Annual Report for 1987
Almond Board of California

Project 87-L14
Tree and Crop Research
Field Evaluation of Almond Varieties

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OUTLINE

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Field Evaluation of Almond Varieties

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Objectives: (1) Obtain and evaluate data on yield and other characteristics of varieties and rootstocks in the Regional Variety Trial (RVT) and other plots. (2) Extend the studies on pollen incompatibility to additional varieties with emphasis on finding the last of the four hypothesized groups from Nonpareil-Mission progeny (possibly Butte). (3) Survey the germplasm collection and progeny in almond-peach and almond-*Prunus webbii* crosses for self-fertility (i.e., self compatibility and capacity for natural self-pollination). (4) Complete the evaluation of new seedling selections for their potential as either germplasm or commercial varieties.

Interpretive Summary:

Yields in the four regional almond variety trials (Kern, Butte, San Joaquin, and Fresno counties) were generally very good to excellent, as they were throughout most of California. With the exception of one plot noted below, weather during bloom time was generally ideal for pollination and had a great deal to do with this year's heavy crop; therefore 1987 data should be a relative good evaluation of the yield potential of many of these varieties. Also, as was apparent throughout California with the very large crop, kernel (meat) size was generally small, especially in the older plots.

In the older Kern County planting, Butte and Nonpareil again tended to be high yielding, as well as did Carrion and Price; however, Harvey, Milow, and Merced produced low yields this year. In San Joaquin County at the Delta College plot, frost affected the early blooming varieties NePlus Ultra and Peerless and reduced yield considerably. Although blooming at the same time Sonora and Jordanolo yielded heavily. Nonpareil and Price also

produced heavy crops. In this Delta plot, inclement weather affected pollination of some of the late blooming varieties and hence yield of some of these was somewhat reduced from what was expected. The Fresno County plot was planted in 1981, and yields in this plot were not as high as some of the older trials. In this trials, LeGrand, Heart and Sonora were among the higher yielding varieties; while Planada, K16-14, Yosemite and Peerless tended to be poor yielding in this season.

A yield study of seven varieties in the San Joaquin plot identified tree size, blossom density, and distribution. Initial nut set (pollination) and final nut set (nut drop) were factors that accounted for differences in yield among varieties. Adjustment of yield to take canopy size (area) into account produced differences among varieties not apparent in actual yields. These relationships provide the basis of a yield-size model for almonds.

A number of varieties were again tested for pollen cross-compatibility with other varieties. Some newer varieties have shown cross-compatibility with other varieties allowing some to be added to particular groups. An updated table on pollen cross-compatibility is attached to this report.

Additional pollination studies have been made to test the potential for self-compatibility (setting nuts with its own pollen) and self-pollination (setting nuts without need of bees) in particular experimental selections. These characteristics were confirmed on certain individuals in an F2 almond-peach population. New studies identified additional individuals in an almond-almond species (*P. webbii*) hybrid population which set high numbers of nuts within an enclosed bag. These studies indicate the existence of sources of germplasm with potential for developing varieties both self-compatible and self-pollinating.

The yield-size concept and model was applied to seedling selections of the various seedling populations being studied in this project. Selection has been made of a group of potential varieties and germplasms encompassing a range of tree sizes and tree and nut characteristics combined with low BF-potential and self-fertility characteristics. These are being propagated for relocation to selection blocks for further study.

Part I. Almond varieties in RVT plots

Experimental procedures.

RVT plots: Procedures similar to those of the past were used to obtain the annual yield and quality data from each of the plots. In addition, phenological information on bloom and maturity, set counts, tree observations, etc. were obtained by various individuals.

Yield study: A detailed study of yield parameters was made in seven varieties in the Manteca RVT plot. Two branches were selected on each of 3 trees of seven varieties. Counts were made of long shoots (12 inches or more), medium shoots (5-12 inches) and spurs (5 inches or less) bearing units (B.U.), flowers per bearing unit, branch and trunk diameters and numbers of "equivalent branches". E-W and N-S diameters of the canopy were measured. Counts were made of nodes, nodes with and without flowers, flowers/BU and nuts per Bu. Counts were made in early March (flowers just after petal fall, early April (first set, i.e., pollination and fertilization and early June (final, after drop). Yields per tree were calculated before harvest and compared to harvest yield.

Yield was expressed as follows:

(a). Size adjusted nuts/tree = $\left(\frac{20^*}{\text{(canopy diameter)}}\right)^2 \times$ nuts/tree

(b). Yield potential = $\frac{\text{nuts/tree}}{\text{canopy area}}$

*20 represents the canopy diameter in feet of a mature Nonpareil trees.

RESULTS

RVT plots

Yield data for the principal varieties in the 4 current RVT plots are given in Appendix I. Nut characteristics are given in Appendix II.

Nut characteristics of some of the newer varieties should be noted.

Double kernels

Older - high % - NePlus Ultra, Monterey Peerless
Intermediate % - Carmel, Robson, Fritz, Merced, Price, Mission
Newer - high % - Sauret No. 2, Grace, Valenta, Pearl
Intermediate % - Sauret #1, Dotty Won, Wood Colony, Lodi, Sorrenti

Shape based on width/length ratio and thickness

Narrow (<50% width/length)

a. Thick - Sauret #2, Monterey

b. Medium-thin - NePlus Ultra, Sonora, Carmel, Solano

Medium (50-60 % w/l)

a. Thick - Sauret #1, Livingston, Fritz, Price, Grace, Hoover, Sorrenti

b. Medium-thin - Nonpareil, Monarch, Mono, Milow, BB-OJ, Valenta, Yosemite

Broad (>60% w/l)

a. Thick - Mission, Butte, Lodi, Elsie, Heart, Ruby

b. Medium-thin - Bonita, Tokyo, Norman

Yield study:

Blossom estimates and tree sizes in the Manteca study (Table 1) show significant differences in tree size, i.e., canopy diameter, among varieties. 'Butte' and 'Nonpareil' were the largest with other varieties grading down to 'Price' as the smallest. Blossoms per tree were greatest in 'Butte' and 'Nonpareil' with others being similar to each other. When adjusted to the same canopy area, blossom number in 'Butte' and 'Price' was very high with 'Carmel' greater than all of the others remaining. 'Mission', had the smallest number. Similar differences are shown in blossoms per square foot canopy area.

Table 1 Blossom production of 7 almond varieties in the Manteca plot in relation to canopy area in 1987.

Variety	Canopy diameter	Blossoms per tree actual	Blossoms per tree adjusted(1)	Canopy area	Blossoms per sq. ft.	% of Nonpareil
	ft	no.	no.	sq. ft.	no.	%
Butte	18.3	63,700a(2)	76,100	263	242	157
Nonpareil	18.2	40,090b	46,200	260	162	100
Padre	17.2	36,500c	49,200	232	157	102
LeGrand	17.2	37,800c	51,000	232	163	106
Mission	17.2	30,000c	40,600	232	129	84
Carmel	16.3	38,670c	58,400	208	185	121
Price	13.9	35,200c	72,800	152	231	150

(1) to 20 foot spacing
(2) different numbers indicate significant differences

Table 2 shows the variation among varieties in final nut count and compares the pre-harvest estimate with the actual harvest count. The pre-harvest count consistently underestimated the final yield by 10 to 20 percent but the relative trends were the same. 'Butte', 'Carmel', 'Nonpareil' and 'Price' were not significantly different in the pre-harvest count. The same relationships were shown in final yield. 'Padre' and 'LeGrand' were both significantly less than 'Butte', 'Carmel', 'Nonpareil', 'Price' and 'Mission' was the lowest in both counts. However, when adjusted to the same tree size, yield of 'Price' increased dramatically, with 'Carmel' somewhat less. 'Nonpareil', 'LeGrand' and 'Padre' were similar to each other and 'Mission' was still less. The same relationships are shown for yield efficiency (nuts/square feet of canopy).

Table 2. Final nut count in 6 different varieties in the Delta plot (1987) in relation to canopy area. Pre-harvest estimations and actual harvest yield counts are provided.

	Pre-harvest					Harvest		
Variety	Canopy diam.	Nuts per tree actual	Nuts per tree adjusted(1)	Canopy area	Nuts per sq ft	Nuts per tree	Nuts per sq ft	P/H
	ft	no.	no.	sq ft	no.	no.	no.	%
Butte	18.3	14,620b	17,460	263	56	18,530	70	79
Nonpareil	18.2	12,730b	15,380	260	49	15,530	58	85
Padre	17.2	10,360c	14,000	232	45	11,543	50	90
LeGrand	17.2	11,460c	15,500	232	49	13,979	60	82
Mission	17.2	8,470d	11,440	232	36	9,920	43	85
Carmel	16.3	12,580b	18,970	208	60	15,810	76	80
Price	13.9	14,750b	30,560	152	97	18,622	122	79

(1) to twenty foot spacing

Distribution of the flowers in relation to bearing habit (Table 3) and blossom set relationships (Table 4) provide insight into the reasons for differences in yield among varieties and identify some significant parameters in variety selection. It should, however, be emphasized that these data apply specifically for the Manteca plot in 1987. First of all, blossom density as measured by flowers per trunk diameter unit and branch diameter unit was highly correlated to the final yield. Butte and Carmel were the highest, followed by Nonpareil grading down to Mission. Spurs accounted for 96 to 98 percent of all bearing units. Nonpareil and Carmel had more long shoots. Significant differences were found in the distribution of the flowers on the three kinds of BU's. Nonpareil having much larger percentage (32%) of long to medium shoots. Carmel (16%), Butte (11%) and Price (10%) were intermediate and the remaining varieties were less (6% or less).

Table 3. Characteristics of bearing habit in 7 almond varieties.

