Field Evaluation of Almond Varieties

Project No.: **11-HORT2-Lampinen**

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Objectives:

The first objective of this project is to evaluate performance of pollenizers and Nonpareil clones in a replicated field trial in McFarland California. A secondary objective is to use the replicated data on light interception and yield to assess the relative productivity per unit of light intercepted for the Nonpareil clones, varieties and selections.

Interpretive Summary:

Yields at the McFarland trial continue to be high compared to the 1993 regional almond variety trials. The McFarland trial reached an average production of 3000 kernel pounds per acre in the 5th growing season which was six years earlier than the 1993 Kern RAVT, while neither the 1993 Butte nor the 1993 Delta trials ever reached this level of production. In order to develop the canopy this quickly, water and other inputs need to be high and this has resulted in high disease pressure (especially hullrot). Because this trial is replicated, unlike the earlier regional almond variety trials, we have the opportunity to more accurately assess yield differences among the Nonpareil clones, varieties and selections. In addition, because we have detailed light interception data, we can assess whether differences in productivity among varieties and selections are due to faster canopy growth or higher productivity per unit light intercepted. Yields in 2011 were quite high- likely a result of the relatively low yields in 2010. Nonpareil yields varied from 4300 to almost 5000 kernel pounds per acre in 2011 and continued to be generally higher than pollinizer yields. There appears to be some separation of cumulative yields for the Nonpareil clones with Nonpareil-Nico highest and Nonpareil-Jones lowest. Hull rot continued to be the major disease related problem with the highest levels in Kochi and Winters with the Nonpareil clones having intermediate hull rot pressure. Summary data from the 2006 to 2011 seasons shows that although bloom

period varied significantly from one year to the next, overlap of Nonpareil bloom with pollenizers was good in all years.

Materials and Methods:

This report will concentrate on a replicated variety trial of eight varieties and eight Nonpareil clones that was planted in 2004 in Kern County near McFarland. Soils at the site consist of McFarland loam and Wasco sandy loam (both Class I soils). The irrigation system is double line drip. Tree spacing is 20 feet between tree rows and 18 feet between trees for a density of 121 trees per acre. Varieties planted included Chips, Kahl, Kochi, Marcona, Selection UCD 2-19e, Sweetheart and Winters, Nonpareil clones planted include Nonpareil 3-8-2-70, Nonpareil 5, Nonpareil 6, Nonpareil 7, Nonpareil Dr., Nonpareil-J, Nonpareil-Newell and Nonpareil-Nico. There are six replications of each variety and Nonpareil clone with 34 trees per replication. Pollenizer and Nonpareil rows alternate in the orchard.

In 2011, data was collected on bloom and maturity timing, disease pressure (scab, *Alternaria* and hull rot), yield and midday canopy light interception. In 2006, 2007 and 2008, midday canopy light interception was measured manually using a hand lightbar. The mobile platform light bar (described in report for Almond Board project titled "Development and Testing of a Mobile Platform for Measuring Canopy Light Interception and Stress in Almond" [11.HORT13.Lampinen]) was used to measure midday canopy light interception in 2009, 2010 and 2011.

Results and Discussion:

The grower started ripping every other row center in 2009 and this has resulted in significant improvements in water penetration in the orchard. This procedure has continued and appears to be beneficial with much better water penetration observed.

Weather during bloom was generally good at the McFarland trial site. For the 2011 bloom period there were 94 good bee flight hours (temperature $\geq 59^{o}$F, windspeed $\leq$ 10MPH, and no rain). This compared to 182, 91 and 58 good bee flight hours in 2008, 2009 and 2010 respectively.

Although the absolute date of bloom for all varieties varied from year to year, bloom overlap among the Nonpareil clones and pollenizers was good in every year (**Figure 1**). Average bloom dates for the 2006 to 2011 seasons are shown in **Figure 2**.

Initiation of hullsplit was slightly late in 2010 and completion of hullsplit was slightly early to average (**Figure 3**, **Figure 4**). In 2011, hullsplit initiation was again slightly late but completion of hullsplit was slightly earlier than normal (**Figure 3**, **Figure 4**).

