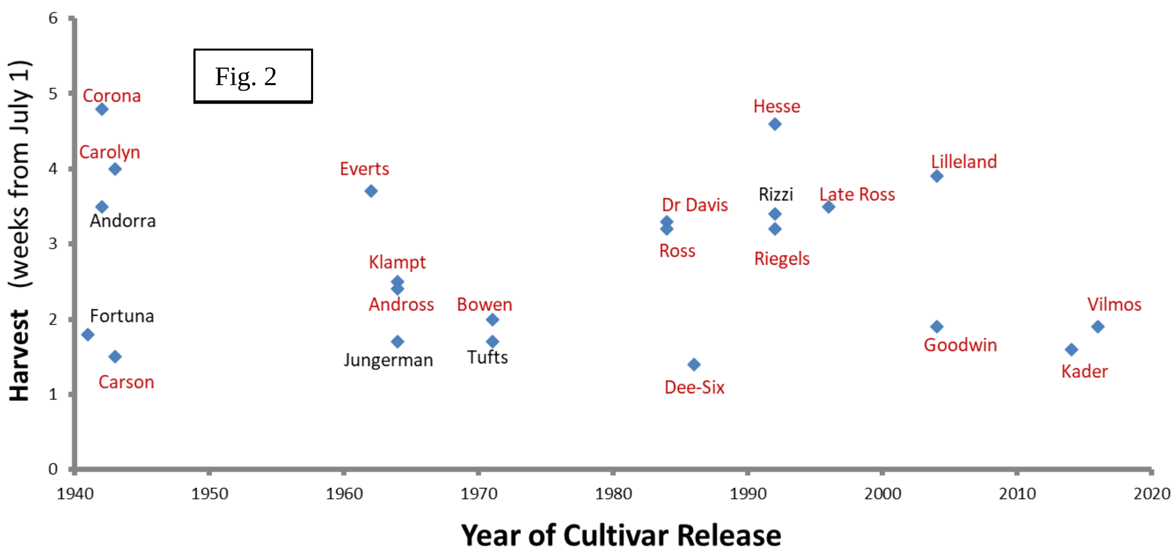
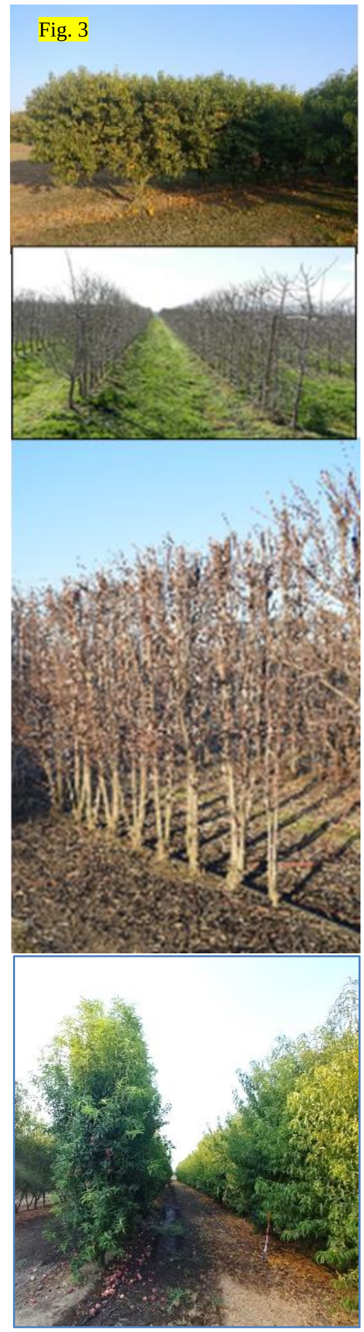


Figure 2 shows the history of UCD/USDA variety releases for processing peach. Prior to our program, most varieties were released in time-concentrated groups, usually representing the final years of that breeding program with a desire to release items proven in earlier multiyear testing. Since taking over the processing peach breeding program in the late 1980s, we have been more regular in variety releases. (I also anticipate a similarly concentrated release of several varieties towards the end of this breeding program to ensure that all promising selections are made available to the industry). University policies on patenting are also becoming more restrictive, which can be particularly problematic for tree crops relative to row crops since the requested ‘additional data’ can sometimes require years to secure. In addition, new departmental policies encouraged the prefix ‘UC’ on future varietal names to document University contributions. Since, with a few notable exceptions, the majority of California processing peach varieties are UCD releases, this may be unnecessary.