I. Distribution of flowers and bearing units

	Blossom density		Distribution of B.U.				Distribution of flowers			
	fl/T.D.	fl/L.D.	Total	Long	Med	Spur	Total	Long	Med	Spur
			No. branch	%	%	%	No. branch	%	%	%
Butte	5403a	1346a	588	1	1	98	2485	9	2	89
Carmel	4713b	1078b	500	2	1	97	2412	14	2	84
Nonpareil	4388b	1063b	442	2	2	96	2077	26	6	78
Price	3926c	839c	519	1	1	98	1956	9	1	90
LeGrand	3647c	749c	440	1	1	98	1347	3	1	96
Padre	3396c	795c	460	1	1	98	1591	3	3	94
Mission	2982d	709d	380	2	1	97	1250	4	1	95

II. Characteristics of Bearing Units

	Long			Medium			Spur
	Ave. nodes B.U.	Nodes w/ flowers	Flowers per node	Ave. nodes B.U.	Nodes/w flowers	Flowers per node	flowers spur
	No.	%	no.	no.	%	No.	No.
Butte	54	44	1.6	19	45	1.4	4.1
Carmel	54	40	1.9	19	32	1.3	4.2
Nonpareil	84	41	1.7	25	44	1.3	3.3
Price	41	37	1.6	17	24	1.4	3.4
LeGrand	50	13	1.4	12	21	1.3	3.0
Padre	17	27	1.1	25	19	1.4	3.4
Mission	34	15	1.2	19	9	1.6	3.2

T.D. = Trunk diameter
L.D. = Limb diameter

Table 4. Percent nut counts in April (initial set) and June (final) in 6 different varieties in the Delta plot in 1987.

Variety	% Nut Set April	June	Loss (%)
Price	61a	42a	19
LeGrand	51b	34c	15
Carmel	37c	33c	4
Nonpareil	36c	31c	5
Padre	34c	30d	4
Mission	28d	28d	0
Butte	32c	23e	9

Further analysis (Table 3) shows that the long shoots of Nonpareil, Butte, Carmel and Price had more nodes/shoot, higher percentage of nodes with flowers and more flowers per node. One to three flowers/node was the range. LeGrand had numerous shoots but these were less floriferous. Mission had less shoots with very few flowers/shoot. Butte and Carmel had significantly more buds/spur than any of the other varieties, a factor apparently important in determining yield density.

Setting characteristics were also shown to differ significantly among the varieties and accounts for differences in final yield. Price had the highest initial set, followed by LeGrand with the others being about the same and Mission the least. Between April and June, drop had occurred with the largest amount in Price, LeGrand and Butte with none in Mission. Final percent set was still the highest in Price, similar in LeGrand, Carmel and Nonpareil, Padre and Mission similar and the lowest in Butte. Thus those with the highest original blossom density or the highest initial set appeared to have the greatest drop suggesting a kind of internal adjustment in yield.

Tree size adjustment analysis was also made in varieties of the Kern and Fresno plots (Tables 5 and 6). In the early blooming group of the Kern plot, a single adjoining Nonpareil row, in which trees were smaller in size and yield than other Nonpareil rows, was used for comparison (see Nonpareil bloom group). There appears to be a location effect that may reduce tree size in the early bloom part of the plot. On this basis, Nonpareil was highest in potential yield, followed by NPU, Jordanolo and Sonora in that order. Sonora yield was less this year largely because of dying back of older bearing shoots. Extensive pruning is needed on this variety to stimulate more new growth.

Table 5. Nut count of different varieties in the Kern plot (1987) in relation to tree size as shown by canopy area.

Variety	Canopy diameter	Nuts per tree actual	Nuts per tree adjusted(1)	Canopy area	Nuts per sq ft	% of Nonpareil
	(ft)	no.	no.	(sq ft)	no.	%
I. Early bloom group						
Nonpareil	18.6	12,200	14,100	271	45.1	100
Jordanolo	18.0	10,400	12,800	254	40.9	91
Sonora	18.0	8,290	10,230	254	32.6	72
NPU	17.6	10,320	13,320	243	42.5	93
II. Nonpareil bloom group						
Nonpareil	20.4	16,000	15,340	328	48.7	100
Fritz	18.6	14,700	17,000	271	54.2	111
Carmel	18.5	14,700	17,190	269	54.7	112
Harvey	16.4	9,300	13,800	185	50.2	103
Price	15.0	13,800	24,600	177	78.2	160
Merced	14.5	11,000	21,011	165	67.0	138
III. Late bloom group						
Ripon	20.6	13,300	12,540	333	40.0	82
Carrion	20.4	12.950	12,400	327	40.0	82
Mission	20.0	11,563	11,375	316	35.2	72
Butte	19.4	18.270	19,400	295	61.9	127
Thompson	17.3	12,526	16,740	235	53.3	109
Padre	15.5	13,410	22,320	180	74.5	153
Ruby	13.6	11,520	24,900	145	79.4	163

(1) to twenty foot spacing

In the Nonpareil bloom group, Nonpareil had the largest yield but the difference was shown to be due to larger tree size. On a size adjusted basis, Price had the largest nut number followed by Merced, Fritz and Carmel in that order. In the late bloom group, Butte had the greatest numbers of nuts and a high number size adjusted. Ruby and Padre showed the highest potential number with Butte and Thompson following. Ripon, Carrion and Mission were the largest trees but with the least number of nuts.

Trees in the Fresno plot were younger (7 years) but size adjustments placed the range of yields on a par with the larger and older trees in the Manteca and Kern plots. Price and Norman had the highest actual yield of all the varieties in the table. When adjusted to a size basis, Norman was the highest, due to its obviously high nut density (spur production) as well as its upright growth habit and narrow tree shape. Price tree size was slightly less than Nonpareil but had greater numbers of nuts. Jordanolo showed a high potential yield per area canopy. Trees had an excellent spur system, as well as an upright growth habit and narrow shape. Two separate Carmel rows showed differences. In one, the trees yielded slightly less and the trees were larger; in the other; trees were smaller and the yield was higher.

Table 6. Final nut counts in the Fresno RVT plot compared to tree size as given by canopy area.

Variety	Canopy diameter	Nuts per tree actual	Nuts per tree adjusted(1)	Canopy area	Nuts per sq ft	% of Nonpareil
	(ft)	(no.)	(no.)	(sq ft)	no.	%
Peerless	13.0	4,870	11,530	133	36.6	74
NPU	12.0	4,510	12,540	113	40.0	81
Sonora	11.6	4,707	14,190	106	45.0	91
Jordanolo	11.2	6,075	19,375	98.5	61.7	125
Janice	11.0	4,348	14,370	95	45.8	97
Solano	15.0	6,000	10,690	177	34.0	69
DB-OJ	14.7	5,200	9,612	170	30.6	62
Carmel	13.8	6,300	13,250	149	42.4	86
1-46	13.1	5,840	13,650	135	43.3	88
Nonpareil	13.1	6,650	15,480	138	49.2	100
Price	12.8	7,920	19,100	129	61.4	125
Carmel	12.3	6,830	18,063	119	57.4	117
Milow	12.3	5,640	14,870	119	47.4	96
Lodi	12.0	6,810	18,930	113	60.3	122
Norman	10.5	7,200	26,100	86.5	83.4	170

(1) to twenty foot spacing

In contrast to the trees in the Fresno plot, the younger trees (1981 planting) of varieties in the Kern Co. plot (Table 7) showed a different picture of yield potential. Nuts/tree among the different varieties tended to parallel the range found in the Fresno plot. Tree size, as shown by canopy measurements, in the Kern plot was much greater on the average than at Fresno, such that, when the trees were compared on a size basis, their potential yield per unit was much reduced. This relationship reflects the vigorous condition of the trees accompanying relatively low bearing density.

Table 7. Yield-size relationships in 1981 planting in Kern Co. RVT plot.

Variety	Average Canopy diameter (ft)	Nuts/tree no.	Size Adjusted Yield no.	Area sq. ft.	Nuts (ft)^2 no.
Mono	18.4	1,932	2,240	268	7.2
2-43W	18.1	5,315	6,460	257	20.0
Yosemite	17.7	2,680	3,420	246	10.1
3-63	17.7	11,288	14,410	246	45.9
Mission	17.0	6,337	8,700	227	27.9
Tokyo	17.1	4,548	6,220	230	20.0
Livingston	16.2	5,886	8,970	206	22.0
2-19E	16.0	6,118	9,560	201	30.4
Monterey	17.6	8,115	10,480	243	32.9
Nonpareil	17.4	3,960	5,230	238	16.6
Sauret #2	16.0	8,107	10,130	201	38.5
Sauret #1	15.4	7,931	13,380	186	41.0
Bonita	14.0	3,028	5,560	154	19.0
Monarch	13.0	3,174	7,510	133	23.9

Rootstock effects on yield and nut characteristics

Kern plot: Data of rootstocks in the Kern plot are given in Table 8. Some differences in plot layout should be noted in the RS portion of the plot. Here 2 adjoining rows of Mission trees were planted with 1 row of Thompson pollinizer. Cross-pollination of the Mission was not as favorable as in the rest of the block and yields may have been less than their potential. Mission/Bright seedling and Mission/Nemaguard in Row 92 were on the edge of the rootstock plot with a pollinizer on each side which may have increased their yields higher than the rest of the plot. Likewise, trees of row 92 tended to grow better with less stress than others in the plot. In contrast, the four Mission/Nemaguard rows (R21, 27, 25, 29) were in the other part of the plot with a pollinizer variety on each side. Mission trees in this section had always showed considerable stress.

