Almond Variety Development: 2014

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Field crosses using mesh bags to exclude bees an so control crossing parents,

Introduction

The California almond industry is in a historic period of transformation driven by increased Central Valley acreage along with increasing environmental and market requirements, reductions in resources such as water, agrochemicals, and natural pollinators, as well as the uncertainties of a changing climate. While almond represents a diverse and highly adaptable species, commercial production in California is dependent almost entirely on the variety *Nonpareil* and a relatively few pollenizers, most of which have *Nonpareil* and *Mission* as direct parents. A long-term emphasis of the UCD almond breeding program has been the identification and incorporation of new and diverse germplasm. Genetic solutions to emerging production challenges are now becoming available from this improved germplasm, including regionally-adapted selections expressing high productivity, self-fruitfulness, and increased insect, disease and environmental stress resistance. Improved breeding lines also offer opportunities to expand market demand by optimizing phytonutrients in new varieties while minimizing potential health and marketing risks including aflatoxins, allergens and salmonella.

New Variety Release

Advanced UCD breeding selection 2-19E has been released as the later *Nonpareil-bloom* pollinizer *Kester*. A prerequisite of all UCD variety releases is a long term (10+ years) testing in all regions of potential plantings prior to patenting and release. Because almond typically takes this long to come into mature production, such a long-term testing is required to identify any deficiencies prior to large-scale grower planting. Over the last 18 years the UCD variety *Kester* has been successfully tested (as breeding line UCD2-19E) in all current regions of Sacramento and San Joaquin valley production. A high productivity with kernel and shell characteristics similar to *Nonpareil*, combined with low susceptibility to important almond diseases have been demonstrated in these long-term regional trials. High yields have been consistently achieved despite a ~20% smaller tree size (which contributes to greater yields for the adjacent *Nonpareil* rows). Multiyear results from the recent and ongoing Kern County trials are presented below. Data are from Bruce Lampinen's McFarland Regional Variety Trial with more detailed information available in his annual reports.

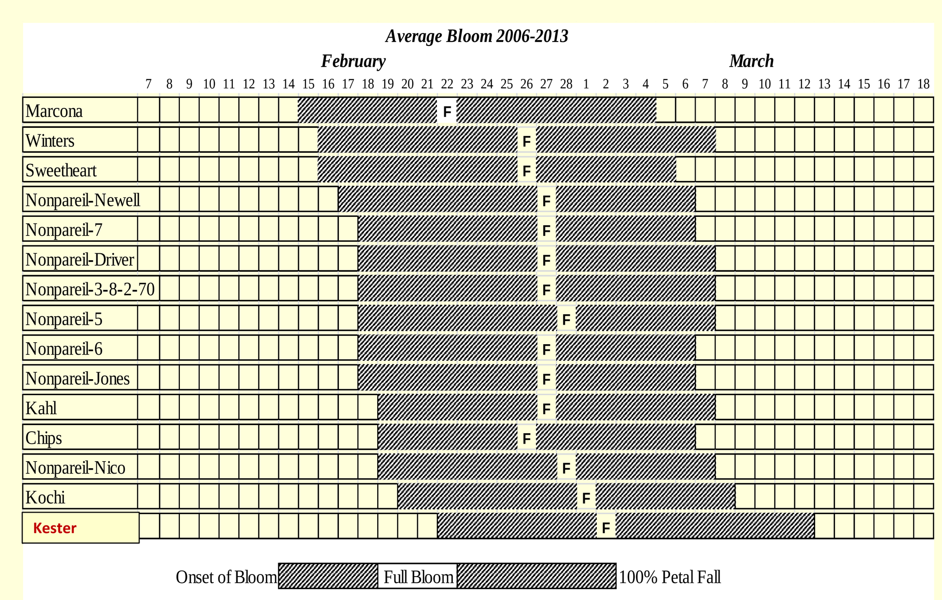
New variety release

Nut characteristics of the variety *Kester* compared to adjacently planted *Nonpareil* from the 2014 RVT.