The focus of recent breeding program output has been replacement varieties for the Early to Extra-early harvest seasons (see summaries in appendix). In addition to working to solve current production variety problems such as red-stained pits and fragmentation, we are also attempting to incorporate traits allowing reduced chemical sprays (fruit brown-rot resistance, etc.) and labor (fruit capable of once-over-harvest and mechanical harvest, etc.). An important objective for the 2021 season is to reevaluate the changing needs of growers and processors in light of ongoing industry shifts. This includes whether we should expand our breeding targets to also include new releases in the Late and Extra-late harvest seasons. For example, to be more grower cost-effective, varieties amenable to mechanical harvest would need to be available throughout the growing season. New marketing opportunities are also possible. The release of Ultra-Early#1 would allow harvest season extension to about 10 days before Loadel thus complementing plantings of the early ripening Ceres-Carson. Because of its ultra-early and so easily isolated harvest time, combined with its high levels of fruit brown rot resistance and deeper gold-orange flesh color (with associated increases in pro-vitamin-A content) it also represents new market opportunities including the organic and more specialized consumer nutrition and baby food markets.

Fig. 3



<u>Transition.</u>

Most of the breeding time is spent in the transition or pipeline phase. Breeding material is refined as it moves through the year-to-year selection pipeline. Refinement is through increasing intensities of trait selection and further recombination through additional controlled crosses. This refinement inherently involves sequential elimination of inferior breeding selections and so a loss of overall genetic variability. New traits, deemed not essential for immediate breeding objectives but which could provide effective options for future, not yet fully recognized industry needs, could be lost. The early emphasis of the breeding program on incorporating new traits, often from related species, has culminated in unprecedented genetic opportunities ranging from California-adapted breeding lines demonstrating good resistance to mildew, to fruit that dry naturally on the tree like prunes, or fruit that are ripe in November. A similar breeding diversity in tree structure and bearing habit has proven particularly useful for developing peach trees amenable to mechanical harvest/pruning/thinning. For example, the top image in figure 3 shows the *compact* tree trait discussed in earlier annual reports as having the benefits of a smaller more compact tree combined with the suppression of aggressive water shoot development when pruned, while the bottom images shows some of the pillar-type peaches under development that are similar in structure to the pillar-apples used extensively in mechanical harvest. Both originated as exotic genes transferred into a cultivated peach background and both are highly heritable (i.e. easily transferred to progeny). In the top-center is a very high density, mechanically pruned, mechanically harvested almond trial in Kern County testing a somewhat similar diversity of tree architectures and

growth habits. My expectation is that most of the approximately 50 almond varieties and UC selections being tested will fail miserably, but we will learn a great deal in the nature of their failings and, in the nature of selections that succeed (or at least don't fail as miserably). In some ways we are in the somewhat fortunate position of probably having the needed solutions, but still largely ignorant about what specific traits will be required to solve the problems of the coming century, again emphasizing the timely need for industry guidance. The fruit in figure 4 also demonstrate how an increasing dependence on mechanization has resulted in more accurate field data. The fruit were picked randomly from different quadrants of the tree as well as the interior in order to get a more unbiased estimate of key characteristics such as size, sugar and acid level, etc.). A major challenge has been determining how much these measurements reflect the genetic potential and how much reflect the growth environment, such as nearby competing fruit. By over thinning trees using the Darwin flower thinner, we eliminate any significant competition between fruit, resulting in fruit characteristics which approached their true genetic potential.
This can be seen in figure 4 by the high degree of uniformity in size, shape and color. The 2020 season also demonstrated that because we are breeding for fruit that holds on the tree at full ripe stage for 10 days to two weeks, we can go to biweekly canning sessions at the Mondavi pilot plant and still get good data concerning the on-tree fruit quality preservation or *stay-ripe* trait of different breeding selections but, at half the processing costs.

