Almond Variety Development

Project No.: **09-HORT1-Gradziel**

Project Leader: Tom Gradziel
Department of Plant Sciences
One Shields Ave.
UC Davis
Davis, CA 95616
(530) 752-1575
e-mail: tmgradziel@ucdavis.edu

Project Cooperators and Personnel:
C. Crisosto**,** M.A. Thorpe, B. Lampinen, J. Adaskaveg, J. Connell, M. Viveros, J. Edstrom, S. Metcalf and P. Schrader

Objectives:

Develop (1) improved pollenizers for Nonpareil, and ultimately, (2) varieties that possess self-fertility and improved market value and resistance to disease, insects and environmental stress. Specific objectives for 2009-10 include:

A. Utilize expanded grower trials to evaluate regional performance of advanced breeding lines to identify the most promising genes/selections for resistance and market quality for inclusion in new Regional Variety Trials.
B. Improve selection efficiency for required traits (productivity, resistance to disease/pest/environmental stress, marketability, sustainability). Prioritize required traits in partnership with growers, handlers and processors.
C. Accelerate the variety development cycle through expanded controlled hybridizations followed by efficient screening of progeny trees for self-compatibility, tree productivity, kernel quality and resistance to key pests, diseases and environmental stresses, including water use efficiency.

Interpretive Summary:

The California almond industry is entering a period of transformation driven by increasing market demands, loss of pollinators, reductions in natural resources including good-quality land and water, and changing climate. While almond represents a diverse and highly adaptable species, (as demonstrated by the proliferation of wild almonds trees along many Central Valley roadsides and creeks), commercial production is dependent almost entirely on the variety *Nonpareil* and its pollenizers, most of which have *Nonpareil* and *Mission* as direct parents. Because of this dependence on a very narrow germplasm base, the UCD almond breeding program has targeted the introduction of new and diverse germplasm and the subsequent breeding of this diverse and often wild germplasm for adaptiveness to Central Valley conditions while retaining the traits of interest, particularly self-compatibility, disease/pest resistance and tolerance

to environmental stresses. Because it takes at least 5 years to grow a seedling tree from seed to bearing tree, the commercial transfer of new germplasm is tedious, requiring decades for the recovery of commercially adapted advanced breeding lines (as shown in **Figure 1**). In addition, unlike the European and Central Asian almond breeding programs, (which primarily utilize the old self-compatible Italian variety *Tuono* as their source of self-compatibility and improved tree productivity), the UC breeding program has incorporated new germplasm from a wide array of sources including cultivated and wild peach and almond species (**Table 1**, see 2008 Annual Report Project 08-Hort1-Gradziel for a more complete listing).

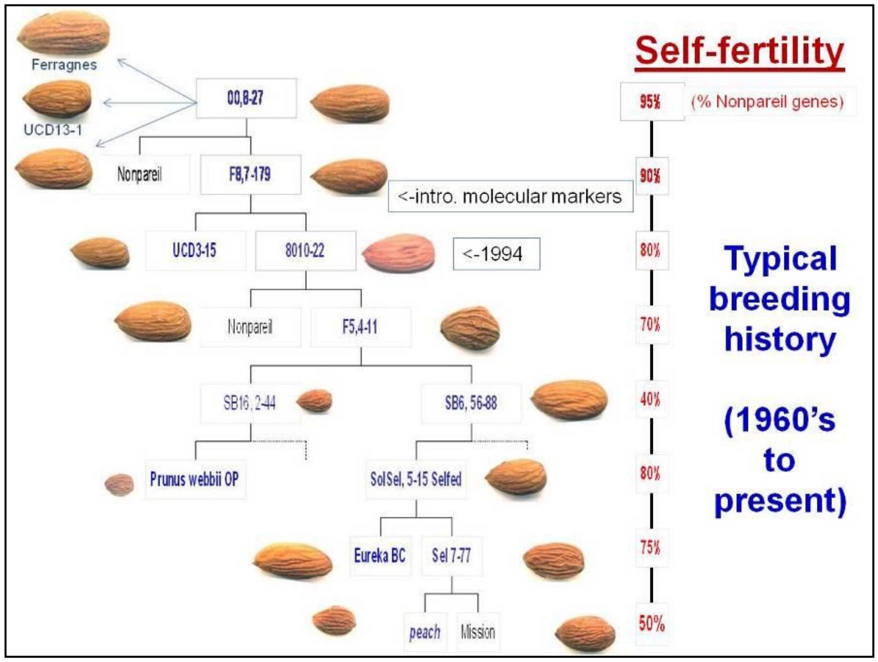

Figure 1. Typical breeding history (1960s to present).