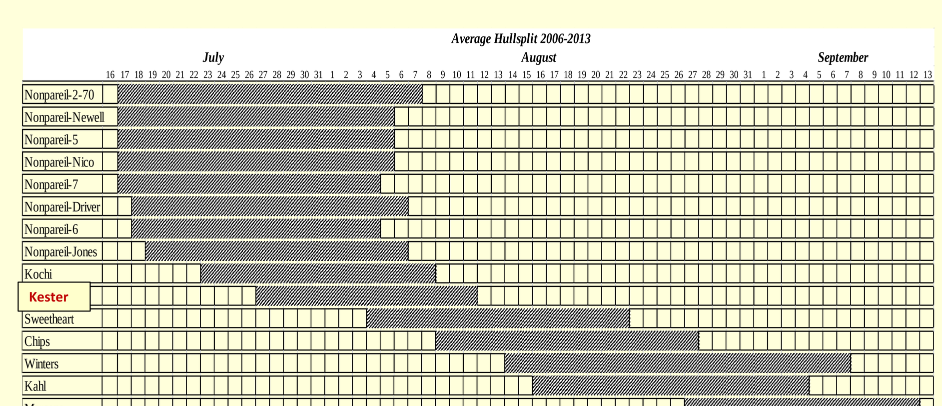
Strong bloom and nut set characteristic of of the variety *Kester*.