In 2010, scab was only observed on Winters and Nonpareil-5 and in 2011 on Winters and selection UCD 2-19e (**Table 1**). Alternaria was not present in 2010 but in 2011 all Nonpareil selections and pollenizers had some present with the worst being in Kahl, Winters, Kochi and Marcona respectively (**Table 1**). There was substantial hullrot in all

varieties and selections with the most severe disease pressure in Kochi and Winters in both 2010 and 2011 (**Table 1**). Kochi also displayed severe hullrot in 2008 and 2009. There was also substantial hull rot in all the Nonpareil clones in 2010 and slightly less in 2011(**Table 1**).

Yield data for the McFarland trial from the 2006 through 2011 seasons are shown in **Table 2**. All of the Nonpareil clones except Nonpareil Jones have tended to have higher yields compared to most of the pollenizers (**Table 2**). Selection UCD 2-19e has had the highest yields among all of the pollenizers in the trial followed by Winters (**Table 2**). The replication provided in this trial adds much value to the data compared to earlier unreplicated variety trials but it comes at a cost in terms of the time required for maintaining, rating and harvesting the plots.

The yields from this trial continue to be high for the age of the orchard. **Figure 5** shows average yield by orchard age for all varieties, selections and Nonpareil sources for the Butte, Delta and Kern trials planted in 1993 compared to the McFarland trial planted in 2004. The McFarland trial reached an average production of 3000 kernel pounds per acre six years earlier than the 1993 Kern RAVT while neither the Butte nor Delta trials ever reached this level of production (**Figure 5**).

The productivity per unit canopy light interception was quite high for the size of the tree in 2009 (ranging from 52 to 85 kernel pounds per unit light intercepted) and was still fairly high in 2010 (ranging from 23 to 51 kernel pounds per unit light intercepted) since our previous data has suggested somewhere around 50 pounds per unit light intercepted is near the normal maximum for almond (**Table 2**). In 2011, yield per unit light intercepted averaged 74.8 for the Nonpareil clones and 40 to 65 for the pollenizers (**Table 2**). Since 2009 and 2011 were “on” years (yield per unit PAR intercepted greater than 50) and 2010 was an “off” year (yield per unit PAR intercepted less than 50), the data for 2012 should give a more complete picture of long term yield for the Nonpareil clones versus the pollenizers.

In general, varieties or selections that produced high yield per unit PAR intercepted also produced high yields overall (**Figure 6**). Perhaps this is because the same factors that result in more rapid growth in the tree canopy (as measured by PAR interception) also result in more productivity per unit light intercepted. An additional factor influencing canopy light interception and yield is canopy loss due to hull rot which was particularly pronounced in Kochi.

When cumulative pollinizer yields are plotted against cumulative adjacent Nonpareil yields, it does not appear that higher pollinizer yields result in lower Nonpareil yields (**Figure 6a**). In general as pollinizer yields increase, yields for adjacent Nonpareil increase as well. If relative values of Nonpareil ($2.20 in 2011) and pollinizers ($1.70 in 2011) are factored in, the highest to lowest cumulative returns were:

UCD 2-19e>Chips>Kahl>Winters>Marcona>Sweetheart>Kochi.

In general, when yields for pollenizers and adjacent Nonpareil rows are averaged, there is a very good relationship with both increasing in concert (**Figure 6b**). This suggests increasing pollinizer yields does not seem to be compromising adjacent row Nonpareil yields in this trial. This is a somewhat unexpected result since data from the 1993 Regional Almond Variety Trials showed that tall pollenizers generally had higher yields compared to adjacent Nonpareil rows.

Acknowledgements:

The authors wish to thank the Almond Board of California for their continued support of this project. We also want to thank the Billings Ranches for their excellent cooperation in managing and maintaining this trial.

Table 1. Scab rating, *Alternaria* rating, and hull rot strikes per tree for the 2010 and 2011 seasons at the McFarland trial. Letters indicate significant difference at the 5% level of significance

2010

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

2011

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

Table 2. Number of nuts per tree, average kernel weight, shelling percentage, and kernel pounds per unit of photosynthetically active radiation (PAR) intercepted, kernel pound per acre, cumulative kernel pounds per acre for the 2006 through 2011 seasons. Data for each year is sorted by cumulative yield.