With these factors in mind, significant differences were shown among the various rootstocks. Mission trees on the seedling hybrids in general were larger and yielded more nuts than the clonal hybrids and the Mission/Nemaguard. However, when nuts/tree were compared on a comparable size basis the average yield in numbers of nuts did not differ between hybrids and peach, as also did the nuts/sq.ft. canopy. A primary difference between hybrids and peach was in kernel weight with hybrids being significantly greater than on Lovell or Nemaguard (ave. 30/ounce vs. 33/ounce). This increase in size can make a difference in pounds per acre except that when compared on a size adjustment basis the difference decreases if not disappears. Peach rootstock produced a higher number of the sticktights. Both of these differences show that a major benefit effect of the hybrid rootstocks is their tolerance to moisture stress at the end of the growing season.

Data was obtained of a second rootstock plot at Nickels Estate, Arbuckle. Results are being given in a report to the Trustees of that group. Accumulated yields for 1984, 1985 and 1986 showed consistently greater numbers of nuts/tree and higher nut weight in trees on hybrid rootstocks than on almond, Nemaguard and Lovell, primarily due to differences in stress conditions existing in 1984.

Table 8. Yield potential and other characteristics of Mission on different rootstocks growing in the Kern RVT plots. Trees were planted in 1974.

Rootstock	Canopy diameter	Nuts/tree actual	Nuts/tree adjusted	nuts sq.ft.	kernels ounce	lbs/acre act.	lbs/acre adj.
	ft.	no.	no.	no.	no.	lbs.	lbs.
A. peach-almond hybrids:seedling							
Bright R92	23.9	20,230	14,170	41.6	32	2,996	2,096
Bright R80	23.5	16,210	11,740	37.3	30	2,569	1,860
Titan x 40A-17 R86	24.0	15,210	10,560	33.6	28	2,594	1,800
2-15 x 40A-17 R81	22.6	14,770	11,570	36.8	31	2,277	1,783
Mean	23.5	16,600	12,020	37.3	30.25	2,609	1,885
B. peach-almond: clonal							
Hansen 536 R77	21.2	16,090	14,310	45.7	34	2,232	1,986
1-83 R90	23.3	15,385	11,330	39.9	29	2,516	1,850
Hansen 2168 R81	21.4	14,540	12,700	40.5	30	2,334	2,029
3-3-9-63 R80		13,657			30	2,160	
6830-1A R80	19.2	12,300	13,360	42.4	28	2,074	2,247
Mean	21.2	14.453	12,925	42.1	30.2	2,263	2,028
C. Nemaguard seedling							
Row 92	18.5	13,920	16,268	54.3	32	2,033	2,376
Row 21	19.0	12,300	13,640	34.8	34	1,723	1,908
Row 27	20.8	12,460	11,510	36.0	33	1,808	1,668
Row 25	19.4	12,470	13,240	42.3	31	1,906	2,026
Row 29	20.6	9,020	8,490	27.5	36	1,176	1,107
Mean	19.7	12,034	12,630	39.0	33.2	1,729	1,817
D. Lovell peach seedling R90							
	20.6	9,800	8,485	34.4	33	1,402	1,322
E. Almond seedling R77							
	23.8	no harvest					

II. Nut characteristics

Rootstock	Percent kernel	Percent sticktights
	%	%
A. Peach-almond hybrids: seedling		
Bright (1)	45	6
Bright (2)	45	18
Titan x 40A-7	41	10
2-15 x 40A-17	44	24
Mean	43.8	14.5
B. Peach-almond hybrids: clonal		
Hansen 536	41	24
1-83	44	10
Hansen 2136	44	26
3-3-0-63	46	28
6830-1A	45	16
Mean	44.0	20.8
C. Nemaguard seedling (cont)		
Row (92)	45	14
Row 21	45	50
Row 27	36	42
Row 25	44	34
Row 29	41	44
Mean	42.2	44.2
D. Lovell peach seedling		
Row	46	36

Part II. Pollination studies

Procedure: Two branches were covered with plastic mesh bags for each treatment. Pollen was applied by hand. Counts were made as described for yield study.

RESULTS AND DISCUSSION

Results of 1987 crosses are given in Table 9 and 10.

Previously genetic control of self-incompatibility in almonds has been shown to involve two kinds of systems.

a. Self-compatibility is controlled by a single gene (known as S) which occurs in various forms, referred to as alleles. These have been given numbers. Two of these alleles are present in the cells of the style of the flower. Only one kind is present in a single pollen grain but a plant will produce two kinds of pollen, each with separate alleles. Consequently a pollen with the same allele as in the style cannot effect fertilization in that variety and, if both are the same as the style, no cross-fertilization can result.

Seedling offspring of Nonpareil x Mission hybridization segregate into four possible groups due to recombination of the four alleles (Table 9).

b. Jeffries type. Jeffries, a chance mutation of Nonpareil, has been found to differ significantly from all other varieties in showing a rare kind of unilateral incompatibility, apparently due to the fact that Jeffries has only the S1 allele, in both the pollen and cells of the style. Thus, Jeffries pollen will only be effective on styles which do not have an S1 allele. On the other hand, Jeffries can be universally fertilized by any other almond variety since, even if the pollenizing variety produces S1 pollen, it will also always produce pollen with a different allele which can affect set.

Compatibility relationships are of two kinds:

J- = Jeffries pollen is incompatible; S1 allele is present

J+ = Jeffries pollen is compatible; S1 allele is missing

Seedling progeny of Nonpareil x Mission hybridization segregate into two groups: J- and J+ as do any cross with Nonpareil as one of the parents.

The combination of these two kinds of systems is given in Fig. 1:

Parents:

Nonpareil S1/S2 J-	X	Mission S3/S4 J+
- IXL, Long IXL, Profuse, Tardy Nonpareil		Ballico Lanquedoc

Fig. 1. Incompatbility systems in almond.

Progeny:

S1/S3 J- Carmel incompatibility group: Carmel, Carrion, Livingston, Sauret #1 Monarch	S1/S4 J- None have been identified
S2/S3 J+ NePlus Ultra incompatibility group: NPU, Merced, Norman, Price, Ripon	S2/S4 J+ Thompson incompatibility group: Thompson, Granada, Harvey, Robson, Sauret #2, Mono

Additional varieties have been tested against these groups without identifying the S1/S4 group and are currently unclassified within this scheme. We have identified those which are Jeffries incompatible (J-) and isozyme studies and other evidence suggest they should be the S1/4 group.

These have been referred to as a X group and include Butte, Monterey, Grace, and Valenta. Further cross-pollination tests need to be made within the X group.

Table 9. Percent set produced by pollen of 'Jeffries' and 'Nonpareil' applied by hand to bagged unemasculated flowers of specific varieties.

		Pollen Parent			
	Seed Parent	Jeffries		Nonpareil	
		Initial	Final	Initial	Final
		%	%	%	%
(1)	Sauret #1	7	8	12	13
	Valenta	8	8	76	60
	Monarch	6	6	16	16
	Grace	0	0	28	24
(2)	Dotty Won	28	28	18	22
	Woods Colony	18	22	29	29
	Aldridge	30	17	28	28
	Pearl	52	49	78	74

Table 10. Percent set produced by pollen of specific varieties applied by hand to bagged unemasculated flowers of specific test varieties.

Pollen Parent	rep	Seed Parent					
		Carmel		Price		Butte	
		initial	final	initial	final	initial	final
		%	%	%	%	%	%
Grace	1	62	48				
	2	54	44				
Valenta	1	50	55	84	65	20	-
	2	34	32	70	54	34	-
Dotty Won	1	47	47	85	65	20	-
	2	39	31	77	64	18	-
Aldridge	1	94	81	100	76	40	-
	2	53	47	68	40	34	-
Bonita	1	38	35	52	42	-	-
	2	48	41	74	58	-	-
Pearl	1	69	67	57	50	-	-
	2	59	41	90	74	-	-
Monarch	1	17	16	-	-	-	-
	2	14	8	-	-	-	-
Sauret #1	1	15	15	-	-	-	-
	2	6	6	-	-	-	-
Ruby	1	-	-	92	60	-	-
	2	-	-	61	56	-	-
Monterey	1	-	-	-	-	36	-
	2	-	-	-	-	38	-
Tokyo	1	-	-	-	-	63	-
	2	-	-	-	-	40	-
Check	1	9	9	6	7	8	-
	2	7	8	38	30	1	-
Average							
compatible		54	46.5	76	60	35	-
incompatible		13	11	-	-	0	-
check		8	8	22	18	5	-

III. Survey of self-fertility in germplasm, selections and seedling progeny

Transfer of self-compatibility genes (or alleles) to almond from other species, such as peach and Prunus mira, has been carried out in several lines of breeding. Private breeders have introduced several varieties, including LeGrand, Self-Set, Madera, All-in-One, and Garden Prince. These are either inadequate from a quality standpoint or have been shown to be less than completely self-fertile. Similarly, eight self-fertile selections were identified by Kester and Asay (UC) in early 1970's from populations of almond-peach and almond-P. mira hybrids and have been maintained in a selection block. Unresolved questions with this material was their degree of self-compatibility and their commercial potentiality. (Kester and Asay, in Almonds: Advances in Fruit Breeding, 1975). Recently European almond breeders have identified self-fertile almond cultivars in Italy and Spain and have incorporated this material into new varieties.

Weinbaum has recently conducted studies to compare self-fertilization vs. self-pollination, first, in peach and almond and then in hybrids of both the F1 and F2 populations developed in this project.

These lines of breeding involving almond, peach as well as other almond species are shown in Appendix 4. The general background of this material was described in the 1986 annual report. With the good weather conditions of 1987, survey was undertaken to identify self-fertile individuals within these populations.

Procedures: (a). (Weinbaum). Limbs were covered with plastic mesh bags as described in Part II. Comparisons were made among (i) open pollinated branches, (ii) bagged branches with blossoms hand self-pollinated, and (iii) bagged branches without hand-pollination (self-pollination).