Year	Planted 2004 Variety	No. of nuts/tree	Average kernel wt (g)	Shelling percentage	Kernel pounds per Tree	Acre	Cumulative kernel yield (lbs/acre)
2006	Kester	6852 a	0.94 g	53.0 d	14.2 a	1718 a	1718 a
	Nonpareil-70	3848 bc	1.07 cde	64.6 ab	9.1 bcd	1101 bcd	1101 bcd
	Nonpareil-J	3717 bcd	1.08 cde	64.0 abc	8.8 bcd	1066 bcd	1066 bcd
	Chips	3623 bcd	1.02 f	53.8 d	8.1 bcde	985 bcde	985 bcde
	Kochi	3134 cd	1.16 b	59.9 c	8.0 cde	965 cde	965 cde
	Nonpareil-7	3288 bcd	1.08 cde	65.1 a	7.8 de	941 de	941 de
	Kahl	3139 cd	1.06 ef	47.8 e	7.4 de	889 def	889 def
2007	Kester	13149 a	0.78 e	54.3 d	22.8 a	2756 a	4474 a
	Nonpareil-70	9340 cde	0.92 bc	66.3 a	18.9 abcd	2291 abcd	3393 b
	Kahl	9594 cd	0.91 bc	47.6 e	19.3 abcd	2332 abcd	3222 bcd
	Nonpareil-J	9137 cde	0.89 bcd	65.5 a	17.8 bcde	2152 bcde	3218 bcd
	Chips	7681 defg	0.87 cd	54.4 d	14.7 ef	1780 ef	2766 bcd
	Kochi	6006 g	1.08 a	59.4 bc	14.3 ef	1729 ef	2694 de
2008	Kester	13472 a	0.93 g	54.3 d	27.4 cd	3321 cd	7795 a
	Nonpareil-70	12506 bcd	1.17 cd	66.3 a	30.7 b	3714 b	7106 bc
	Nonpareil-J	11071 d	1.09 cde	65.5 a	26.6 de	3224 de	6442 cd
	Kahl	10720 de	0.96 fg	47.6 e	22.6 fg	2733 fg	5954 de
	Chips	11465 cd	0.97 fg	54.4 d	24.4 ef	2956 ef	5722 ef
	Kochi	5882 f	1.28 b	59.5 bc	16.5 h	2002 h	4696 g
2009	Kester	14706 a	0.84 f	65.6 f	27.1 c	3285 c	11080 a
	Nonpareil-70	13756 ab	1.04 bcd	74.6 ab	31.4 ab	3798 ab	10905 abc
	Nonpareil-J	12803 abc	1.04 bcd	71.6 bcd	29.0 bc	3513 bc	9955 cd
	Kahl	11035 cde	0.87 ef	59.1 g	21.1 de	2559 de	8513 ef
	Chips	9771 ef	0.93 def	58.6 g	20.0 e	2422 e	8144 ef
	Kochi	7252 g	1.17 a	68.9 de	18.7 e	2259 e	6955 h
2010	Nonpareil-70	8823 bcd	1.28 abcd	72.3 ab	24.9 a	3011 a	13916 ab
	Kester	6833 efg	1.10 bcdef	56.1 e	16.7 bc	2020 bc	13100 bc
	Nonpareil-Jones	8315 cde	1.23 abcdef	70.9 ab	22.6 a	2737 a	12691 c
	Chips	9089 abc	1.15 bcdef	65.9 abc	23.0 a	2789 a	10933 d
	Kahl	7587 cde	1.01 f	56.5 de	16.9 b	2048 c	10561 d
	Kochi	3902 h	1.40 a	64.4 bcd	12.1 bc	1466 bc	8421 e
2011	Nonpareil-70	17744 abc	1.05 bc	70.7 a	41.0 a	4962 a	18878 ab
	Kester	18253 ab	0.91 bcde	64.8 abcd	36.8 a	4460 a	17560 cd
	Nonpareil-Jones	16993 abcd	0.96 bcde	70.0 ab	36.0 a	4360 a	17051 d
	Chips	11901 f	0.94 bcde	60.3 de	24.7 bcd	2985 bcd	13918 e
	Kahl	12420 f	0.89 cde	53.5 f	24.4 bcd	2953 bcd	13514 e
	Kochi	8701 g	1.22 a	63.5 cde	23.3 d	2825 d	11247 f
2012	Nonpareil-70	8530 b	1.2 bc	70.9 bc	22.6 ab	2733 ab	21611 ab
	Kester	7617 bc	1.19 bcd	69.4 bcd	20.1 abc	2432 abc	20270 bc
	Nonpareil-Jones	8855 b	1.18 bcd	67.7 bcd	23.0 ab	2783 ab	19833 c
	Chips	9008 b	0.92 h	75.3 ab	18.2 bc	2201 bc	16416 d
	Kahl	8830 b	1.05 fg	55.0 d	20.4 abc	2465 abc	15979 d
	Kochi	2025 d	1.41 a	26.0 e	6.3 d	763 d	12816 e
2013	Nonpareil-70	18718 b	0.87 b	63.5 a	36.0 a	4354 a	25965 ab
	Nonpareil-Jones	18241 b	0.87 b	63.5 ab	35.1 a	4243 a	24076 b
	Kester	16267 c	0.66 c	56.6 b	23.9 c	2890 c	22958 c
	Chips	12689 d	0.89 b	57.3 b	24.9 bc	3.10 bc	19466 d
	Kahl	15587 c	0.85 b	55.3 b	29.1 b	3524 b	19503 d
	Kochi	7911 e	1.09 a	63.7 ab	19.0 d	2300 d	15651 e

Performance of *Kester* relative to *Nonpareil* and other pollinizers in the McFarland RVT from 2006 to 2013. (Data for 2014 presented in the Lampinen 2014 Regional Variety Trial poster).



Averaged 2006 to 2013 bloom times relative to *Nonpareil* sources in the McFarland RVT.



Averaged 2006 to 2013 hull split and harvest times relative to *Nonpareil* sources in the McFarland RVT.