As demonstrated in **Figure 1**, advanced breeding lines are approaching commercial quality and currently over 40 breeding selections are in Sacramento and San Joaquin grower trials. While the ultimate goal is a series of self-fruitful and productive *Nonpareil*-type varieties with differing harvest dates, many current advanced lines also express a range of kernel quality traits and tree architectures, providing greater grower options for tailoring varieties to specific cultural and market needs. [Detailed descriptions provided in the 2008 Annual Report Project 08-Hort1-Gradziel.] These include regionally-adapted selections expressing high levels of self-compatibility as well as improved insect, disease and environmental stress resistance. Processor evaluations of recent regional samples have determined that approximately half of these selections still possess levels of kernel flavor (typically a slight amaretto taste) and seed coat color (which is associated with higher antioxidant activity) to preclude their mixture which standard Nonpareil and California marketing groups and many of these less traditional selections are in the process of being discarded. Such unique characteristics, though, have also been perceived by some growers and processors as having the potential to expand current, traditional markets and several selections are advancing to large-scale field and market testing, and germplasm made available to private breeders. An example is the recent UCD released *Sweetheart* variety as a premium quality, heart-shaped Marcona-type almond, which possesses partial self-compatibility, very high levels of the heart-healthy phytonutrient oleic-acid, and improved resistance to hull-rot, navel orangeworm and aflatoxin contamination. To be successful, both traditional and new market-type varieties will need to combine quality and productivity with the changing (and yet to be fully determined) needs of tomorrow's orchards and markets. Continued breeding progress depends upon identifying and prioritizing essential traits, the efficient recombination of these often novel (and so untested) genetic solutions with established genes for local productivity and marketability, and the generation of the large numbers of progeny from controlled crosses to ensure recovery of the rare individuals possessing the best genetic combinations. For example, recent reports from European breeding programs indicate that their dependence on a single genetic source (*Tuono*) for self-compatibility has ultimately led to lower cultivar productivity because of genetic inbreeding depression. The extensive genetic diversity (extensive and costly field plots) which has allowed the UCD program to avoid this problem has is fast becoming a liability because of ongoing University cuts. We are consequently in the process of dramatic reductions of field plots and so breeding germplasm, and grower and processor participation in this rouging-out process is crucial to prevent loss of genes/traits needed to solve future almond industry problems.

Table 1. Selected breeding lines used as parents for self-compatibility and kernel quality. (Bloom – days before (-) or after (+) Nonpareil. Origin refers to the germplasm source of the major trait of interest (i.e. self-compatibility, disease resistance, etc.) since most selections have complex origins [see **Figure 1**]. Self-set refers to average self-set (bagged) compared to adjacent set on unbagged, insect pollinated branch).

Selection	Bloom vs. Nonp.	Kernel (g)	Shell-out (%)	Doubles (%)	Origin	Length (mm)	Width (mm)	Thick (mm)	Self-set (%)
UCD2-19E	5	0.95	0.62	1	California almond	21	11.4	8.1	6
Sweetheart	0	0.95	0.51	0	Peach (P. persica)	19.6	13.2	8.7	12
LG-05	8	1.08	0.62	8	Peach	21.8	11.9	9.4	59
F8,8-4	1	1.36	0.60	9	Prunus webbii	25.7	12.9	9	76
F8,8-161	5	1.16	0.50	14	Prunus fenzliana	25.3	12	8.3	79
F8,8-160	5	1.29	0.62	0	Prunus mira	27.1	11.9	8.3	88
F8,7-180	2	1.27	0.60	0	Prunus webbii	29.3	12.8	7.5	11
F8,7-179	2	1.08	0.62	3	Peach	27	12.2	8.5	73
F7,1-1	0	0.68	0.71	0	Peach	17.4	10.2	8.2	98
F10C,2-4	2	1.18	0.44	15	Californa almond	25.7	13.2	7.8	4
F10C,1-16	4	1.16	0.68	3	Californa almond	26.2	11.4	8.5	7
D3-26	5	1.22	0.63	1	Prunus webbii	25.3	12.9	8.5	12
D,1-6	2	1.45	0.73	18	Californa almond	26.1	13.5	8.2	8
D,1-25	5	0.74	0.40	1	Prunus mira	24.4	11.6	6.9	79
C,1-10	3	1.22	0.69	2	Californa almond	27.1	14.3	7.5	5
99,9-86	0	1.33	0.51	0	Prunus webbii	25.6	13.8	8.9	81
99,4-8	6	1.51	0.27	0	Peach	26.2	16.8	8.5	4
99,3-79	4	1.30	0.42	12	Prunus webbii	21.3	13.3	10.5	7
98,3-53	-1	1.72	0.75	0	Peach	29.6	15	8.7	65
98,2-305	5	1.06	0.52	0	Prunus argentia	24.9	13.3	7.5	4
97,3-40	-5	1.77	0.45	1	Prunus fenzliana	32.3	14.5	9.3	7
97,2-240	3	1.19	0.65	3	Prunus webbii	22.6	13.1	9.4	3
97,15-109	3	1.22	0.66	3	Prunus argentia	27.2	13	8	67
95,1-26	1	1.80	0.56	2	European almond	29.1	14.2	9.6	63
2000,2-3	1	1.17	0.57	3	Peach	24.4	12	9.1	90
2000,16-81	3	0.93	0.52	4	Irradiated almond	21.5	11.7	9.8	82
2000,8-27	3	1.07	0.51	10	Prunus webbii	24.1	11.7	8.4	92
2004,14-158	0	1.48	0.39	0	Prunus fenzliana	25.9	14.2	8.8	62
2002, 7-159	4	1.14	.64	3	Tuono almond	26.7	11.5	8.8	67
2004,8-160	3	1.85	0.65	0	Prunus mira	30.4	15.4	8.5	96