(b). (Kester). The second procedure was to bag two limbs per tree and count the setting blossoms in April (initial) and again in June (final) in order to identify individuals. Previous bagging tests had been made in some of the trees.

RESULTS

1. Older selections

These 8 selections were produced by backcrosses of almond to peach-almond hybrids or to Prunus mira-almond hybrids. These had primarily been held as germplasm. Items tested were 8.

B. Almond species hybrids

Almond hybrid populations involved backcrosses of Prunus webbii-almond-peach individuals to different almond varieties.

Group 1. Parental material: 9 individuals tested

Self-fertility level	Tested No.	Nuts under bag Average No.	Nuts under bag Range
low	4 (44%)	0.8	0 - 3
medium	1 (12%)	6	6
high	4 (44%)	20	13 - 29

Group 2. Progeny of material in Group 1 in backcrosses to several almond varieties and selections. 25 individuals tested.

Self-fertility level	Tested No.	Nuts under bag Average No.	Nuts under bag Range
low	8 (32%)	2.5	1 - 5
medium	7 (28%)	6.3	6 - 10
high	10 (40%)	15.1	11 - 38

Group 3. Progeny of many crosses of two almond varieties (Sonora, Padre and others) with F1 hybrids of almond with other species including *P. argentea*, etc. 8 individuals tested.

Self-fertility level	Tested No.	Nuts under bag Average No.	Nuts under bag Range
low	4 (50%)	2.3	1 - 4
medium	3 (37.5)	8.0	6 - 7
high	1 (17.5)	11.0	

This group tended to have a lower potential for producing self-fertile individuals but possibly a higher potential for producing higher yielding individuals.

Group 3. F2 peach-almond hybrid populations

These are progeny of F2 population of six almond varieties (Nonpareil, Nonpareil BF, 2-2, 6A-11 and Padre) crossed with genetic dwarf peach. The purpose was to study the segregation of BF in genetic crosses (see 1986 annual report). In addition this population has been used to study the effect of the dw gene (genetic dwarf) on productivity and to examine the segregation of peach and almond growth habits, as well as self-fertility.

(1) Normal statured group (Dw/-). Approximately 75% of population were in this group.

Dr. Steve Weinbaum studied selfing under bags with and without hand-pollination to separate between self-compatible and self-pollinating. Forty two individuals were tested, out of about 800 individuals in the population.

Self fertility Level	Tested No.	Nuts under the bag	
		hand self	not hand-self
		no.	no.
none	13 (31%)		
low	4 (1%)	1-5	
medium (8-10 nuts)	8 (2)	8-10	
high	7 (16%)	more than 10	low set
	10 (24%)	more than 10	equal set

(1). Dwarfed stature group (dw/dw). Approximately 25% segregated for the genetic dwarf hybrid. The dw gene shortens the internodes. About 300 individuals are present of which 23 have been tested for selfing. Only those with high set under bag in previous years were tested this year.

Self fertility Level	Tested No.	Nuts under the bag	
		Initial set	Final set
		No.	No.
None	4	trees were sterile	
High a)	15	72/bag	low number
b)	4	30/bag	24/bag
			range 7 - 47

Part IV. Yield size analysis of seedling progeny in breeding lines at UCD

A. Breeding lines at UCD are given in Appendix III.

1. Hybrids of peach and almond. The original purposes of these crosses were (a) to produce hybrid rootstocks, (b) to transfer self-fertility from peach to almond and (c) to study the inheritance of BF-potential. A more recent objective has been (d) to study the feasibility of transferring a specific dwarfing gene (dw) into almond and its effect on productivity and other tree characteristics. F1 population from crosses of dwarf peach x 6 varieties of almond were grown to study BF inheritance (described elsewhere). Approximately 1300 seedlings (planted 1982) have been studied from 1984-1987. Information on self-fertility is described in Section III. In addition, data of yield phenology, tree size, growth habit, and nut characteristics have been compiled.

2. The germplasm collection at UCD has also included a number of wild species of almond. One of the most interesting has been Prunus webbii, a small, late blooming, bushy almond from Yugoslavia. These had been crossed with Nonpareil, Mission and Tardy Nonpareil in the past and some of these in turn crossed with some peach-almond hybrid selections. Specific individuals have been used as parents in crosses with Nonpareil, Sonora (both shoot bearing) and Padre (spur bearing). These parental individuals had been previously tested in progeny tests with BF Nonpareil to have a low BF-potential.

3. Other almond species have included Prunus argentea, and other species. One character was a unique thin, hard shell which was thought to have interest for NOW resistance. Individuals with this characteristic were crossed with Sonora, Padre and with each other. Tests for self-fertility were described in Part III.

Procedure

Trees are growing in close planted rows at Wolfskill Experimental Orchards, Winters. Procedures described for yield determination (Part I) were applied to selected items in 1985, 1986 and 1987. Nut samples have been collected and evaluated. Preliminary selections were made in 1985, 1986 and 1987. Selections from group 2 and 3 have been propagated for planting at UCD in 1987-88.

RESULTS

Dwarf Peach almond F2. The F1 hybrids (Dw/dw) were all normal statured because the dwarf gene is recessive. However, the F2 group segregated at 2:1 or 3:1 for normal (Dw/-):dwarfed (dw/dw) (Table 11). There was a wide range in tree size, growth habit, time of bloom and tree and nut characters. Peach-almond and intermediate tree and nut types appeared. Forty to 63% of the normal sized (Dw/-) seedlings were sterile (poor pistils) so were 79 to 97% of the dwarf (dw/dw). Average crop rating of Dw/- seedlings was higher than the dw/dw.

Normal sized: Trees were planted in spring 1982. Trees with peach (shoot bearing) growth habits bloomed in 1984 (3rd year) and those with almond (spur bearing) growth habits bloomed in 1985 (4th year). Very high yields were produced on the fertile plants and self-fertile and self-pollinizing selection were identified. These had potential value as parents in future generations (Dr. Weinbaum). Bad weather in 1986 eliminated most crop. In 1987, weather was excellent; good potential crops were present but the trees had become so crowded that overall set was inhibited and much nut drop occurred.

Dwarfed (dw/dw) trees. Approximately 300 dwarfed seedling trees were produced showing a range of height from 2 to 6 or 7 feet at 6 years. Blooming began in 1984, some seedlings were very high blossom density due to their strong peach growth habit condensed through shortening of the internodes. However, despite very good weather at bloom, nut production was extremely poor compared to that produced by the comparable non-dwarfed trees both of the peach-almond origin and those of the almond-almond origin (see later). In 1985, again a year with good weather at bloom, there was very high bloom density and relatively poor crop. However, as the season progressed some reasonably good crops became apparent on some individuals. Individual limbs were bagged and a number of self-fertile individuals were found. In 1986 crops were very poor because of rain at bloom but prior to that many of the trees that yielded best in 1985 had low bloom density in 1986. In 1987, excellent weather at bloom and their greater age, producing an expanded and exposed bearing surface, resulted in a number of trees with good yield.

A detailed study of yield as described in part 1 was carried out:

1. One of the causes of poor cropping in the hybrid material (both normal and dwarfed) was found to be defective pistils that produced sterility (Table 11). The proportion of plants with sterile pistils varied with the

Table 11. Distribution of dwarfism, pistil fertility, and crop rating in the F2 generation of different almond varieties crossed with dwarf (dw/dw) peach.

Almond grandparent	Genotype (1)	Total No.	Total %	Proportion of pistils fertile %	Ave. Crop rating (2)
Nonpareil BF	Dw/-	332	64	37	4.5
	dw/dw	187	36	21	3.7
Nonpareil	Dw/-	160	69	45	4.6
	dw/dw	72	31	25	4.3
6A-11	Dw/-	114	79	45	5.5
	dw/dw	30	21	20	3.8
2-2	Dw/-	166	75	50	4.5
	dw/dw	54	25	9	5.0
Padre	Dw/-	130	79	60	5.6
	dw/dw	35	21	3	3.0

(1) Dw/- is normal phenotype but genotype is either Dw/Dw or Dw/dw.
(2) based on 2-9 visual rating.

almond grandparent variety. The lowest percentage of sterile trees was produced by Nonpareil (a shoot producer) and the highest by Padre (a spur producer). (In contrast, in the normal statured group, Padre and 6A-11 produced the lowest number of sterile trees and the highest crop density.)

2. Blossom density was high on many individual plants (Table 12) but on a size adjusted basis (Table 12) was no more than found in the range of almond varieties (Table 2) and/or almond seedlings (see later).

Table 12. Blossom production of 6 most productive dw/dw selections in relation to tree size.

Numbered Selection (dw/dw)	Canopy Dia. (ft)	Canopy Area $(ft)^2$	Blossoms (No.)	Size adjusted blossom (No.)	Blossoms sq. ft. No.	Blossoms sq. ft. %[1]
25-16	11.4	102	16,926	51,966	166	108
30-42	9.8	65	10,649	50,619	162	105
25-27	9.1	61	5,436	28,415	89	58
25-10	7.8	59	6,832	44,916	142	92
30-51	7.2	41	6,400	49,422	156	101
25-51	3.9	12	1,820	47,880	152	99

(1) of Nonpareil, Manteca plot, Table 1.

3. Crop density was high in only a few individuals of the entire populations (Table 13) but for most it was disappointingly low even though normal pistils were present. Even with the best, (Sel. 25-10), the total productivity on an equivalent tree size basis was within the range of standard almond varieties.

Table 13. Yield production (no. of nuts) in selections of dw/dw genotypes 1987. Planted 1981-82.

