Almond Variety Development

Project No.: **07-HORT1-Gradziel/Crisosto**

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Objectives:

1. Develop (1) improved pollinizers for *Nonpareil*, and ultimately, (2) varieties that possess self-fertility and improved market value and disease/insect resistance.
2. Release *Sweetheart* as a premium quality resistant variety. Expand field trials of new UCD selections and monitor performance of advanced selections now in regional/grower testing.
3. Continue to develop rapid selection/breeding techniques for Noninfectious Bud-failure, self-compatibility, disease resistance, and pest (especially NOW) resistance.
4. Generate the next generation of almonds from controlled crosses and screen progeny trees for self-compatibility, tree productivity, kernel quality and resistance to key pests/diseases.

Interpretive Summary:

In 2007 over 10,000 seed were recovered from 22 separate crossing combinations. Approximately 95% of controlled crosses were directed towards improved yield consistency and pest/disease resistance. Approximately 36,000 seedling trees developed from previous controlled crosses between parents with promising levels of kernel quality, disease resistance and or self compatibility were evaluated. Promising selections have been placed in regional evaluation plots in the Sacramento and San Joaquin Valleys. Advanced selections in previously established long-term regional trials continue to perform well, including the previously released Winters variety, the FPS#1

low Bud-failure source for Carmel, the recently released Sweetheart variety (selection 36-52) and the promising high-yield selection 2-19E.

Effective molecular markers are being developed for self-incompatibility / self-compatibility, and key developmental processes involved in hull maturation (including hull and shell split and associated susceptibility to kernel diseases and insect pests. Molecular based markers, developed as part of a Industry-University BioStar project, allow the more accurate selection of desired traits as well as a clearer understanding of the key genetic and developmental mechanisms controlling those traits. Advanced selections combining self-compatibility with good commercial quality are now available for grower testing.

Progress in 2007

The recent release of the *Sweetheart* and *Winters* almond varieties and low Bud-Failure *Carmel* sources to the California nursery industry addresses the initial breeding objective of dependable, productive pollinizers for *Nonpareil*. Our next objective is a series of almond varieties having production quality and yields comparable to *Nonpareil* but with self-compatibility to improve insect pollination and yield consistency, and reduce orchard management costs. Additional priorities include good shell-seal to control worm, ant, and fungal (*Aspergillus)* entry, with high crack-out percentages, freedom from Non-infectious Bud-failure and improved disease/pest resistance.

In 2007 over 10,000 seed were recovered from 22 separate crossing combinations. Approximately 95% of controlled crosses were directed towards improved yield consistency and pest/disease resistance. Disease and pest resistance in initial seedling trees are being assessed through evaluation of natural infections in seedling blocks. The bulk of field activities in 2007, however, involve the evaluation of the approximately 36,000 seedling trees developed from controlled crosses between parents with promising levels of kernel quality, disease resistance and or self compatibility. Tree and nut data are being collected/analyzed to determine the value of various parental crossing combinations, to rouge-out or eliminate ~80 % of 3rd & 4th year trees (to reduce field costs while allowing a more detailed quality assessment of remaining crossing progeny in subsequent years) and to select promising genotypes for regional testing in anticipation of future variety releases.

UCD 36-52 has been released as the cultivar ‘Sweetheart’. This new cultivar combines very high kernel quality (high oleic acid which confers good processing quality and phytonutrient value and lower susceptibility to rancidity in storage), good productivity, partial self-fertility, and improved resistance to navel orangeworm and associated aflatoxin contamination. Because of its unique ‘Marcona’-like heart shape, Sweetheart provides an alternative/replacement variety for the premium quality, niche-market, Spanish variety ‘Marcona’ which is currently being test-planted in California.