Fig. 4

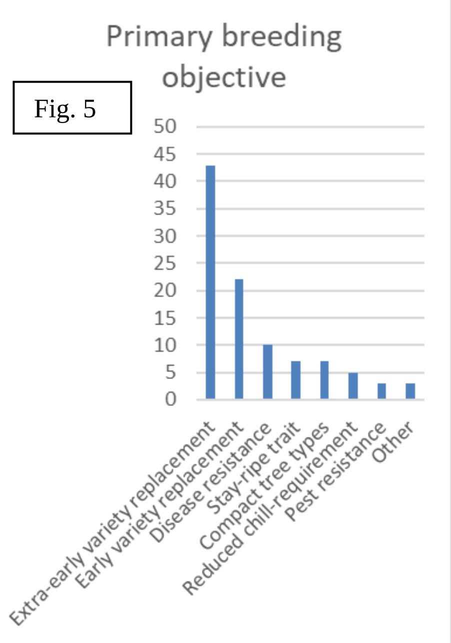
Another way that we are maintaining, perhaps even improving, breeding progress while keeping a flat budget in the face of increasing field costs is to use fewer agrochemical sprays to control pests and disease (since the entire cost of agrochemicals is now being charged back to the programs). The consequence is greater disease and pest damage, but this actually allows us to do a better job screening for resistance (as long as the mildew doesn't blow up so quickly that it spreads over into Ted DeJong's adjacent block of Fantasia nectarines).

Maintaining genetic diversity in the breeding populations also has advantages beyond direct varietal improvement. Because the multi-state, multimillion-dollar SCRI RosBREED funding focused on peach and apple owing to their economic importance, and because cultivated peach is highly inbred and so lacks the genetic variability required for effective molecular markers development, much of the germplasm analyzed in RosBREED-1 and RosBREED -2 came from our breeding program because we had the required genetic variability already available in mature, bearing breeding populations. Consequently, a large proportion of RosBREED molecular-marker development achieved with collaboration from a range of international experts in genomics, molecular biology and statistics/computer modeling, focused-on and benefited California processing peaches. All high-cost of molecular-based research was thus supported by state and federal funds, allowing all industry funds to target applied breeding goals. Because molecular-genetic projects can be completed in a relatively short time, this research has also resulted more publications in premier scientific journals, thus enhancing my academic standing within the department and university. In 2020/21 we have again successfully secured SCRI funds for molecular analysis of oak root fungus resistance in peach and hybrid rootstocks as part of a multi-state, Clemson University initiated project. Our diverse, segregating breeding populations are also a core component in a second anticipated SCRI-type proposal to develop molecular-markers to allow accelerated breeding progress towards developing Prunus cultivars more resistant to the low-chill winters anticipated with increasingly warmer climates.

Inputs.

The majority of current inputs, that is progeny from 2020/21 breeding crosses that will be entering into the breeding pipeline, represent further refinements in already advanced breeding lines targeting current goals of high-yielding, defect-free {particularly pit staining and fragmentation} peaches ripening in the Extra-Early and Early seasons (Figure 5 with breeding parents summarized in the appendix). To allow continued breeding advancement in the next generation of the breeding program, new germplasm should be injected now. The first research that I completed and published after coming to UC Davis was a 1993 analysis of the genetic diversity within the available UCD processing peach breeding germplasm (Publication -1 below). At that time, virtually all commercial varieties could be traced back to less than 10 founder varieties, which were themselves often interrelated. Essentially, this germplasm had already been effectively mined by previous breeding programs and the likelihood of new traits to solve the new problems emerging in the 1990s was diminishingly small. It took the next 10 years of tedious hybridizations and backcrossing (for example, for fruit brown rot resistance from Brazilian landraces and almond; *'stay-ripe'* trait for maintaining ripe fruit on the tree for a week or more, from South African heirloom varieties such as Woltemade shown in figure 2, as well as almond species; compact tree/watersprout suppression from peach species and bud-sport mutations, etc.) to develop the current level of genetic variability in a California-adapted background which has allowed us to pursue new traits for solving California processing peach production problems. Interestingly, the transfer of the peach compact tree/water sprout suppression trait to almond would address many of the requirements for developing an almond variety amenable to mechanical, catch-frame harvest and would only take about 10 years given that control is by a single semi-dominant gene. But I may not have 10 years and there may not be a university supported breeder when I retire. For example, when Ted DeJong recently retired, he recommended that his prune breeding program be transferred to a cooperating nursery to ensure continuity. However, the department rejected's recommendation, preferring to keep control of the breeding program yet declining to provide any support for its maintenance. It has also been the trend that some of the larger breeding programs such as strawberry and wheat to recruit a MS level researcher to do the applied breeding with the academic position focusing on grant management and more basic research.