Selection	Tree dia. ft.	Final Nut Count actual no.	Final Nut Count size adjusted no.	Canopy area sq.ft.	Nuts sq.ft. Nuts	Final set %
30-42	9.1	2,975	14,385	65	46	28
25-10	7.8	2,944	19,325	48	61	43
25-16	11.4	2,184	6,705	102	20	13
30-51	7.2	1,160	9,022	41	28	18
25-27	8.8	708	3,653	61	12	13
25-25	8.7	572	3,024	59	10	17
25-51	3.9	325	8,542	12	27	10
23-25	9.8	225	918	75	3	3
25-24	5.0	138	1,208	20	7	1

4. The per cent set (see Table 13) of the best yielding (25-10 and 30-42) was equivalent to that produced in almond and peach that year but it was very low in other trees. Many of the hybrid seedlings were highly self-fertile as shown by the high numbers of nuts produced under bags (Table 14). However, there was a very high drop of nuts occurring after the initial set in the low setting individuals. This situation did not occur with the high yielding selections (See Sel. 25-10). Observations and light intensity measurements made in August indicate that the very high foliage density in these trees correlated to low set probably indicating its inhibiting effect on nut setting. These effects include excessive bud density, high disease incidence, and increased nut drop. There may be a direct effect where low light intensity induces nut drop during and following initial set.

Table 14. Nut set under bags in April and June. Growth habit. Light.

Selection	Nut count under bag		Drop	Light	Blossoms on		
	April No.	June No.	A-J %	%(1)	long %	medium %	short %
29-26	142	13	129	-	-	-	-
30-42	122	25	107	13	78	11	13
30-51	120	25	95	23	-	-	-
24-17	112	4	108	32	-	-	-
25-16	56	5	51	44	58	28	13
25-24	49	6	43	-	-	-	-
25-10	46	47	0	53	34	33	34
25-25	31	29	2	31	-	-	-
23-25	29	1	28	10	-	-	-
25-27	16	5	11	10	86	0	18

(1) % of full sun.

5. None of the trees were pruned in the early years in order to encourage early flowering and fruiting and to study natural growth tendencies. This procedure has been successful with non-dwarfed trees as it was with the other seedling populations, both Dw/- peach almond hybrids of the same origin and the almond species hybrids (see later). It appears that to be able to satisfactorily evaluate their potential, such dwarfed trees with this type of growth habit will require extensive pruning (somewhat like peaches) in their early years to be able to increase light penetration and produce satisfactory cropping patterns.

B. Almond and almond species hybrids.

Table 15 shows tree size and blossom production of a group of hybrids selections from Prunus webbii - almond - peach origin which have been used as parents of part of the present seedling populations (See Appendix III).

Table 15. Blossom production of selections from *P. webbii* used as parents.

Selection No.	Canopy diameter	Canopy area	Blossom actual	Blossom size adjusted	Blossom per sq. ft.
	ft.	sq.ft.	no.	no.	no.
4-4	21.4	359	60,970	53,220	170
4-42	17.1	230	101,730	139,210	442
4-3	15.2	181	81,900	141,820	452
4-6	14.2	91	36,670	72,820	403
4-10	10.5	86	44,900	163,780	522

These trees are strong spur producers. They are over 10 years old and show a range of tree size. Progeny trees with a BF Nonpareil reveal them to have low Bf-potential. They have been pruned very little. Table 16 shows that their yield potential was on a par with the range of almond varieties previously reported. However, the yield pattern shows internal adjustment

Table 16. Yield (no of nuts) of selections from *P. webbii* in relation to % set.

Selection Number	Final Nuts actual	Final Nuts size adjusted	Nuts per sq.ft.	Set April	Set June
	no.	no.	no.	%	%
4-4	11,620	10,450	32	35	19
4-42	11,310	15,345	50	16	11
4-3	15,060	26,160	83	15	16
4-6	7,260	14,400	46	18	16
4-10	5,040	18,420	59	11	11

as described in Part I. Per cent set was relatively low except for Sel. 4-4 which then dropped nuts. The pattern is consistent with that found at Manteca in that high blossom densities resulted in lower per cent sets and the highest sets produced greater subsequent nut drop. Most of these individuals were found to be self-fertile (see Part III).

Similar data is presented for selected seedling offspring in the populations produced by both the breeding lines of almond and almond species hybrids described in Appendix III. The first of these seedlings began to bear in 1982 (third year) although some did the previous year (1981) on long shoots. Blossoms set heavily with none of the inhibition shown in the dwarf dw/dw hybrids. Adverse weather occurred in 1983 and inhibited nut set. Excellent crops were produced throughout in 1984 and 1985. Adverse weather produced poor set in 1986 but as in other blocks excellent conditions prevailed in 1987. However, by this time, the crowded conditions of the close planted seedling blocks had reduced vigor such that total blossoming was somewhat reduced.

Table 17 and 18 show the range of tree sizes, and productivity shown among individuals of these populations. Nut set was within the expected range with no reduction after initial set except in one case where a relatively high initial set occurred. Growth habit types among this group of selections were either (a) a combination of shoot and spur bearing or (b) spur bearing. Some individuals also have a third type characterized by long lateral bearing shoots. These are less desirable and take longer to come into bearing. Self-fertile selections were also discovered among these populations this year as described in Part III.

Table 17. Blossom production of offspring of almond species hybrids.

Selection	Canopy		Blossoms		Blossoms
	diameter	area	actual	size adjusted	per sq.ft.
	ft.	sq.ft.	no.	no.	no.
16-1	16.7	219	34,390	49,493	157
10-9	12.7	127	15,295	38,540	120
20-68	11.8	109	15,220	43,860	140
19-49	9.2	66	8,485	40,210	128
8-31	6.8	36	1,532	13,250	42
20-52	5.6	25	2,050	26,150	82
20-38	4.8	18	3,080	53,520	171

Table 18. Yield (nuts/tree) of offspring of almond species hybrids.

Selection	Final nuts		Nuts per	Set	
	actual	size adjusted	sq. ft.	April	June
16-1	7,250	10,415	33	20	21
10-9	5,390	13,330	42	51	35
20-68	3,430	9,820	31	24	22
19-49	3,430	16,250	36	28	28
8-31	1,250	10,840	35	62	62
20-52	700	8,952	28	34	34
20-38	721	12,530	40	23	23

Approximately 50 selections have been made and trees propagated for replanting. These show a range tree size and growth habit, kernel and shell types as well as self-fertility. This list will be further reduced as further analysis of this material is carried out.

CONCLUSIONS AND DISCUSSION

During the past number of years, inheritance encompassing a wide range of almond genetic material has been studied. Although the possibility of obtaining potential commercial varieties was a factor in the original conception of the studies, more important objectives were (a) to investigate the genetic basis for such complex characteristics as yield and productivity, bud-failure potential, and self-fertility, (b) to establish the breeding technology for early selection of these and other desirable traits and (c) and to determine the potential of a range of exotic germplasm, some of which have never before been used in almond breeding. This includes the various almond species (*Prunus webbii*, *Prunus argentia* and others), genetic dwarf (*dw/dw*) peach as well as standard peach. This report summarizes some of the main points but there is much more that is being analyzed and will be summarized in upcoming papers and reports.

Part of the plant material described herein has been eliminated and the promising germplasm and potential varieties are being propagated and replanted. In addition the entire germplasm collection at UCD has been evaluated and the useful material is being relocated into newer blocks either with the Department of Pomology orchards or in the Davis Clonal Germplasm Repository (USDA) at Winters.

To a large extent the objectives stated have been accomplished and the basis for a potential productive breeding program in almond has been laid which will be able to combine the characteristics of low bud-failure potential, precocious and heavy production, and self-fertility with a range of tree sizes and characteristics as well as nut and kernel types. Some of the present material may have possibilities as commercial varieties but these have not yet been sorted out completely. Their potential as germplasm for future crossing is probably more significant.

Some comments on individual materials follow:

a. Progeny of *P. webbii*, almond and other species combining traits of self-fertility, low BF potential, early precocity from shoot bearing and later productivity from spurs, open exposure to light and thin but hard shells appear to be among the most promising for breeding.

b. Control of tree size in almonds needs to be given consideration and material is available ranging from very small (essentially dwarfed) to very large. There is also a potentiality of combining various tree sizes with vigorous rootstocks (peach-almond) or semi-dwarfing (Marianna 2624) to produce the maximum in efficiency.

c. Although one cannot rule out completely use in breeding of the genetic dwarf (dw/dw) trait which produces short internodes on long bearing units in peaches (in contrast to the spur which produces short internode bearing units naturally), there are many problems with this material that need to be overcome and extra management efforts, as pruning, are needed. Furthermore, these studies indicate that their suggested advantages in yield and precocity can be paralleled by specific genetic potentialities that already exists in almond or in other almond species. There may be particular uses for this material in genetic studies where large populations and high densities might be useful, as in further studies on bud-failure or in rapid incorporation of specific traits.

d. Early production (precocity) is another very important trait. This trait is expressed most in individuals that begin to produce flowers laterally on long shoots (as in a peach) in the third year combined with the rapid induction the following year of spurs. This trait is found in Nonpareil, Sonora, and others and is shown by various individuals in these populations.

e. Traits of both self-fertility and self-pollinations are now available for incorporating into commercial varieties and some may be present among the current selections. However, further clarification needs to be made to determine the actual level of self-fertility.

f. Low bud-failure potential is shown for some of the parental material from Prunus webbii hybridization although the specific level within their offspring may vary with each other. This material also produces offspring that is the most almond-like, has best quality, as well as has self-fertility, and should be very useful.

Valuable material also is present within the peach hybrid populations, but the potential and method of handling are different from that of the almond-almonds species material. Their main value is the existence of the self-fertile and self-pollinated genotypes. Also the combination of the almond and peach growth habit is potentially great. On the other hand much of this material has inferior nut qualities and will require further breeding to produce commercial types. The probability for low BF-potential is greatest in the families from Padre and 6A-11 and least in the Nonpareil (and BF Nonpareil) although BF-potentiality of any one individual may also be high. These two families (Padre, 6A-11) produce highest production in the average in the normal statured trees and least in the dwarfed trees. Consequently the only viable families for good production in the dwarfed (dw/dw) group is the Nonpareil which also has the higher probability for BF.

