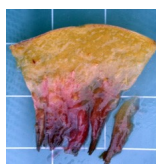


Breeder profile: Tom Graziel

By Audrey M. Sebolt, project assistant

**What is a melting versus non-melting peach?**

Melting flesh peaches have flesh that become soft and fibrous at maturity. They tend to have ragged edges when sliced during processing and so are easily damaged. Melting flesh types can be clingstone or freestone.



Non-melting flesh peaches remain firm at maturity. Most commercially canned cultivars are non-melting and all non-melting types are clingstone.

Stony-hard flesh peaches do not produce ethylene and therefore peaches with a stony-hard gene are very slow to soften. Candidate genes for this trait are under investigation with the goal of incorporating MAS during seedling evaluation (www.rosaceae.org/node/176).

What is a clingstone peach?

- In a clingstone peach, the flesh 'clings' or adheres to the stone as opposed to a freestone peach, where the stone and the flesh separate at maturity allowing the stone to be easily removed. Clingstone peaches are also firm and less easy to bruise than their freestone counterpart.
- Because all non-melting peaches are also clingstones, the clingstone trait is tolerated in both processing and fresh market cultivars despite its obvious disadvantages.

The California Cling Peach Industry - By the Numbers (www.calclingpeach.com/html/nav/industry.html)

- \$943 million: CA Peach Industry's contribution to California's total economy
- 450,000-550,000: tons of peaches that are harvested and processed each year
- 4.2 pounds: United States per capita consumption of cling-stone peaches in a given year!
- \$120 million: estimated value of the crop when harvested. The value increases to over \$500 million after processing

Over half the peaches grown in the US are for processing. Most processing peaches are canned, with California accounting for 96% of the total market share, making it the largest producer in the world. Unlike fresh market cultivars, which frequently change in response to market trends, processing peach cultivars entail a long-term commitment by both growers and processors because of the specialized equipment involved. The industry currently processes approximately 25 to 30 different cultivars in a season, which spans the time frame of July 1 to mid-September, with a different cultivar ripening every 2 to 3 days in order to keep the processing plants running at full capacity. To be commercially viable, an acre of processing peaches must produce close to 20 tons per year (44,820 kg/ha) with an expected orchard production period of 20 years or more to be commercially successful. Located primarily in the Sacramento and San Joaquin Valleys of California, there are currently over 600 clingstone peach producers on approximately 30,000 acres (12,140 hectares).

Most processing peach cultivars are non-melting clingstones (see box on left) because the non-melting trait, with its firm, non-melting flesh, allows the fruit to be harvested at the preferred tree-ripe stage, transported to the processing plant and processed without appreciable loss in fruit integrity. This capacity to provide 'tree-ripe' fruit to the market without loss in either eating quality or phytonutrient content,



Tom pointing out young peach seedlings in his UC Davis breeding program.

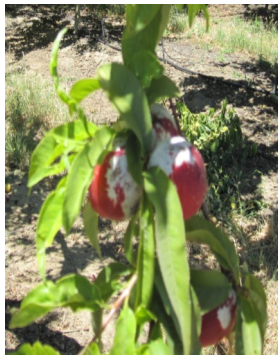
has also made non-melting, clingstone peaches a popular fresh market fruit in Europe and Central and South America. Many new early-season fresh market US peach cultivars now utilize the non-melting, clingstone trait for this reason. Clingstone peaches are processed for canned peaches and fruit cocktail; other products include frozen peaches, baby food and fruit concentrate.

Tom Gradziel, RosBREED peach Demonstration Breeder, has been at UC Davis since 1988, and welcomes the unique challenges of breeding new cultivars for California. He currently manages 80 acres of high-density peach and almond seedlings at Davis, with additional grower test plantings of over 50 advanced selections in plots located from Redding, northern California, to Bakersfield, southern California.