Fig. 5



My ongoing efforts to fully integrate the processing peach with the almond breeding programs have proved beneficial in providing effective new, often interspecifically transferred, traits for greater disease/pest resistance and improved production and quality. Because of this synergism, any continuity of the almond breeding project will probably involve continued work with peach as well. Finally, in addition to providing already established and segregating populations for the recently funded, multi-year SCRI Oak Root Fungus resistance project, I will be synthesizing new hybrids and backcrosses between not just peach and almond but also including plum and related species. Progeny will have direct application as potential peach rootstocks but also could serve as the source of future even more extensive germplasm injections (as well as future SCRI -type projects) for the next generation of peach and almond variety improvement.

Recent or Relevant Publications

1. Gradziel, T.M., W. Beres, and K. Pelletreau. 1993. Inbreeding in California canning clingstone peach cultivars. Fruit Varieties Journal, 47(3): 160-168.

2. 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.

3. 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.

4. 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.

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

6. 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

7. 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.

8. 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.

9. 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

10. 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

Appendix. Description of advanced UCD selections being considered as breeding parents for 2021 crosses. [In addition, all selections considered as candidates for regional testing as described in the Regional Testing annual report are also considered as possible parents for 2021 breeding crosses].

<u>**Ultra-Early Season Extension**</u>

4,2-148. Ripening between Ultra-Early#1 (Ogawa) and Ceres Carson. Fruit are medium in size with no tendency for developing red coloring of the pit. Resulting from a cross between the more traditional parents, including 96,3-153, this selection combines early season with relatively good fruit color and firmness. Firmness holds well for a week to 10 days but in some years can soften rather rapidly after that. Fruit are consistently at the higher end of sugar concentration. Fruit size and final productivity are too small for a commercial release but the selection appears to be a promising parent particularly for this very early season.

<u>**Extra-Early season**</u>

Carson harvest time.

1,12-54. Also product of the older 2nd generation of selections, this item is also the result of crosses within traditional germplasm. This selection shows very good size, and productivity but softens rather rapidly a week to 10 days after tree ripe. It had also consistently been on the higher end of fruit sugar concentration. Trees appear to have exceptional potential for productivity in this Extra-Early-season while producing fruit with good size and color. It's tendency of becoming soft make it unacceptable for commercial release but its other exceptional characteristics make it promising as a parent.

16,10-388. An advanced fourth-generation selection combining traits from different species including almond and wild peach. Fruit are large and firm and free from red-staining of the pit. Some split-pits were observed in over thinned trees 2020 though not in previous years. Fruit show very good firmness, with the 2020 canning example (shown) averaging 7 pounds at 12 days after full ripe. Fruit stay firm for up to two weeks after tree ripe but can develop water-soaked, browning of flesh after that. The fruit skin is totally free of any red pigmentation which contributes to the greater resistance of red-staining of the pit.

Dixon harvest time.

11,23-65. With a lineage containing both the plant introduction PI292557 as well as the traditional variety *Dixon*, this second-generation breeding selection ripens in the *Dixon* harvest season while maintaining good processed fruit size, color and firmness up to 16 days after tree-ripe (image). Fresh fruit have a red to pink blush on approximately 70% of the surface. A slight pink coloration can occasionally be observed at the pit-cavity in some delayed-harvested fruit, though this is lost in processing (see image from

2018). A smaller pit cavity also contributes to higher case yields. The tree continues to be productive, producing fruit of uniform size and shape. In some years fruit have had a tendency to be irregular in shape, and this discourages its consideration as a variety release.