Selection for self-fertility is the only feasible route for the peach hybrid material. BF-potential of individual trees may be tested by using a seedling progeny test from selfed individual to isolate inbreeding lines of low BF-potential which could later be crossed to produce commercial material.

APPENDIX I
Yield Data in RVT Plots
for 1987

Kern RVT Plot
McFarland, California
Yield Summary - 1987

Variety	No. of trees	No. of nuts/tree	Ave. kernel wt. gms.	Ave. kernel wt. no./oz.	% Kernel	Weight lbs/tree	Weight lbs/acre
Planted 1974, 1976							
Early blooming varieties							
Jordanolo	26	10,391	0.97	29	67	22.1	1,682
NePlus Ultra	45	10,320	0.95	30	63	21.6	1,639
Sonora	25	8,291	1.18	24	72	21.6	1,642
Mid blooming varieties							
Carmel	25.5	14,723	0.77	37	66	25.1	1,904
Fritz	26	14,700	0.80	35	54	26.1	1,980
Nonpareil	419.4	14,303	0.96	30	67	30.1	2,285
Price	25.7	13,839	0.91	31	65	27.6	2,101
Solano	26	12,933	0.79	36	67	22.4	1,703
Jeffries	24	12,884	0.85	34	69	24.0	1,826
Milow	23	12,462	0.71	40	71	19.5	1,478
Merced	25.5	11,044	0.82	35	72	20.0	1,517
Harvey	26	9,289	0.91	31	65	18.6	1,416
Late blooming varieties							
Butte	26	18,270	0.78	36	52	31.4	2,388
Padre	20	13,410	0.70	40	51	20.8	1,582
Ripon	26	13,316	0.74	38	47	21.8	1,660
Carrion	26	12,951	1.00	28	66	28.6	2,170
Thompson	26	12,526	0.86	33	67	23.6	1,797
Ruby	26	11,520	0.86	33	50	21.9	1,668
Mission	207.5	9,801	0.85	33	46	18.5	1,402
Planted 1981							
Mid blooming varieties							
Sauret #2	25	8,107	1.18	24	59	21.0	1,597
Monterey	26	8,015	1.26	22	45	22.3	1,697
Sauret #1	25	7,931	1.17	24	64	20.5	1,560
Nonpareil	149.8	4,268	1.30	22	63	12.2	924
Monarch	23.5	3,174	1.16	25	54	8.1	615
Bonita	26	3,028	1.12	25	59	7.5	567
Late blooming varieties							
Mission	102.5	6,427	1.05	27	47	14.9	1,434
Livingston	20	5,886	1.26	23	64	16.3	1,239
Tokyo	25	4,548	1.08	26	47	10.9	826
Yosemite	25	2,680	1.04	27	53	6.1	466
Mono	25	1,932	1.16	24	47	5.0	377

Butte Co. RVT Plot
California State University, Chico (CSUS)
Durham, California
Yield Summary - 1987
Planted 1976

Variety	No. of trees	No. of nuts/tree	Ave. kernel wt. gms.	Ave. kernel wt. no./oz.	% Kernel	Weight lbs/tree	Weight lbs/acre
Early blooming varieties							
NePlus Ultra	39	17,722	1.33	21	50	52.0	3,955
Sonora	21	16,778	1.14	25	70	42.2	3,205
Mid blooming varieties							
Nonpareil	289	13,845	1.21	23	64	36.7	2,790
Norman	26	12,231	0.93	30	67	25.1	1,914
Fritz	30	11,336	1.03	27	44	25.8	1,960
Robson	26	10,706	1.18	24	57	27.9	2,120
Carmel	22	10,285	1.23	23	56	28.0	2,126
Solano	22	10,260	1.04	27	62	23.5	1,788
Merced	21	9,999	1.17	24	64	25.7	1,953
Price	24	9,617	1.14	25	58	24.2	1,837
Harvey	25	6,915	1.18	24	64	17.9	1,363
Late blooming varieties							
Butte	25	13,061	0.99	29	51	28.4	2,162
Padre	63	10,339	1.11	25	51	25.4	1,930
Mission	177	9,673	1.15	25	45	24.3	1,849
Carrion	33	9,108	1.36	21	63	27.3	2,075
Thompson	32	9,033	1.23	23	60	24.6	1,868
Ripon	31	6,990	1.08	26	42	16.6	1,260

San Joaquin Co. RVT Plot
Delta College
Manteca, California
Yield Summary - 1987

Variety	No. of trees	No. of nuts/tree	Ave. kernel wt.		% Kernel	Weight	
			gms.	no./oz.		lbs/tree	lbs/acre
Planted 1978							
Early blooming varieties							
Sonora	27	15,891	1.21	23	75	42.5	3,227
Jordanolo	26	10,153	1.70	17	67	38.1	2,892
Neplus Ultra	26	6,402	1.60	18	59	22.5	1,712
Peerless	27	2,143	1.40	20	39	6.6	504
Mid blooming varieties							
Fritz	26	19,164	0.96	30	57	40.6	3,082
Price	27	18,622	0.96	30	68	39.4	2,995
Carmel	27	15,810	1.23	23	69	42.9	3,264
Nonpareil	476	15,052	1.20	24	68	39.7	3,021
Solano	27	14,639	0.98	29	67	31.6	2,404
Merced	27	12,850	1.16	24	68	32.8	2,493
Monterey	24	12,556	1.36	21	47	37.6	2,861
Sauret #1	27	10,424	1.15	25	66	26.4	2,005
Monarch	27	10,056	1.11	26	55	24.6	1,867
Sauret #2	26	9,708	1.31	22	61	28.0	2,128
Planted 1980							
Grace	25	4,631	1.06	27	64	10.9	826
Late blooming varieties							
Butte	23	18,530	1.04	27	60	42.5	3,229
Le Grand	25	13,979	1.25	23	68	38.4	2,918
Padre	18	11,543	1.10	24	55	28.0	2,131
Livingston	23	11,490	1.35	21	66	34.2	2,599
Mission	114	9,922	1.21	23	52	26.5	2,012
Ripon	21	8,299	1.03	28	49	18.8	1,432
Tokyo	22	8,121	1.36	21	56	24.4	1,853
Thompson	22	8,118	1.32	21	64	23.7	1,801
Ruby	22	7,864	1.32	22	57	22.8	1,734
Yosemite	20	5,096	1.13	25	56	12.7	963
Mono	22	4,949	1.35	21	52	14.7	1,116
Planada	20	3,597	1.45	20	60	11.5	875
Planted 1983							
Valenta	27	3,100	1.12	25	53	7.7	582
Aldridge	27	2,655	1.10	26	62	6.4	489
Dottie Won	27	2,276	1.06	27	56	5.3	403
Rosetta	27	1,849	1.31	22	53	5.3	407
Jeffries	27	1,743	1.16	24	70	4.5	339
Wood Colony	27	1,645	1.33	21	66	4.8	368
Pearl	26	1,191	1.08	26	59	2.8	216

Fresno County RVT Plot
California State University, Fresno (CSUF)
Fresno, California
Yield Summary - 1987
Planted 1981

Variety	No. of trees	No. of nuts/tree	Ave. kernel wt.		% Kernel	Weight	
			gms.	no./oz.		lbs/tree	lbs/acre
Early blooming varieties							
Jordanolo	20	6,075	1.20	24	62	16.1	1,224
Peerless	20	4,871	1.01	28	36	10.8	824
Sonora	20	4,774	1.10	26	68	11.6	880
NePlus Ultra	80	4,513	1.37	21	59	13.6	1,036
Janice	19	4,348	1.10	26	51	10.5	798
Mid blooming varieties							
Fritz	19	8,592	0.82	35	51	15.5	1,178
Price	20	7,922	0.82	35	60	14.3	1,086
Norman	19	7,211	0.92	31	65	14.7	1,116
Hoover	20	6,892	0.92	31	58	14.0	1,065
Nonpareil	508	6,885	1.04	27	60	15.8	1,198
DB-OY (Lodi)	20	6,813	0.89	32	57	13.4	1,020
Monterey	20	6,621	1.08	26	44	15.8	1,200
Carmel	40	6,575	1.01	28	57	14.6	1,106
Jeffries	20	6,095	1.05	27	64	14.1	1,074
Solano	20	6,013	0.93	31	61	12.3	933
Sorrenti	20	5,797	0.98	29	56	12.5	952
Elsie	20	5,720	1.08	26	57	13.6	1,035
Milow	20	5,645	0.81	35	68	10.1	770
Sauret #1	19	5,398	1.00	28	61	11.9	904
DB-OJ	20	5,195	1.02	28	48	11.7	888
Sauret #2	20	5,124	1.08	26	54	12.2	924
Heart	17	5,115	1.46	19	61	16.4	1,249
Valenta	20	4,671	1.08	26	52	11.1	847
Bonita	20	4,231	1.13	25	56	10.5	798
Merced	20	3,657	1.11	26	61	8.9	680
Grace	20	3,169	0.98	29	51	6.8	520
Monarch	20	2,765	1.09	26	46	6.6	504
Late blooming varieties							
LeGrand	37	8,984	0.86	33	57	17.1	1,298
Ripon	19	7,750	0.86	33	40	14.7	1,119
Padre	20	7,432	0.87	33	52	14.2	1,078
Tioga	18	6,725	0.71	40	52	10.5	800
Butte	20	6,300	0.93	30	47	12.9	984
Mission	281	5,716	0.96	30	45	11.9	906
Livingston	20	5,580	1.14	25	60	14.0	1,066
Tokyo	20	4,650	1.01	28	46	10.4	788
Thompson	17	4,194	1.09	26	59	10.1	769
Mono	20	3,949	1.03	28	43	8.9	680
Ruby	20	3,717	1.16	24	45	9.5	725
Yosemite	20	1,791	1.07	26	50	4.2	321
Planada	19	1,231	1.27	22	43	3.4	262