A major challenge to peach breeding is the very narrow genetic base, making it difficult to impossible to find new genetic solutions to address emerging cultural and marketing needs. Almond, also a rosaceous species that readily hybridizes with peach, however, possesses an extensive genetic diversity in the cultivated landraces and related wild species located throughout Europe, North Africa, and Asia. Tom has utilized this interspecies germplasm in his breeding program to introgress new traits including improved disease and pest resistance, elevated phytonutrient contents, and

Breeder profile cont.**Traits of interest for breeding clingstone peaches for the CA industry**

- Flesh color
- Firmness
- Flavor
- Texture
- Increased phytonutrients (carotene, phenolics, a-tocopherol and fatty acids)
- Increased sugars
- Low incidence of pit fragmentation during processing
- Avoidance of split pits during ripening
- Disease and pest resistance (brown rot, flower blight, leaf curl, mildew, and green peach aphid)
- Rootstock compatibility
- Single pass harvestability (typically a cultivar is picked 2-3 times where only the ripest fruit are harvested, with approximately 3 days between each harvest)
- Fruit that will hold on the tree once ripe a minimum of 2-3 weeks and not undergo post-harvest deterioration



Peach fruit infected with brown rot

improved postharvest fruit texture integrity. It has taken him approximately 10 years to reach the current stage where approximately half of the advanced peach breeding lines and over 90% of the advanced almond breeding lines contain genes from another species.

The unique challenges inherent in this breeding approach, along with the long-term (typically 10 to 15 years) field testing required prior to cultivar release, mandate a team-based approach to cultivar development. The foundation for UC Davis breeding program progress and success has been its ability to leverage the high level of expertise of collaborators such as Abhaya Dandekar and Carlos Crisosto (molecular and postharvest biology); Rick Bostock and Jim Adeskaveg (Plant Pathology); Diane Barrett (Nutrition); and Mary Ann Thorpe (Horticulture).

Tom sees the similarly team-based approach of RosBREED as one of its biggest assets as it allows an efficient and precise evaluation of the extensive molecular and phenotypic data that will be compiled and shared within the group. This result will allow breeders to better understand their genetic lines and core germplasm. More specifically, it may allow a better understanding of the interaction of genes and genomes in vegetatively propagated cultivars and rootstocks.

Tom's program has been using marker-assisted selection (MAS) since the mid-1990s in its efforts to transfer self-fertility from peach to almond. More recently, they have been using markers developed with Cameron Peace and Eben Ogundiwin for characterizing allelic differences for the endoPG gene as markers for peach improvement (see "Jewel in the Ge-

Scion and Rootstocks released by Tom Gradziel

Hesse peach (1992) is high yielding and has increased levels of the phytonutrient vitamin A. The fruit ripen uniformly for minimum pickings and have low incidence of split pits.

Rizzi peach (1992) is a high yielding, midseason variety which offers excellent storage qualities. Fruit can be held in cold storage for up to eight weeks and still maintain good canning quality and so offer a raw product supply buffer to processors during peach production times.

Goodwin peach (2001) has a desirable 'Dixon' season ripening time, good yields, and disease tolerance. Fruit cultivar remain free from the anthocyanin red staining of pit-cavities as occurs in 'Dixon' and 'Andross' cultivars which it replaces.

Lilleland peach (2002) has a desirable 'Halford' season ripening time and produces superior fruit that have excellent flesh color, texture, and flavor. Trees produce high yields of firm fruit with the capacity for 'once-over' harvest.

Winters almond (2002) has high productivity with good kernel quality and flowers with the economically important early 'Nonpareil' almond bloom. Winters has partial self-compatibility, allowing some self-pollination to help buffer production when inclement weather at bloom reduces cross-pollination.

Sweetheart almond (2008) is a premium quality 'Marcona-type' almond, combining high productivity with high kernel phytonutrient levels as well as improved insect and disease resistance. Sweetheart flowers with the economically important early 'Nonpareil' almond bloom and also shows partial self-compatibility, allowing some self-pollination to help buffer production when inclement weather at bloom reduces cross-pollination.

nome" for further details). This extensive experience with MAS has both dampened and rekindled Tom's breeding team's perception of the ultimate value of MAS. Tom further explained how the transfer of self-compatibility gene from peach to almond using MAS was not a wild card that made winning almond cultivars. He said "This was because even the highly desirable self-compatible almonds still needed a wide range of other production and market attributes as well as new disease, pest and stress resistance genes for commercial success." In this situation, while MAS allowed the selection of parents to ensure all seedlings would possess the self-compatibility gene, since the population was also segregating for a large number of other important traits, breeders were not able to only use MAS knowledge to produce a winning almond cultivar.

Because the UC Davis cultivar improvement program is simultaneously pursuing a range of different breeding goals, the MAS game is currently perceived as more similar to 'Solitaire' where the 'right complementation' of genes is being pursued simultaneously for a number of different objectives. In this scenario, the game becomes a lot easier if MAS allows greater knowledge of the cards still hidden in the deck.