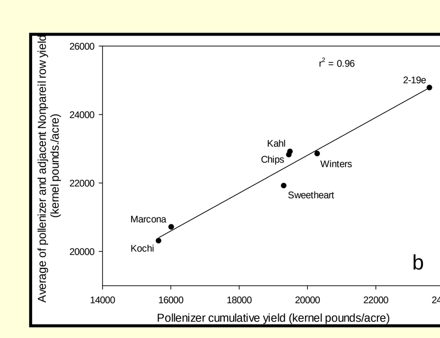
Scab Rating		Alternaria rating		Hull Rot Strikes	
selection 2-19e	0.00 a	Chips	0.00 a	Kahl	8.33 a
Chips	0.00 a	Kahl	0.00 a	Sweetheart	11.00 a
Kahl	0.00 a	Kochi	0.00 a	Marcona	13.33 a
Kochi	0.00 a	Marcona	0.00 a	selection 2-19e	18.83 a
Marcona	0.00 a	Nonpareil 3-8-2-70	0.00 a	Price	23.01 a
Nonpareil 3-8-2-70	0.00 a	Nonpareil-5	0.00 a	Chips	24.00 a
Nonpareil-6	0.00 a	Nonpareil-6	0.00 a	Nonpareil-Nico	30.67 a
Nonpareil-7	0.00 a	Nonpareil-7	0.00 a	Nonpareil 3-8-2-70	61.33 a
Nonpareil-DR	0.00 a	Nonpareil-DR	0.00 a	Nonpareil-J	62.67 a
Nonpareil-J	0.00 a	Nonpareil-J	0.00 a	Nonpareil-5	65.17 a
Nonpareil-Newell	0.00 a	Nonpareil-Newell	0.00 a	Nonpareil-7	72.67 a
Nonpareil-Nico	0.00 a	Nonpareil-Nico	0.00 a	Nonpareil-6	82.83 a
Price	0.00 a	Price	0.00 a	Nonpareil-Newell	83.67 a
Sweetheart	0.00 a	selection 2-19e	0.00 a	Nonpareil-DR	98.17 a
Nonpareil-5	1.00 a	Sweetheart	0.00 a	Kochi	262.00 b
Winters	2.00 b	Winters	0.00 a	Winters	539.67 c

Scab Rating		Alternaria rating		Hull Rot Strikes	
Chips	0.00 a	Nonpareil-Nico	0.67 a	Kahl	2.33 a
Kahl	0.00 a	Nonpareil-7	0.67 a	Marcona	3.33 a
Kochi	0.00 a	Nonpareil-J	0.83 a b	Chips	5.00 a b
Marcona	0.00 a	Sweetheart	1.00 a b	Nonpareil-DR	10.33 a b
Nonpareil 3-8-2-70	0.00 a	Nonpareil-Newell	1.00 a b c	Nonpareil-Nico	10.67 a b
Nonpareil-5	0.00 a	Nonpareil-5	1.00 a b c	Nonpareil-5	15.00 a b
Nonpareil-6	0.00 a	Nonpareil-6	1.00 a b c	Nonpareil 3-8-2-70	22.00 a b c
Nonpareil-7	0.00 a	Nonpareil 3-8-2-70	1.00 a b c	Nonpareil-J	26.67 a b c
Nonpareil-DR	0.00 a	2-19E	1.17 a b c d	Nonpareil-7	31.00 a b c
Nonpareil-J	0.00 a	Nonpareil-DR	1.17 a b c d	Nonpareil-Newell	34.00 a b c
Nonpareil-Newell	0.00 a	Chips	1.50 b c d	Nonpareil-6	39.67 a b c
Nonpareil-Nico	0.00 a	Marcona	1.67 c d e	Sweetheart	48.67 a b c
Sweetheart	0.00 a	Kochi	1.83 d e	2-19E	94.00 b c
2-19E	0.17 b	Winters	2.33 e	Winters	104.83 c
Winters	3.00 c	Kahl	2.33 e	Kochi	325.83 d