Butte Co. RVT Plot

APPENDIX II
Nut Data in RVT Plots
for 1987

Kern RVT Plot
McFarland, California
Nut Characteristics - 1987

Variety	Kernel lnth (cm)	wth (cm)	thick-ness (cm)	wth/lnth	sealed %	hull %(1)	shell %(1)	Damage dbls %	twins %	Navel orange-worm %	Twig borer %	blanks %
Planted 1974												
Early blooming varieties												
Jordanolo	-	-	-	-	54	59	28	0	0	0	0	6
Ne Plus Ultra	2.48	1.17	0.79	0.47	91	49	32	29	1	0	1	1
Sonora	2.72	1.26	0.76	0.46	84	55	33	2	0	0	0	2
Mid blooming varieties												
Carmel	2.00	0.97	0.73	0.49	98	46	35	12	6	0	0	0
Fritz	-	-	-	-	92	46	29	2	0	0	0	2
Nonpareil	2.16	1.18	0.72	0.55	65	57	30	5	1	1	0	1
Price	-	-	-	-	58	55	29	8	4	0	0	2
Solano	-	-	-	-	98	55	30	0	0	0	0	2
Jeffries	-	-	-	-	54	55	31	0	0	0	0	0
Milow	-	-	-	-	92	51	34	4	0	2	0	0
Merced	-	-	-	-	98	51	35	10	0	0	0	2
Harvey	-	-	-	-	94	47	34	2	0	0	2	0
Late blooming varieties												
Butte	-	-	-	-	60	43	30	0	0	0	2	0
Padre	-	-	-	-	100	48	27	4	0	0	0	0
Ripon	-	-	-	-	100	42	28	0	0	2	0	2
Carrion	-	-	-	-	74	47	35	0	2	0	0	2
Thompson	-	-	-	-	92	55	30	0	0	0	0	0
Ruby	-	-	-	-	92	47	27	0	0	0	0	6
Mission	-	-	-	-	100	41	27	4	0	0	0	1
Planted 1981												
Mid blooming varieties												
Sauret #2	2.67	1.23	0.81	0.46	78	51	29	22	4	0	0	14
Monterey	2.64	1.23	0.86	0.47	86	40	27	42	2	4	0	16
Sauret #1	2.21	1.24	0.83	0.56	26	49	32	16	2	0	0	4
Nonpareil	2.59	1.39	0.77	0.54	44	62	24	5	1	1	0	2
Monarch	2.51	1.39	0.76	0.55	90	59	22	10	0	0	0	8
Bonita	2.40	1.49	0.69	0.62	98	53	28	4	4	0	0	2
Late blooming varieties												
Mission	2.12	1.34	0.97	0.63	100	48	25	12	1	0	0	1
Livingston	2.40	1.26	0.86	0.53	42	48	34	6	0	0	0	0
Tokyo	2.22	1.36	0.77	0.61	70	52	23	0	0	0	0	0
Yosemite	-	-	-	-	76	60	21	0	0	0	0	2
Mono	2.40	1.33	0.74	0.55	96	52	22	8	0	0	0	6

(1) of whole fruit (hull + shell + kernel)

Butte Co. RVT Plot
California State University, Chico (CSUS)
Durham, California
Nut Characteristics - 1987
Planted 1976

Variety	Kernel lnth	wdth	thick-ness	wdth lnth	sealed	hull[1]	shell[1]	dbl	twin	NOW	tgb	blk
					%	%	%	%	%	%	%	%
Early blooming varieties												
Ne Plus Ultra	-	-	-	-	34	39	30	40	0	10	0	0
Sonora	-	-	-	-	38	46	16	4	4	16	0	0
Mid blooming varieties												
Nonpareil	-	-	-	-	50	55	16	4	0	7	0	2
Norman	-	-	-	-	18	48	17	0	0	12	0	0
Fritz	-	-	-	-	90	43	32	18	0	0	0	4
Robson	-	-	-	-	46	46	23	18	0	12	0	2
Carmel	-	-	-	-	94	49	22	8	4	0	0	4
Solano	-	-	-	-	62	56	17	4	0	2	0	4
Merced	-	-	-	-	40	53	17	8	0	12	0	0
Price					53	56	19	14	1	3	0	0
Harvey	-	-	-	-	12	50	18	6	0	32	0	0
Late blooming varieties												
Butte	-	-	-	-	60	46	26	6	0	8	0	0
Padre	-	-	-	-	100	52	23	4	0	2	0	0
Mission	-	-	-	-	100	45	30	9	0	1	0	1
Carrion	-	-	-	-	74	52	18	10	0	36	0	0
Thompson	-	-	-	-	48	55	18	10	0	32	0	0
Ripon	-	-	-	-	96	43	33	0	0	6	0	0

San Joaquin Co. RVT Plot
Delta College
Manteca, California
Nut Characteristics - 1987

Variety	Kernel lnth (cm)	wdth (cm)	thick-ness (cm)	wdth lnth	sealed %	hull[1] %	shell[1] %	dbl %	twin %	NOW %	tgb %	blk %
Planted 1978												
Early blooming varieties												
Sonora	2.54	1.21	0.86	0.48	48	45	14	2	6	2	0	0
Jordanolo	-	-	-	-	64	57	14	2	0	2	0	2
Ne Plus Ultra	-	-	-	-	74	54	19	20	0	2	0	0
Peerless	-	-	-	-	100	60	25	20	0	2	0	0
Mid blooming varieties												
Fritz	2.09	1.16	0.92	0.56	94	46	23	0	0	0	0	0
Price	1.98	1.09	0.93	0.55	62	52	15	10	18	0	0	0
Carmel	2.27	1.21	0.94	0.53	88	46	17	0	2	0	0	2
Nonpareil	2.30	1.28	0.84	0.56	46	55	14	3	1	1	0	1
Solano	2.33	1.08	0.81	0.46	62	51	16	0	0	2	0	0
Merced	-	-	-	-	34	51	16	14	2	4	0	0
Monterey	2.67	1.31	0.89	0.49	90	40	32	36	0	0	0	12
Sauret #1	-	-	-	-	44	53	16	2	0	2	0	2
Monarch	2.33	1.23	0.81	0.53	100	55	20	4	0	0	0	2
Sauret #2	-	-	-	-	68	53	18	14	2	0	0	4
Planted 1980												
Grace	-	-	-	-	40	51	18	16	0	0	0	4
Late blooming varieties												
Butte	2.05	1.22	0.95	0.60	54	45	22	0	4	2	0	0
LeGrand	-	-	-	-	40	47	17	2	0	0	0	0
Padre	-	-	-	-	100	49	23	2	0	0	0	2
Living-ston	2.50	1.31	0.88	0.52	38	47	18	2	0	6	0	0
Mission	2.06	1.34	0.99	0.65	99	50	24	2	0	0	0	4
Ripon	-	-	-	-	100	39	31	0	2	0	0	4
Tokyo	2.37	1.40	0.89	0.59	38	54	20	0	0	0	0	4
Thompson	-	-	-	-	60	53	16	2	0	0	0	0
Ruby	-	-	-	-	72	56	19	2	0	0	0	2
Yosemite	-	-	-	-	38	62	17	0	0	0	0	0
Mono	2.51	1.30	0.86	0.52	100	52	23	2	2	0	0	2
Planada	-	-	-	-	100	54	18	0	0	0	0	18
Planted 1983												
Valenta	2.30	1.23	0.86	0.53	38	35	31	48	0	12	0	0
Aldridge	-	-	-	-	82	43	22	8	0	0	0	0
Dottie Won	-	-	-	-	44	46	24	12	0	0	2	6
Rosetta	-	-	-	-	86	53	22	4	0	2	0	2
Jeffries	-	-	-	-	4	56	13	0	0	0	0	8
Wood Colony	-	-	-	-	90	48	18	10	0	0	0	0
Pearl	-	-	-	-	70	55	18	30	0	0	4	8

Fresno County RVT Plot
California State University, Fresno (CSUF)
Fresno, California
Nut Characteristics - 1987
Planted 1981