2009				Kernel pounds per			
Variety	No. of nuts/tree	Average kernel wt (g)	Shelling percentage	unit PAR int.	Tree	Acre	Cumulative kernel yield (lbs/acre)
Nonpareil-Nico	13773 ab	1.05 bcd	74.7 ab	69.3 abcd	31.8 ab	3851 a	11417 a
Nonpareil-Newell	14513 a	1.03 bcd	74.8 ab	72.8 abc	33.1 a	4004 a	11090 a
2-19e	14706 a	0.84 f	65.6 f	71.6 abc	27.1 c	3285 c	11080 a
Nonpareil-Driver	13856 ab	1.08 ab	75.8 a	76.1 ab	32.9 a	3977 a	11062 a
Nonpareil-3-8-2-70	13756 ab	1.04 bcd	74.6 ab	71.8 abc	31.4 ab	3798 ab	10905 abc
Nonpareil-7	13051 ab	1.03 bcd	72.6 abc		29.5 bc	3571 bc	10606 abc
Nonpareil-5	12070 bcd	1.08 ab	74.2 ab	68.5 abcd	28.7 bc	3476 bc	10577 abc
Nonpareil-6	13505 ab	1.02 bcd	71.2 cd	68.9 abcd	30.2 abc	3661 abc	10139 bc
Nonpareil-J	12803 abc	1.04 bcd	71.6 bcd	63.4 bcde	29.0 bc	3513 bc	9955 cd
Winters	9434 ef	0.96 bcde	61.6 g	63.8 bcde	20.0 e	2415 e	9258 de
Kahl	11035 cde	0.87 ef	59.1 g	79.2 a	21.1 de	2559 de	8513 ef
Chips	9771 ef	0.93 def	58.6 g	55.9 de	20.0 e	2422 e	8144 ef
Sweetheart	12798 abc	0.85 ef	73.3 abc	59.6 cde	24.0 d	2906 d	7965 fg
Marcona	8977 fg	1.07 abc	32.5 h	77.7 a	21.2 de	2562 de	7563 gh
Kochi	7252 g	1.17 a	68.9 de	52.6 e	18.7 e	2259 e	6955 h

2010				Kernel pounds per			
Variety	No. of nuts/tree	Average kernel wt (g)	Shelling percentage	unit PAR int.	Tree	Acre	Cumulative kernel yield (lbs/acre)
Nonpareil-Nico	9521 abc	1.24 abcdef	72.5 ab	49.7 a	25.9 a	3141 a	14558 a
Nonpareil-Newell	8429 cde	1.31 ab	73.6 a	45.2 abc	24.2 a	2931 a	14022 ab
Nonpareil-3-8-2-70	8823 bcd	1.28 abcd	72.3 ab	47.1 ab	24.9 a	3011 a	13916 ab
Nonpareil-Driver	8368 cde	1.28 abcd	71.0 ab	46.2 abc	23.6 a	2849 a	13911 ab
Nonpareil-7	10612 ab	1.16 bcdef	69.8 ab	49.4 a	27.1 a	3282 a	13916 ab
Nonpareil-5	9410 abc	1.24 abcde	72.3 ab	50.8 a	25.8 a	3130 a	13708 abc
Nonpareil-6	9499 abc	1.21 abcdef	71.8 ab	48.7 ab	25.5 a	3081 a	13220 bc
2-19e	6833 efg	1.10 bcdef	56.1 e	33.7 def	16.7 bc	2020 bc	13100 bc
Nonpareil-Jones	8315 cde	1.23 abcdef	70.9 ab	43.8 abc	22.6 a	2737 a	12691 c
Winters	6601 efg	1.11 bcdef	60.7 cde	38.5 bcde	16.0 bc	1945 bc	11203 d
Chips	9089 abc	1.15 bcdef	65.9 abc	48.4 a	23.0 a	2789 a	10933 d
Sweetheart	10915 a	0.80 g	71.8 ab	42.2 abcd	23.4 a	2839 a	10804 d
Kahl	7587 cde	1.01 f	56.5 de	43.4 abcd	16.9 b	2048 c	10561 d
Marcona	5073 gh	1.28 abc	26.2 g	36.7 cdef	14.4 bc	1745 bc	9308 e
Kochi	3902 h	1.40 a	64.4 bcd	23.5 g	12.1 bc	1466 bc	8421 e