10,8-456. Also representing a second-generation breeding selection derived from a cross with *Dr. Davis* and advanced selection *UltraEarly-1* as grandparents, this Dixon-period selection shows good size for the season. Good field resistance is also observed which has been verified following Bostock lab inoculation and testing. In addition to good size and flesh color, fruit demonstrate good firmness and freedom from pit-staining and fragmentation. Good processing fruit quality is maintained on-tree for over 2 weeks post-ripe though the fruit may soften to below 5 pounds pressure by this time. The seedling tree shows good productivity but continued to show only moderate vigor in 2018 in our very high density selection block so in 2019 it was propagated to a more standard planting density.

Bowen harvest time.


10,13-80. Ripening in the Bowen harvest season, this advanced selection is a third-generation hybrid with *Vilmos* and so represents a further refinement/introgression of the PI292557 s lineage. As in the related selections, fruit quality is very good in terms of color, flavor, and firmness, and with good but not exceptional fruit size. The tree is productive and vigorous. Fruit quality and firmness are maintained on the tree for 2 weeks following the full ripe. Fruit show good resistance to brown-rot both in the field in 2018 and 2020 and in earlier Bostock lab inoculation (image). Fruit also appear free from pit-staining and associated fragmentation and appears to contain a *hi-lighter* type gene which suppresses anthocyanin production and so eliminates the risk of red pit-staining in this and genetically related selections. Moderate fruit sizes, without any trace of pit-staining were again observed in 2019 and 2020 though some split pits were observed in 2019.

17,3-185. A fourth-generation hybrid between Early-6 and a pollen parent having the Freestone peach O'Henry and Compact-1 as grandparents. Fruit are large and uniform in shape with a light gold-yellow color throughout. Both fruit skin and fruit-pits are free from any red-staining even in overripe fruit. Fruit maintain firmness for two weeks beyond the tree-ripe stage though water-soaking and flesh-browning occur in older peaches. Low levels of fruit brown rot resistance were observed in the field in 2020 though because of the newness of this selection, it has not yet been analyzed under controlled lab conditions. Tree is moderately vigorous, upright to spreading. This selection will be used as a parent to confer good fruit characteristics and productivity targeting this important harvest time.

<u>Early season</u>

Andross harvest time.

11,11-233. A progeny from a 3rd-generation introgression line, this selection has consistently shown good tree productivity and fruit size, quality and firmness. Fruit quality has been maintained for up to 2 weeks following tree-ripe though the fruit tend to be a bit softer than other advanced selections in this harvest time. Fruit are generally free from red-staining of the pit and associated pit fragmentation, though a light pigmentation can occur on overripe fruit that cooks out with processing but discourages its consideration as a possible variety release. Pits are medium to small in size. The uniform yellow-gold skin and flesh color are also maintained up to 2 weeks following tree-ripe contributing to a good-quality processed product (images) as well as enhance consumer nutrition (i.e. higher levels of antioxidants). Fruit show low levels of fruit brown rot in natural field inoculations but have not yet been tested under laboratory conditions. Fruit also show reduced levels of flesh bruising.

10,18-528. This selection is derived from 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 initial fruit brown rot infection as well as improved lye-peeling. Fruit show moderate size and good firmness but greater susceptibility to flesh bruising. As with other 00,16-92 breeding selections, epidermis and fruit pit are free from any red pigmentation, even in overripe fruit. Breeding line 00,16-92 is from a 2nd and independent almond germplasm source, which appears associated with greater fruit structural integrity and so firmness, particularly for the inner flesh near the pit cavity. It is one of the firmest selections in this maturity season and the flesh firmness holds well to 2 weeks or more after tree ripe. The seed parent, 2000,16-92, also possesses exceptional firmness but had a tendency to soften rapidly at about 10 days after tree ripe. By selfing (seed were derived from self-pollinations of the parent), we appear to have been successful in roguing-out some of the softening factors while maintaining good fruit quality but have also lost a little in fruit size. Good brown-rot resistance is observed following Bostock lab inoculation (image) as well as in field evaluations in 2018, 2019 and 2020. Fruit is generally free from red skin blush or pit-staining except in very overripe fruit.