Variety	Kernel lnth	Kernel wdth	Kernel thick-ness	wdth lnth	sealed	hull	shell	dbl	twin	NOW	tgb	blk
	(cm)	(cm)	(cm)		%	%	%	%	%	%	%	%
Early blooming varieties												
Jordanolo	-	-	-	-	82	69	12	4	0	0	0	4
Peerless	-	-	-	-	92	44	36	32	0	0	0	0
Sonora	2.49	1.15	0.77	0.46	50	49	16	0	6	0	2	0
Ne Plus Ultra	-	-	-	-	43	50	21	28	2	0	0	0
Janice	2.53	1.15	0.75	0.45	92	48	25	2	0	0	0	0
Mid blooming varieties												
Fritz	1.96	1.06	0.87	0.54	92	43	28	6	0	0	0	0
Price	2.06	1.08	0.79	0.52	54	55	18	10	4	0	0	0
Norman	2.10	1.25	0.73	0.60	38	55	16	0	6	0	0	2
Hoover	2.04	1.21	0.88	0.59	88	44	24	6	0	0	0	0
Nonpareil	2.33	1.23	0.73	0.52	66	54	18	1	2	0	1	0
DB-OY (Lodi)	1.79	1.14	0.88	0.64	92	47	23	16	2	0	0	0
Monterey	2.37	1.22	0.80	0.51	94	48	34	24	2	0	0	0
Carmel	2.16	1.12	0.88	0.52	80	42	25	10	7	0	0	0
Jeffries	-	-	-	-	38	57	15	2	2	0	0	0
Solano	-	-	-	-	84	54	18	0	0	0	0	0
Sorrenti	2.18	1.11	0.93	0.51	76	38	28	10	0	0	0	0
Elsie	2.10	1.26	0.90	0.60	42	32	29	2	0	0	2	0
Milow	2.10	1.10	0.71	0.52	92	51	16	0	0	0	0	0
Sauret #1	-	-	-	-	86	53	18	4	0	0	2	2
DB-OJ	2.23	1.31	0.77	0.59	94	52	25	0	0	0	0	0
Sauret #2	-	-	-	-	78	52	22	16	4	0	0	0
Heart	2.20	1.49	0.87	0.68	98	51	19	8	8	0	0	0
Valenta	2.34	1.28	0.76	0.55	48	44	27	26	2	0	0	0
Bonita	2.27	1.47	0.72	0.65	94	52	21	2	4	0	0	0
Merced	-	-	-	-	40	53	18	16	0	0	0	0
Grace	2.15	1.20	0.82	0.56	54	48	25	24	0	0	0	0
Monarch	2.50	1.30	0.70	0.52	100	56	24	0	0	0	0	0
Late blooming varieties												
LeGrand	-	-	-	-	94	44	24	8	0	0	0	1
Ripon	-	-	-	-	100	41	36	0	2	0	0	2
Padre	-	-	-	-	100	49	25	0	0	0	0	0
Tioga	-	-	-	-	98	53	23	0	0	0	0	0
Butte	2.01	1.21	0.83	0.60	100	46	29	0	0	0	0	0
Mission	1.92	1.19	0.89	0.62	99	46	30	2	0	0	0	1
Living-ston	2.46	1.25	0.82	0.51	42	49	21	8	2	0	4	2
Tokyo	2.27	1.34	0.76	0.59	48	52	26	0	0	0	0	0
Thompson	-	-	-	-	54	60	16	0	0	0	0	0

Fresno (continued) Nut Characteristics - 1987

Variety	Kernel lnth	wdth	thick- ness	wdth/lnth	sealed	hull	shell	dbl	twin	NOW	tgb	blk
	(cm)	(cm)	(cm)		%	%	%	%	%	%	%	%
Mono	2.30	1.27	0.70	0.55	96	51	28	0	0	0	0	0
Ruby	2.20	1.46	0.81	0.66	100	51	27	0	0	0	0	0
Yosemite	2.31	1.28	0.72	0.55	56	39	30	4	0	2	2	0
Planada	-	-	-	-	100	48	30	0	0	2	0	4

APPENDIX III
Update on Pollination Requirements

Almond Research Conference
December 1, 1987

UPDATE OF POLLEN INCOMPATIBLE GROUPS

Not all varieties are cross compatible with all other varieties but fall into distinct groups. Table 1 summarizes present knowledge on cross-incompatible varieties. Those within each group are considered cross-incompatible with others of the same group and cross-compatible with all varieties of other groups.

TABLE 1. Pollen incompatible groups

Nonpareil	Mission	NePlus Ultra	Thompson	Carmel	Solano
IXL	Ballico	Merced	Granada	Carmel	Kapareil
Long IXL	Mission	NePlus Ultra	Harvey	Carrion	Solano
Jeffries*	Languedoc	Norman	Robson	Livingston	Sonora
Nonpareil		Price	Thompson	Sauret 1	Vesta
Profuse		Ripon	Sauret 2	Monarch	Jeffries
Tardy Nonpareil			Mono	Jeffries*	Eureka

*Jeffries is a mutation of Nonpareil and should belong to the Nonpareil incompatibility group. However, field experience combined with controlled tests show that Jeffries possesses a kind of incompatibility (unilateral) which is unique among all other varieties. All varieties tested so far -- including the parent Nonpareil-- can fertilize Jeffries. But Jeffries is unable to fertilize Nonpareil, Solano, Carmel and all varieties in these incompatibility groups as well as Butte, Monterey, Valenta and Grace. On the other hand, Jeffries can fertilize Merced and all members of the NePlus incompatibility group, Thompson and all members of this incompatibility group, Mission and Fritz.

Table 2 lists varieties which have been tested for pollen incompatibility and for which no separate incompatibility group has yet been identified. For each variety, the list of successful test crosses completed is given.

TABLE 2. Varieties which have been tested and show cross-compatibility.

Variety	Varieties Tested
Butte	Nonpareil, Mission, Carrion, Fritz, Merced, Norman, Monterey, Mono, Padre, Ruby, Tioga, Tokyo, Thompson, Aldrich, Valenta.
Fritz	Butte, Carrion, Merced, Harvey, Padre, Thompson, Ripon, Mission, Nonpareil, NePlus Ultra, Jeffries.
Monterey	Thompson, Carmel, Merced, Butte, Price, Thompson.
Padre	Nonpareil, Mission, Thompson, Fritz, Carrion, Ruby, Butte.
Ruby	Nonpareil, Mission, Thompson, Ripon, Mono, Tioga, Carrion, Merced, Padre, Carmel, Price, Bonita, Grace, Pearl, Valenta.
Tokyo	Nonpareil, Merced, Carmel, Butte, Thompson, Ruby, Fritz, Padre.
Yosemite	Fritz, Ruby, Padre, Thompson, Butte.
Tioga	Nonpareil, Norman, Ruby, Butte, Thompson, Carmel, Tokyo.
Aldrich	Butte, Carmel, Price, Thompson, Ruby.
Valenta	Butte, Carmel, Price, Thompson and Ruby.
Bonita	Carmel, Price, Thompson, Ruby.
Pearl	Carmel, Price.

APPENDIX IV
Almond Breeding Lines at UCD

CURRENT BREEDING PROGRAMS AT UCD

I. Peach-Almond Hybrids

	A.	B.	C.
Parents Peach:	40A-17 (low)*	Fay Elberta (High)*	54P455** (moderate)*
Almond:	- Nonpareil - Nonpareil BF - Many varieties	- Nonpareil - Jordanolo - Mission	- Nonpareil - Nonpareil BF - Titan - 6A-11 - Padre - 2-2
F1 First generation	- BF in varying amounts ranging from 0% to about 50% - Test cross for BF	- no BF offspring	- no BF offspring 1982 - 1987
F2 2nd generation	varying amounts of BF segregation; weak to vigorous trees	not tested	- segregates varying % of severe BF or RB offspring - 25% dwarf 75% normal - about 50% sterile individuals - range of peach to almond types - range of self-fertile

* refers to chilling requirement
**dw/dw genetic dwarf

II. ALMOND-ALMOND SPECIES HYBRIDS

I. *P. webbi* x Pch-alm hybr.

1973

4-3 4-10
4-4 4-11
4-5 4-42
4-6 4-62

Nonp BF

Test cross
for
BF-potential

Nonpareil
Solano
Padre
Milow

1980 to 1987

- range in tree size
- range of kernel, sheet type
- early maturity
- tendency for spur type
- presence of self-fertile

II. various species x Nonpariel Mission

1968

1-5 1-21
1-13 1-23
1-19 1-28
1-29

1979
to
1987

Sonora;
self-fertile PA

- range in tree sizes
- range in kernel, shell type
- some thin-shelled
- highly productive; growth habit combine shoot & spur type
- probably little self-fertility

Steve A. Weinbaum

Appendix I SELF-FERTILITY IN ALMOND

Introduction

Inadequate pollination is often the major production-limiting factor in almond. Insufficient pollination due to inclement weather during almond bloom occurs even in orchards with optimum spacing and distribution of pollenizers and 2-3 beehives/acre. Self-incompatibility (SI) in almond is manifested as a retardation of pollen tube growth within the style following self-pollination. SI and the lack of self-fertilization results in decreasing fruit set with increasing distance of a cultivar from its pollenizer. In contrast, peach, a species closely related to almond, is self-compatible (SC) and can set fruit and seed with its own pollen. Peach does not require bees for pollination and fruit set.

Short-term objectives

To assess the distribution and possible linkage of a) self-compatibility and b) capacity for natural self-pollination (NSP), i.e., pollination without bees in peach-almond progenies.

Results

Of 55 profusely flowering peach-almond F_2 hybrids originally tested, 31 individuals were discarded. Of the 31, 9 individuals were found to be sterile, i.e., no fruit set ever on open-pollinated limbs, and 22 individuals had very low fertility (at least in our densely spaced breeding block). Of the remainder, 6 are SI (almond-like), and 18 are SC. Of the 18 SC genotypes, 7 could set fruit in a bag (i.e., without bees) and 11 SC's were incapable of setting fruit in a bag (i.e., presumably needing bees for pollination).

Table contains idealized data to illustrate clearly the differential responses of almond types (SI) as well as self-compatible genotypes to unlimited availability of self-pollen (self-pollination by hand), and level of natural self-pollination, NSP (on bagged limbs, no bees).

Category	No. of hybrids tested	Fruit Set (%) Open pollinated	Fruit Set (%) Self-pollination by hand	Fruit Set (%) Bagged; no bees
Self-incompatible (almond-like)	6	30%	2%	0%
Self-compatible				
+ NSP[1] (peach-like)	7	30%	30%	26%
- NSP	11	3%	30%	2%

[1]Capable of natural self-pollination (i.e., without bees).

Future implications of this work include the possibility of converting the almond mating system to the type exhibited by that of its close relative, the peach. The intent is to make pollinations independent of the need for pollenizers and bees in almond orchards of the future. The implications of this scenario are a) more regular annual cropping (less influenced by adverse whether at bloom) and b) reduced production costs associated with reduced dependence on bees.

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