2011				Kernel pounds per			
Variety	No. of nuts/tree	Average kernel wt (g)	Shelling percentage	unit PAR int.	Tree	Acre	Cumulative kernel yield (lbs/acre)
Nonpareil-Nico	18776 a	0.99 bcde	68.0 abc	90.1 a	41.0 a	4964 a	19523 a
Nonpareil-3-8-2-70	17744 abc	1.05 bc	70.7 a	79.5 ab	41.0 a	4962 a	18878 ab
Nonpareil-Newell	17790 abc	1.00 bcd	70.1 ab	69.4 abc	39.2 a	4745 a	18767 abc
Nonpareil-Driver	17943 ab	0.98 bcde	66.0 abcd	72.8 ab	38.7 a	4683 a	18593 abc
Nonpareil-7	17078 abcd	0.83 e	69.2 abc	72.3 ab	31.4 a	4555 a	18443 abc
Nonpareil-5	15744 de	1.03 bc	70.4 ab	70.2 abc	35.9 a	4342 a	18050 bcd
Nonpareil-6	16630 bcde	1.04 bc	70.0 ab	74.7 ab	38.2 a	4619 a	17838 bcd
2-19e	18253 ab	0.91 bcde	64.8 abcd	65.2 bcd	36.8 a	4460 a	17560 cd
Nonpareil-Jones	16993 abcd	0.96 bcde	70.0 ab	70.0 abc	36.0 a	4360 a	17051 d
Winters	15979 cde	0.83 e	58.7 ef	56.8 cde	29.4 b	3554 b	14757 e
Sweetheart	14969 e	0.86 de	64.1 bcde	47.3 cde	28.2 bc	3412 bc	14215 e
Chips	11901 f	0.94 bcde	60.3 de	44.7 de	24.7 bcd	2985 bcd	13918 e
Kahl	12420 f	0.89 cde	53.5 f	45.6 de	24.4 bcd	2953 bcd	13514 e
Marcona	9633 g	1.07 b	30.8 g	45.0 de	22.7 d	2746 d	12054 f
Kochi	8701 g	1.22 a	63.5 cde	39.4 e	23.3 d	2825 d	11247 f