03,1-329. Resulting from a cross between traditional peach germplasm and the wild peach *P.mira*, this selection produces fruit with good size and color. Fruit firmness is also maintained for 10 days or more after tree-ripe. *P. mira* thus appears to be another, independent source for the *stay-ripe* trait expression but is not as strong as in almond derived sources. This selection has been an important parent in crosses to combine *stay-ripe* from different genetic sources to improve both total firmness as well as environmental resilience. Fruit can show 85% or more blush with some slight red imprint in common in pits even at tree-ripe and becoming darker with overripe fruit. Some split-pits are

observed but at relatively low frequencies given the vigor of tree. Trees are very vigorous and productive. While the red in pit and flesh softening after 10 to 15 days make this item less desirable as a released variety, it has consistently performed well in the field as well as being an effective parent in previous hybrids for conferring size and firmness.

Klampt harvest time.

11,22-233. This selection ripens with Klampt and is derived from the F8,5-166 almond by peach hybrid source. This germplasm has been a

good source for brown-rot resistance (see image following Bostock lab-controlled inoculation) and has also been a promising source for mildew resistance. The skin may show a slight blush covering about 40% of the fruit. Fruit flesh remains generally free of any red pit staining and associated pit fragmentation. Fruit maintained good firmness and a bright yellow-gold color 2 weeks or more after tree ripe. The tree is vigorous and productive producing large fruit of uniform size and shape. No leaf curl was observed in 2018 and 2019 field evaluations and a reduced mildew is generally observed in this selection. Although ripening with Klampt, the staying-power of this selection can be seen in the image at right showing fruit harvested on September 6, 2020.

11,9-104. Derived from the almond by peach F8,5-166 germplasm, from a cross between *ExtraLate-1* with *ExtraLate-6*, this selection harvests with *Klampt* despite the very late maturation of its parents. [As previously discussed, this transgressive harvest shift has been a useful strategy to target the Dixon maturity gap]. Fruit are large with uniform size and shape and free from red-blush as well as red pit-staining and associated pit fragmentation. Flesh color is a dark yellow gold that may be too dark for commercial production but acts two complement color when crossed with lighter colored breeding selections such as 17,3-185 described above. Good resistance to fruit brown-rot has been observed in the field and following Bostock lab inoculation (image). Good fruit firmness and quality is maintained up to 2 weeks following tree ripe. Processed fruit firmness averaged 8.4 pounds despite been harvested 10 days after tree ripe stage. Tree is moderately vigorous and productive.

11,6-80. This selection is also derived from almond germplasm but through a different lineage than the previously described selections. A earlier ripening budsport of Carson was used as the seed parent with the intention of targeting this maturity time with good size fruit and productive tree characteristics. Fruit share many of the same characteristics, being of good size and shape. Color is a commercially-desirable golden-yellow. Fruit skin can show about 30% red blush and flesh is free of red-staining and associated pit fragments. Some slight pinking can be observed in peach pits when fruit become overripe and while this cooks out and processing it precludes it probable release as a variety. A relatively small pit also contributes to improved case yields. Fruit flesh maintains good firmness and integrity for up to 2 weeks following tree-ripe, though rapid softening can occur in excessively overripe fruit. Some fruit brown-rot disease has been observed in the field, including 2018 and 2020 but this item has not yet been tested under controlled conditions of the Bostock lab. Tree is moderately vigorous and productive. Tree architecture is upright to upright spreading.

11,9-90. The last selection also has the most exotic lineage. The germplasm is derived from the wild almond species *Prunus argentea*, which shows promising levels of resistance to a number of diseases and environmental stresses but generally produces small poor quality fruits on a plant that is more shrub than tree. The result of a series of backcrosses to cultivated peach, culminating in self-pollinations to sort-out desirable from undesirable genes, this selection continues to show promise as a parent for future crossing and as a possible candidate for regional grower testing. Fruit are medium-sized and uniform with a moderate red blush, depending on year. Flesh is yellow to golden-yellow with some red pit staining in very over-ripe fruit in 2019 (but not 2020) with no serious pit fragmentation. Pit size is medium to small. Fruit have shown good resistance to fruit brown-rot disease in both Bostock lab evaluations (image) and field, including 2018, 2019 and 2020. Fruit show good firmness, which is maintained to 2 weeks after full-ripe. Fruit integrity is maintained even with overcooking during processing as occurred in 2016 (center image). The tree is vigorous, upright spreading and productive.