Scab Rating		Alternaria rating		Hull Rot Strikes	
Nonpareil-5	0.0 a	Nonpareil-6	0.67 a	Marcona	0.00 a
Chips	0.0 a	Nonpareil-Newell	0.83 a	Kahl	1.83 a b
Kahl	0.2 a b	Nonpareil 3-8-2-70	0.83 a	Chips	4.17 a b c
Nonpareil-J	0.2 a b	Nonpareil-Nico	0.83 a	Nonpareil-Nico	13.83 a b c d
Nonpareil-6	0.2 a b	Nonpareil-DR	0.83 a	Nonpareil-DR	17.17 a b c d
2-19E	0.3 a b c	Chips	1.00 a	Nonpareil 3-8-2-70	23.67 a b c d e
Nonpareil-Nico	0.3 a b c	Nonpareil-J	1.00 a	Nonpareil-5	25.00 a b c d e
Nonpareil-7	0.5 a b c	Sweetheart	1.00 a	Nonpareil-7	25.00 a b c d e
Nonpareil-DR	0.5 a b c	Nonpareil-7	1.00 a	Nonpareil-Newell	30.67 b c d e
Marcona	0.5 a b c	Kahl	1.17 a	Nonpareil-J	33.17 c d e f
Kochi	0.5 a b c	Nonpareil-5	1.17 a	Sweetheart	41.83 d e f
Nonpareil 3-8-2-70	0.7 b c	Marcona	1.50 b	Winters	47.17 e f
Nonpareil-Newell	0.8 c	Kochi	1.50 b	Nonpareil-6	47.17 e f
Sweetheart	1.8 d	2-19E	1.50 b	Kochi	56.67 f g
Winters	3.0 e	Winters	2.50 c	2-19E	81.00 g

Scab Rating		Alternaria rating		Hull Rot Strikes	
Nonpareil-DR	0.0 a	Nonpareil-J	0 a	Marcona	2.83 a
Nonpareil-7	0.0 a	Nonpareil-DR	0 a	Kahl	3.33 a
Nonpareil-J	0.0 a	Nonpareil-7	0 a	Chips	9.50 a b
Nonpareil-5	0.0 a	Nonpareil-Newell	0 a	Winters	16.83 a b
Nonpareil-6	0.0 a	Nonpareil-Nico	0 a	Nonpareil-Nico	21.00 a b c
Nonpareil-Newell	0.0 a	Nonpareil 3-8-2-70	0 a	Nonpareil-6	21.50 a b c
Kochi	0.0 a	Nonpareil-5	0 a	Sweetheart	22.00 a b c
Nonpareil 3-8-2-70	0.0 a	Nonpareil-6	0 a	Nonpareil 3-8-2-70	22.67 a b c
2-19E	0.0 a	Kochi	0 a	Nonpareil-5	23.17 a b c
Sweetheart	0.0 a	2-19E	0 a	Nonpareil-7	24.17 a b c
Nonpareil-Nico	0.0 a	Sweetheart	1 a	Nonpareil-J	28.17 a b c
Chips	0.0 a	Chips	1 b	Nonpareil-DR	30.33 a b c
Kahl	0.2 a b	Kahl	1 b	Nonpareil-Newell	33.33 b c
Marcona	0.3 b	Marcona	1 b	Kochi	51.00 c d
Winters	1.2 c	Winters	2 c	2-19E	68.67 d