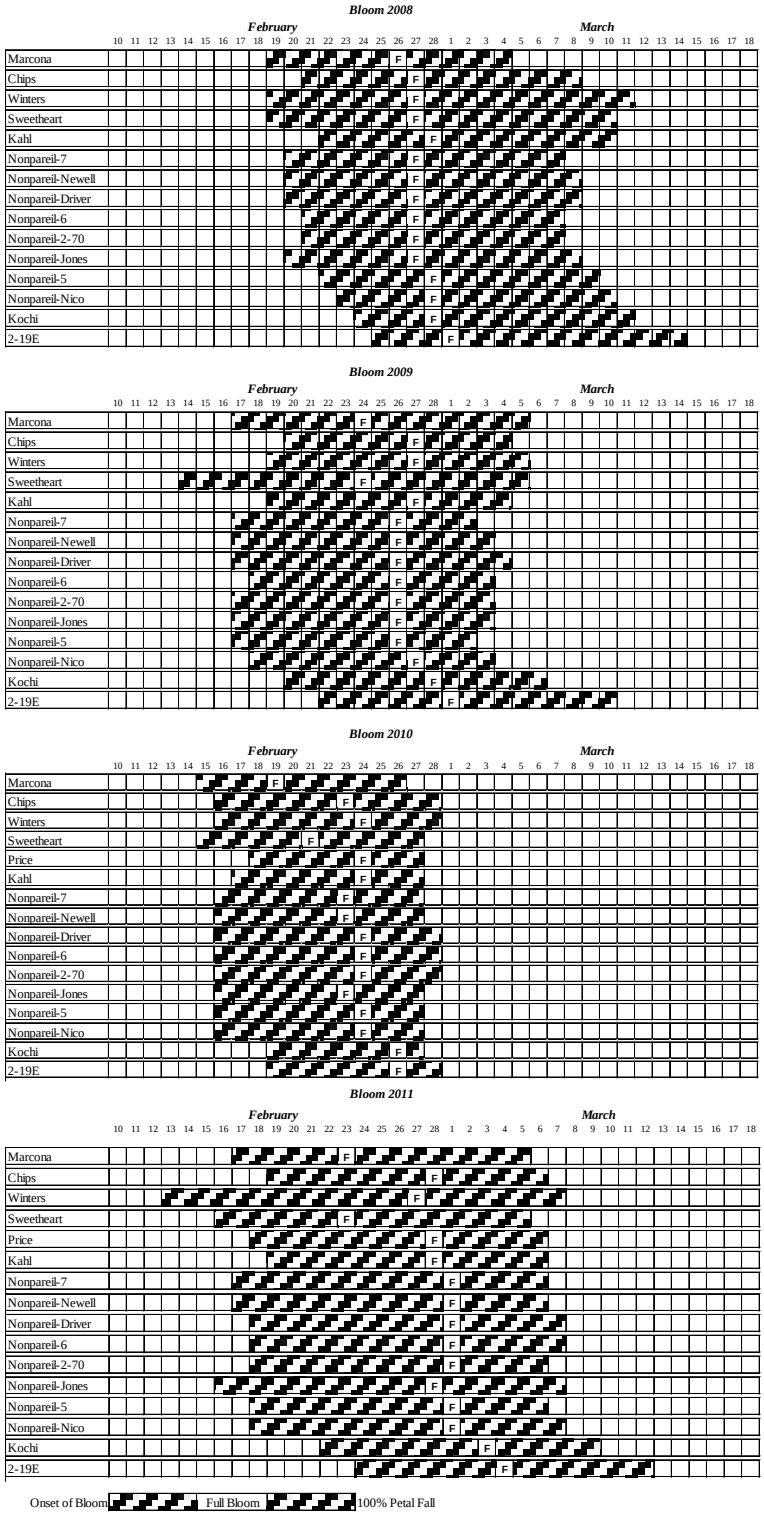


Figure 1. Bloom data for the McFarland Trial for the 2008-2011 seasons. Cross hatched area indicates onset of bloom to 100% petal fall. “F” indicates full bloom.

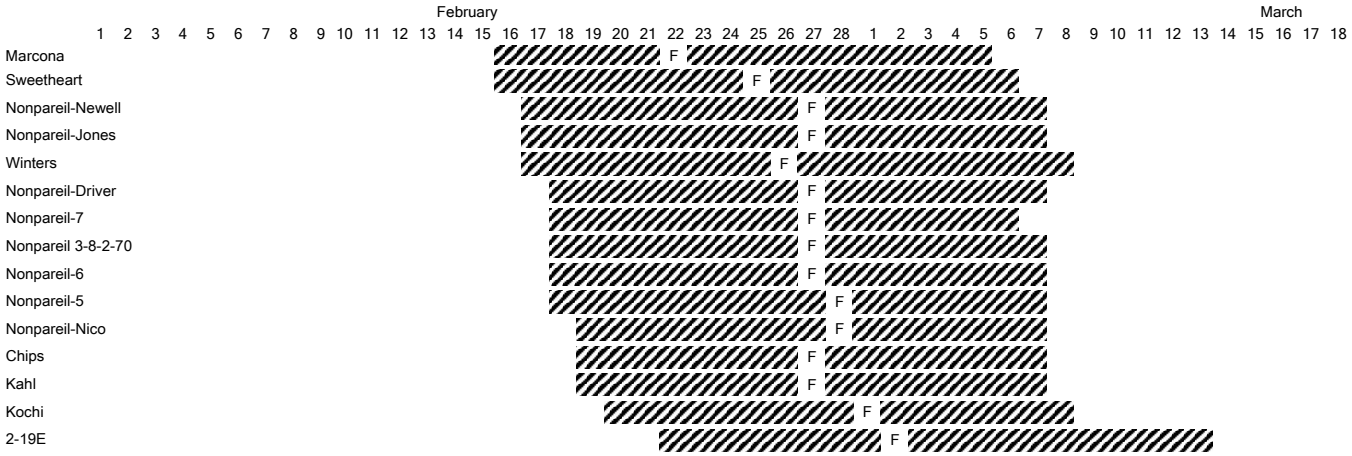
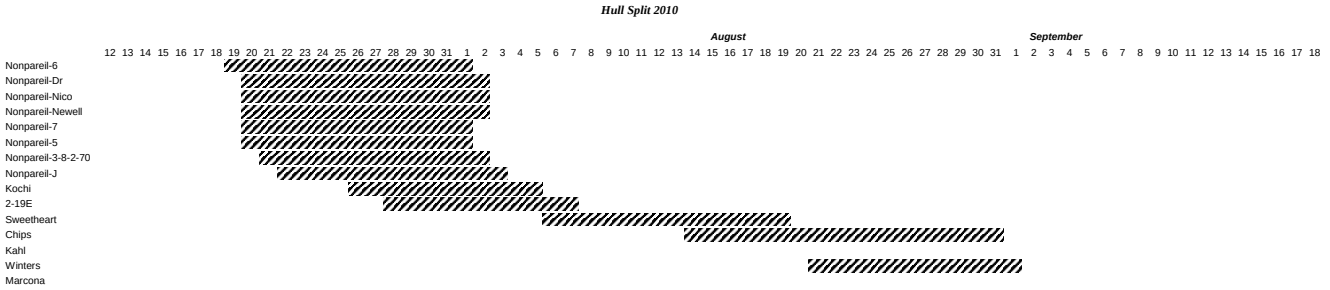