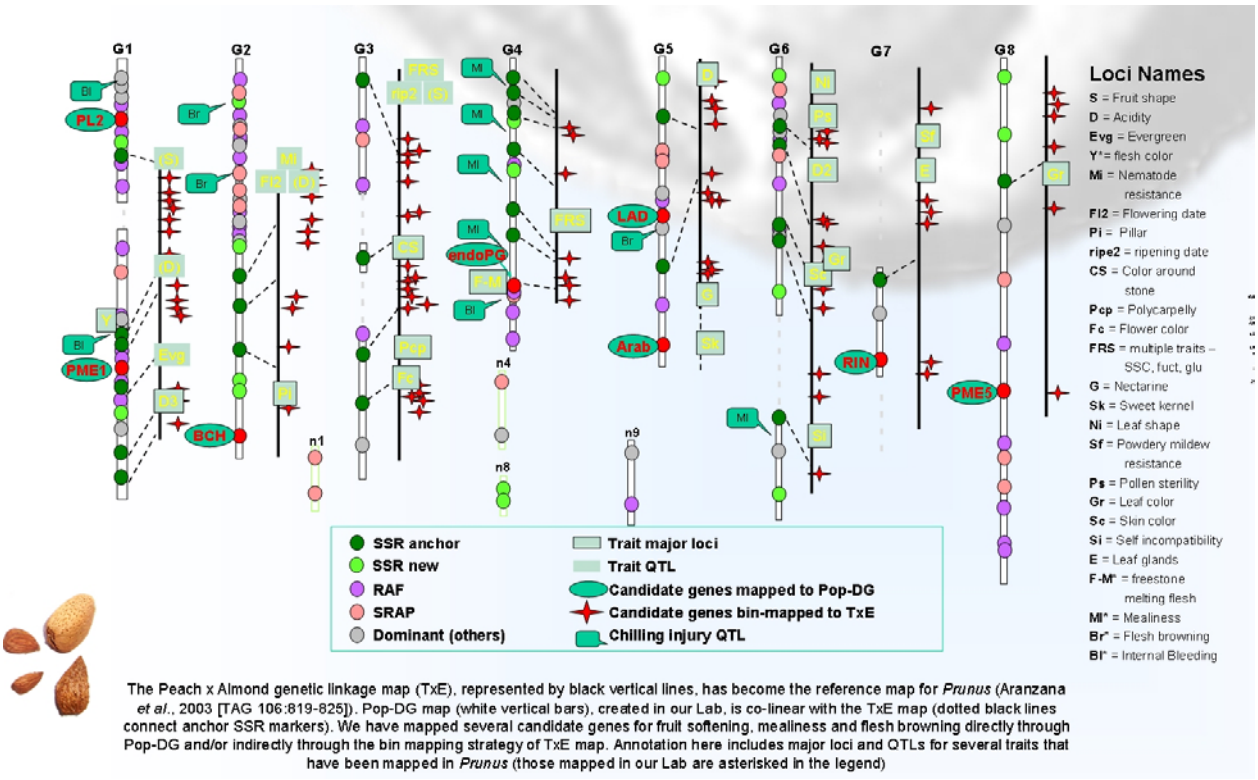
UCD 2-19E is a very productive but potentially alternate bearing pollinizer for the Nonpareil late-bloom. New plantings of this selection have recently been established in

Sacramento Valley and San Joaquin Valley test plots to determine whether consistent high yields are possible with higher levels of irrigation/fertilizer inputs.

Thirty advanced UCD experimental selections, demonstrating promising levels of self-compatibility, pest/disease resistance, kernel quality and/or tree productivity, have been planted in medium-scale (10-100 tree) grower test plots in Kern and Colusa Counties and are now coming into bearing. Results from the first harvests have identified several individuals with particular promise but have also identified several individuals with possible deficiencies (disease susceptibility, undesirable tree structure, low yields, etc.). Tree and kernel characteristics of the most promising seedling selections will be displayed at the 2007 Conference.

Since genes ultimately determine specific plant characteristics, the best selection marker for a difficult to distinguish trait such as self-compatibility or disease resistance, is the gene itself. Molecular markers developed with Drs. Crisosto and Dandekar are proving accurate and efficient in identifying California self- and cross-incompatibility groups. In addition, specific markers for the self-compatibility (self-fertility) sources used in the breeding program are being effectively utilized to select the most promising breeding lines for further tests/controlled crosses. Molecular markers to identify the specific self-compatibility alleles present in advanced selections also allow the formulation of controlled crosses resulting in up to100 percent self-compatible progeny. (This is achieved by selecting as pollen parent, a self-compatible selection having a self-incompatible allele in common with the seed parent. Then, only pollen containing the self-compatible allele will be compatible with and so set seed on the seed parent utilized). Molecular marker based strategies are now being developed to better understand and positively manipulate both bud-failure and important pest/disease problems as well as key developmental processes including kernel and shell development (explained in greater deail in the 2006-07 Project Report).

The figure below shows our current genetic linkage map of almond (and the closely related peach). Linkage maps allow us to locate key quality/resistance genes and to develop strategies for their manipulation; particularly the concentration of commercially desirable genes and the elimination of those genes conferring poorer quality, yield, disease/pest resistance, etc.



The Peach x Almond genetic linkage map (TxE), represented by black vertical lines, has become the reference map for *Prunus* (Aranzana *et al.*, 2003 [TAG 106:819-825]). Pop-DG map (white vertical bars), created in our Lab, is co-linear with the TxE map (dotted black lines connect anchor SSR markers). We have mapped several candidate genes for fruit softening, mealiness and flesh browning directly through Pop-DG and/or indirectly through the bin mapping strategy of TxE map. Annotation here includes major loci and QTLs for several traits that have been mapped in *Prunus* (those mapped in our Lab are asterisked in the legend)