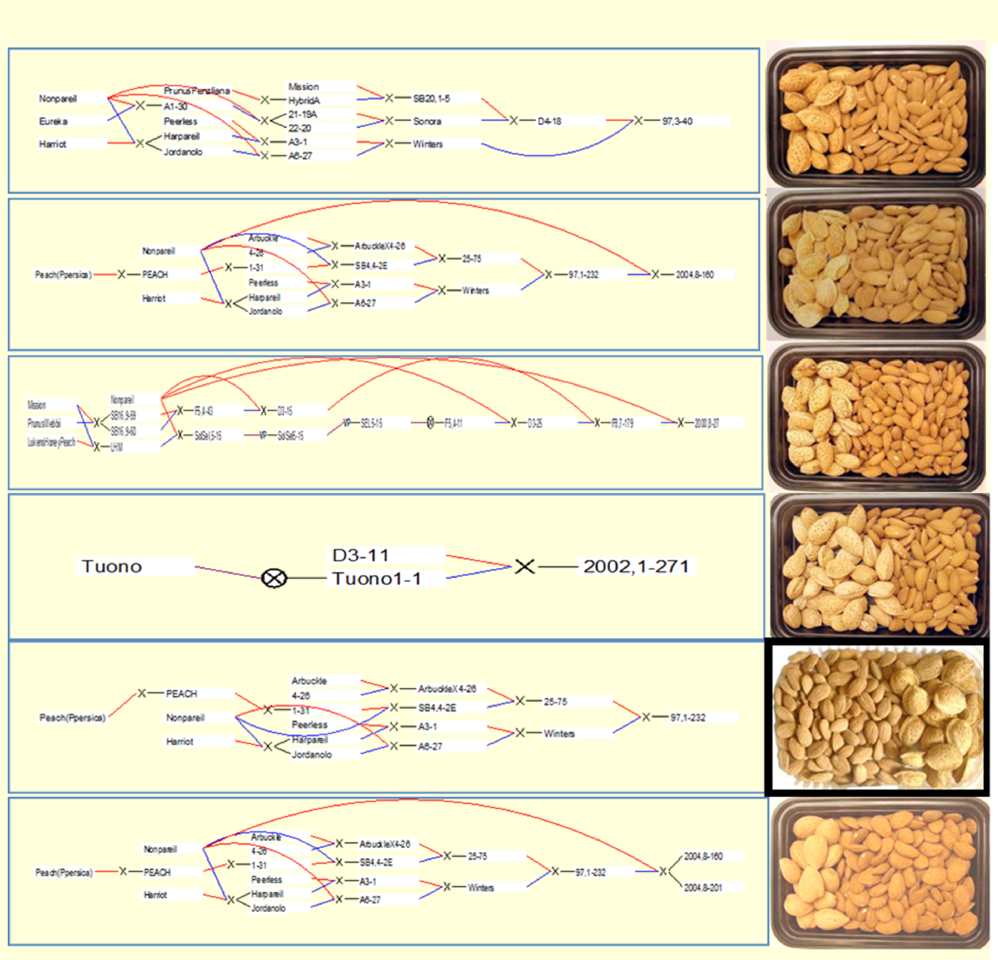
Disease ratings of *Kester* (designated here as selection 2-19E) relative to *Nonpareil* and other pollinizers in the McFarland RVT from 2010 (top) to 2013 (bottom). [Note higher hull rot in 2013 associated with water stress].



Graph of 2006 to 2013 cumulative yield of *Kester* (2-19E) and other pollenizers plotted against adjacent *Nonpareil* and pollinizer rows showing high yield potential of Kester (2-19E) relative to *Nonpareil* despite ~20% smaller tree size.

Breeding and Testing the next generation of California Almond Varieties

Because traditional almond varieties lack the characteristics needed for the next generation of California production (including self-fruitfulness, improve disease and pest resistance as well as improved resistance to drought stress and other consequences of climate change), new germplasm has been incorporated from European and Asian varieties as well as wild almonds and cultivated and wild peach. Through a process of cross-hybridization and recurrent selection, desired traits from a diversity of germplasm sources have now been introgressed or incorporated into California-adapted breeding lines. The first generation of these adapted introgression lines were planted in 2014 in the new Regional Variety Trials (RVT-see accompanying poster). The second-generation of California-adapted introgression breeding lines target the consolidation of the most promising self-fruitful and resistance traits into productive almond varieties with good commercial qualities. A major challenge of this selection cycle will be anticipating the critical production/resistance needs of almond varieties destined for California planting 10 to 20 years from present.



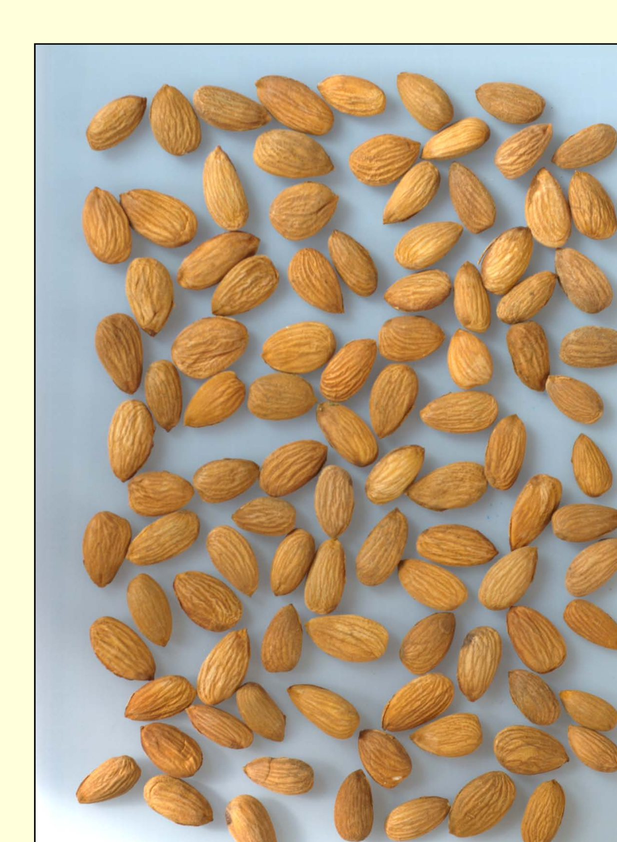
Lineages and nut samples demonstrating diverse origins of advanced UCD self-fruitful selections currently in new Regional Variety Trials (RVT).