Figure 2. Average bloom data (2006 to 2011) for the McFarland Trial. Cross hatched area indicates onset of bloom to 100% petal fall. “F” indicates full bloom.

2010



2011

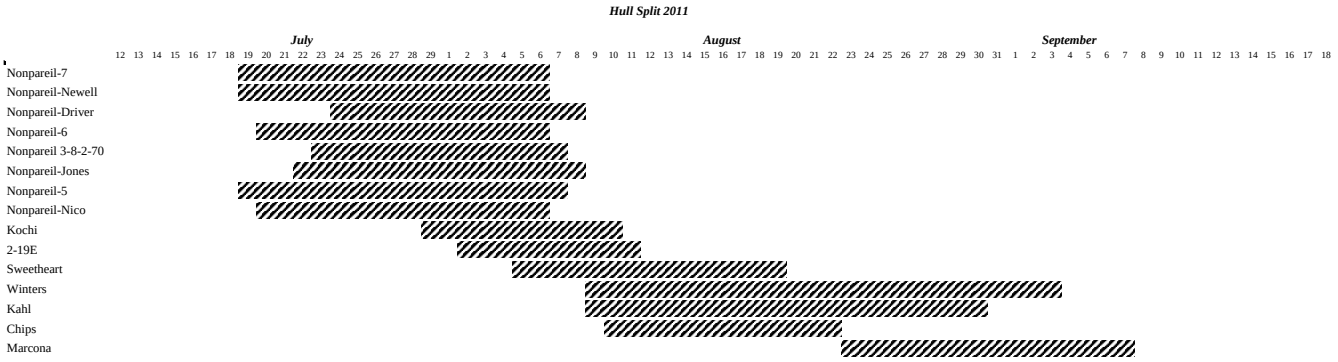


Figure 3. Hullsplit progression by variety and Nonpareil source in 2010 and 2011 at the McFarland trial.

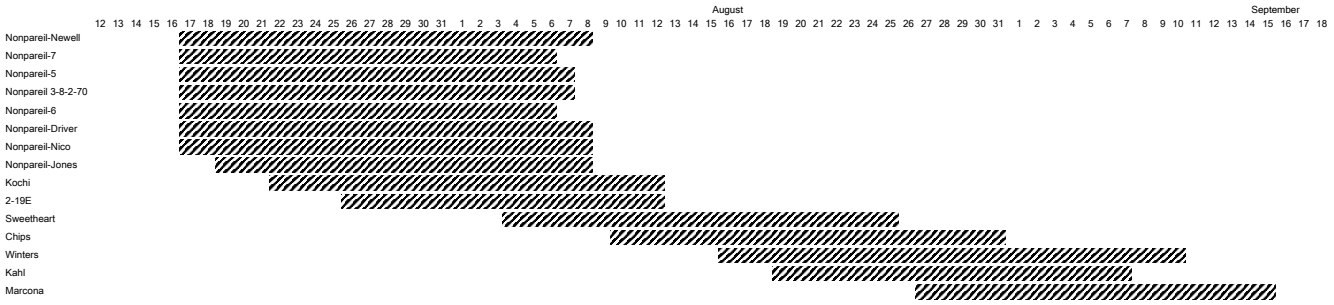


Figure 4. Average hullsplit progression by variety and Nonpareil source for 2006 to 2011 seasons at the McFarland trial.