Selection	Seed Paren	Pollen Parent	Origin	Pedigree	
2005,10-270	Winters	F8,7-179	*WP*	D3-15 (NP*F5,4-43[W*W][SEL5-15SLF])) * D3-25(NP*F5,4-11[W*W][SEL5-15SLF])	
2005,2-108	Nonpareil	A98,2-348	*P*	D3-11 * F7,1-1 (Sel5-15[NP*LukensHoneyXMis]*WSB3b25)(Sel5-15[NP*LukensHoneyXMis]*	
2005,5-17	Winters	A97,1-232	*M*	25-75 [Arb * 4-26]*[SB4, 4-2E] * WINTERS	
2005,9-340	Winters	F8,7-179	*WP*	D3-15 (NP*F5,4-43[W*W][SEL5-15SLF])) * D3-25(NP*F5,4-11[W*W][SEL5-15SLF])	
2006,2-24	Nonpareil	A00,1-180 +A97,3-40	*WP*	D3-15 (NP*F5,4-43[W*W][SEL5-15SLF])) * D3-25(NP*F5,4-11[W*W][SEL5-15SLF])	
2006,2-60	Nonpareil	A00,1-180 +A97,3-40	*WP*	D3-15 (NP*F5,4-43[W*W][SEL5-15SLF])) * D3-25(NP*F5,4-11[W*W][SEL5-15SLF])	
2006,3-19	Winters	A00,8-27	*WP*	NP *F8,7-179	
2006,4-134	Nonpareil	A96,1-133	*P*	F7,2-9 (Sel5-15 slf) F2	
2006,5-134	Tardy NP	A96,1-133	*P*	F7,2-9 (Sel5-15 slf) F2	
2006,5-40	Nonpareil	A96,1-133	*P*	F7,2-9 (Sel5-15 slf) F2	
2006,5-46	Nonpareil	A96,1-133	*P*	F7,2-9 (Sel5-15 slf) F2	
2007,2-127	Winters	A97,1-227	*M*	25-75 [Arb * 4-26]*[SB4, 4-2E] * WINTERS	
2008,3-125	Nonpareil	A00,8-27	*WP*	NP *F8,7-179	

Pedigrees, origins and nut samples of some of the UCD self-fruitful selections evaluated in 2013-14 (*P-peach; M-Prunus mira; W-Prunus webbii*).

Item	Sealed #/50	Hull g/50	Inshell g/50	Kernel g/50	Crack-out	Double (%)	Twin (%)	NOW (%)	Blank (%)	Broken (%)	Crease (%)	Gum (%)	Sl. Shr (%)	Sev. Shr (%)	Rupture (%)	Seedparent	Pollen parent	Origin
05,3-103	50	64.1	216.6	58.2	0.27	7	-	-	4	7	3	-	47	-	2	Ferragnes	A97,2-240	Frgs
05,3-55	49	80.5	175.5	63	0.36	15	-	-	1	6	4	-	42	1	-	Ferragnes	A97,2-240	Frgs
05,3-69	33	100.6	109.4	63.3	0.58	11	-	1	1	-	10	-	8	2	-	Ferragnes	A97,2-240	Frgs
05,3-99	50	101.8	256.1	86.1	0.34	-	-	-	3	8	3	-	33	3	-	Ferragnes	A97,2-240	Frgs
05,6-234	45	86.5	128.1	56.9	0.44	7	-	-	4	4	7	-	45	-	-	Winters	**A97,1-232**	*M*
07,2-292	46	82.1	139.9	60	0.43	6	1	2	1	1	11	-	42	8	1	Winters	A97,1-227	*M*
05,5-17	46	88.5	126	60.5	0.48	2	-	-	1	4	5	4	41	6	-	Winters	**A97,1-232**	*M*
05,5-11	24	74.2	121.4	63.5	0.52	1	1	-	1	5	4	-	49	-	-	Winters	**A97,1-232**	*M*
05,5-169	46	94.7	132.5	64.4	0.49	1	4	-	-	2	12	6	32	12	-	Winters	**A97,1-232**	*M*
04,17-210	27	90.1	136	69	0.51	-	1	3	-	4	-	-	49			NP	97A,1-232	*M*
06,4-27	50	127.8	287.5	65.6	0.23	-	1	-	2	14	7	-	24	2	-	NP	A96,1-133	*P*
06,3-330	48	123.2	179.8	73.5	0.41	19	1	-	-	2	9	-	30	5	-	NP	A96,1-133	*P*
06,5-160	47	99.5	136.9	76.2	0.56	5	2	2	2	-	16	-	30	8	-	Tardy NP	A96,1-133	*P*
06,3-238	37	195.2	155.3	79.3	0.51	2	4	2	1	-	9	6	32	11	-5	NP	A96,1-133	*P*
06,4-134	27	170.2	128.5	80.3	0.62	2	1	4	2	1	30	1	38	9	-	NP	A96,1-133	*P*
06,3-297	47	154.4	315.9	83.3	0.26	16	2	-	1	9	2	-	38	14	-	NP	A96,1-133	*P*
06,3-105	37	183.7	202.6	86.4	0.43	35	-	6	3	3	11	-	35	15	2	NP	A96,1-133	*P*
06,3-82	44	198.9	138.8	89.4	0.64	-	-	5	1	3	1	25	13	34	-	NP	A96,1-133	*P*
06,4-188	40	123.3	278.7	91.6	0.33	18	-	2	-	6	6	-	43	7	-	NP	A96,1-133	*P*
06,3-319	26	152	176.3	94.6	0.54	2	1	3	-	6	11	-	28	4	-2	NP	A96,1-133	*P*
06,3-121	48	189.1	278.9	100.4	0.36	3	3	-	-	8	23	4	37	13	-	NP	A96,1-133	*P*
05,8-317	40	88	132.4	55.7	0.42	5	-	-	-	6	3	-	24	-	-	Winters	F8,7-179	*WP*
05,9-100	44	79.6	127.8	58.4	0.46	6	1	-	-	-	-	-	49	1	2	Winters	F8,7-179	*WP*
05,8-402	34	74.4	114.8	60.5	0.53	6	-	2	1	-	2	-	47	2	-	Winters	F8,7-179	*WP*
05,9-281	42	73.4	100.9	64.3	0.64	5	1	-	2	4	4	3	32	6	-	Winters	F8,7-179	*WP*
05,9-249	29	87.2	163.7	68.9	0.42	31	-	-	-	6	1	-	48	2	-	Winters	F8,7-179	*WP*
06,2-60	5	79.6	134.8	75.6	0.56	1	1	1	-	-	7	-	48	2	-	NP	A00,1-180	*WP*
06,2-24	N/A	-	-	-		-	-	-	-	-	-	-	-	-	-	NP	A00,1-180	*WP*

Parentage, origins and nut quality data of some of the UCD self-fruitful selections evaluated in 2013-14 (*Frgs*- cv. Ferragnes; *P-peach; M-Prunus mira; W-Prunus webbii*).



Samples from progeny of cross *Nonpareil* x breeding selection A00,8-27 segregating for self-fruitfulness. [Each kernel represents a separate progeny].