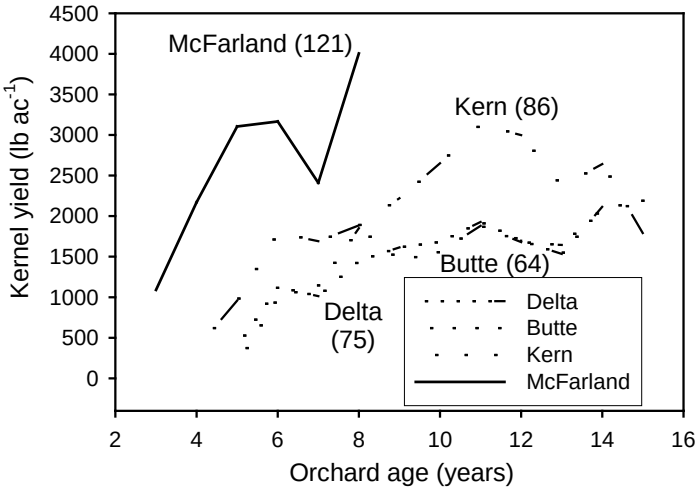


Figure 5. Average yield for all varieties, selections and Nonpareil sources by orchard age for the 1993 Butte, Delta and Kern Regional Variety Trials as well as the McFarland variety trial that was planted in 2004. Number in parenthesis after trial name is number of trees per acre.

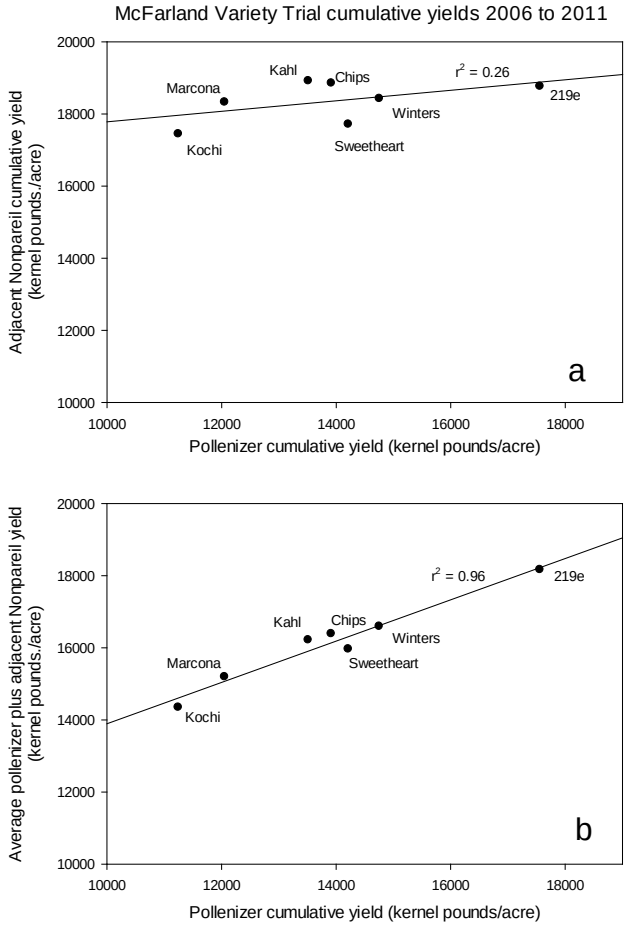


Figure 6. 2006 to 2011 pollenizer cumulative yield versus 2006 to 2011 adjacent Nonpareil rows cumulative yield (a) and 2006 to 2011 pollinizer average cumulative yield versus 2006 to 2011 cumulative yield of pollinizer plus adjacent Nonpareil rows (b). 2011 price for Nonpareil was $2.20 and for all others $1.70.