Almond Board of California
Annual Report
March 1995

Project No.: 94-L21 - Field Evaluation of Almond Varieties & Rootstocks (cont. of Project 93-L20)

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Objectives:

1. Continue data collections and observations from selected varieties in the older CSU, Chico, and Delta RVTs since long-term performance of promising varieties has been indicated as high priority by members of the almond industry. Data on susceptibility to pests, disease and other disorders will be collected as opportunities occur.

2. Three new RVTs were planted in 1993. Advise/assist grower cooperators for these trials on tree training and management decisions as needed. Observe and evaluate trees for growth, pest and disease susceptibility and noninfectious bud failure symptoms, as appropriate. Collect bloom, harvest and nut data once bearing begins.

3. Make further cross-pollinations to identify the pollen compatibility of newer varieties as well as important older varieties where this information is still lacking.

4. Continue collection of yield and tree size data from the rootstock evaluation plots in Fresno and Merced Counties. Continue obtaining compatibility information on varietal compatibility and/or interstem studies with Marianna 2624 plum in Colusa and Butte Counties.

5. Summarize and analyze data associated with this project and publish and otherwise disseminate this information as appropriate.

Abstract:

Production and nut quality data were again collected from many, but no all varieties in the two older Regional Variety Trials (RVT's) at California State University at Chico and San Joaquin Delta College. Yields in 1994 from these plots, like many commercial orchards in California, were generally excellent with few exceptions.

Trees in the three new RVT's, planted in 1993, are generally growing well. Trees were added (where adequate trees were not available in 1993) or replaced as necessary.

Studies of cross-compatibility of a number of varieties were continued. Butte and Monterey continue to give questionable cross-pollination results and may be in the same compatibility group. Aldrich

does not appear to be in any established pollination group. Rosetta may not be in the Ne Plus Ultra group as once believed.

While trees on peach-almond hybrid rootstocks out-produce those on peach rootstock (on a per tree basis), trees on hybrid are also larger and their greater production appears to be a result of their larger size and not that they are inherently more productive.

Experimental Procedure:

The procedures used for variety and rootstock evaluation, including graft compatibility of almond varieties on Marianna 2624, were the same as used in previous years, as were those for studying pollen cross-compatibility.

Results and Discussion:

Older Regional Variety Trials.

In the California State University at Chico trial (planted in 1976) most of the varieties that were evaluated produced exceptionally well with Sonora and Butte producing over 3,000 kernel pounds per acre (Table 1). In addition, Price, Padre, Carrion, Carmel, Fritz and Ne Plus Ultra all produced more than 2,500 kernel pounds per acre. Price, as has been reported previously, has shown a significant alternate bearing pattern in this trial with low yields (below 1,500 kernel pounds per acre) in 1991 and 1993 and high production in 1992 and 1994. However, Sonora, another variety that at times has shown alternate bearing tendencies, has now produced excellent crops for three consecutive years. Four varieties were added to this trial in 1987 (where other varieties had been removed). These varieties all produced between 2,000 and 1,600 kernel pounds per acre with Aldrich being the highest yielding of the four.

In the CSU,Chico planting the only varieties evaluated to have 10% or more double kernels were Ne Plus Ultra (16%) and Ruby (10%). Worm damage was not a serious problem in the trial in 1994 with Norman and Sonora having the highest damage, each with 4%. Several varieties had kernels that showed some shrivel in 1994. These were Fritz (26% of the kernels showing shrivel), Mono (20%), Ne Plus Ultra (12%) and Norman (10%).

At the San Joaquin Delta College RVT, yields were also exceptional in 1994. In the 1978 planting, Sonora, LeGrand, Ruby, Livingston, Mono, Butte, Padre, Nonpareil, Sauret 2 and Monterey all produced over 3,000 kernel pounds per acre (Table 2). In this trial Price has not shown as clear an alternate bearing pattern as in the CSU,Chico planting, and Sonora has had only one poor crop (1993) in the past six years. Seven varieties were added to this planting in 1984. These varieties produced their heaviest crops in 1994 with all but Pearl having excellent to good production. Pearl continued to be the lowest yielding of this group.

A number of varieties in this trial produced a significant percentage of double kernels, but not as high as in 1993. Those with the greatest percentages of double kernels in 1994 were Dottie Won and Pearl (18%), Valenta (16%), Peerless and Price (12%) and Monterey and Ne Plus Ultra (10%). No variety in this trial had more than 2% worm damage in 1994. Jordanolo had 16% gummy kernels. Like at the CSU,Chico trial, several varieties had a significant percentage of kernels with some shrivel. These were Ruby (20%), Fritz (18%), Valenta and Wood Colony (16%) and Mission and Padre (14%).

New Regional Variety Trials.

Three new RVT's were planted in 1993 at CSU,Chico, San Joaquin Delta College (Manteca) and Paramount Farming (Kern County). The same varieties were planted in each of these trials with only a couple of exceptions. Varieties in these trials are Nonpareil and Mission as standards, Butte, Carmel, Fritz

(except Chico), Monterey, Padre, Price, and Sonora as "new standards", seventeen test varieties (mostly newer ones) and six numbered selections. Trees in these plantings generally are growing well. Trees of a few varieties were added in 1994 to complete the plots, and a few trees are still needed at Delta College. Replacement trees have been and will continue to be planted as necessary. Yield and nut characteristic and quality data will be taken as soon as trees begin significant production, possibly as early as 1995.

Pollination.

Studies on the cross-compatibility of a number of varieties, especially newer ones, were continued. At one time Rosetta was believed to be in the Ne Plus Ultra pollination group; however, recent studies have raised questions about this classification and further work will be needed to clarify the cross-compatibility status of this variety. From 1994 studies, Aldrich appeared to be cross-compatible with Fritz, Price and Rosetta while Livingston showed cross-compatibility with Butte, Mono and Padre. Test crosses between Butte and Monterey again gave questionable results; thus, this combination should not be planted in the same orchard unless other compatible varieties with coincident bloom are also included to insure cross-pollination.

Rootstock Plots.

Four rootstocks (Bright's hybrid, Hansen Hybrid, Lovell peach and Nemaguard peach) were compared during their ninth growing season in a test plot in western Fresno County. Based on trunk circumference, the two hybrid rootstocks produced trees that were significantly larger than those on Lovell which gave significantly larger trees than did Nemaguard; although, numerically the difference between the two peach rootstocks was not great (Table 3). In 1994 trees on Bright's hybrid out-produced those on the other three rootstocks. It was evident when evaluating the data from this trial that while trees on hybrid rootstock out-produced those on peach rootstock (on a per tree basis), trees on hybrid were also larger and their greater production was a result of this larger tree size and not that they were inherently more productive if the size factor was removed.

Trees on six rootstocks growing in a sandy soil in Merced County were compared in 1994, their sixth growing season. The rootstocks compared were Nemaguard, Red-Leafed Nemaguard, Lovell and Halford peach and Bright's and Hansen peach-almond hybrids. With Nonpareil, because of variability, there was no significant different in tree size between the rootstocks. However, Nonpareil trees on Halford and Hansen out-produced those on Nemaguard and Bright's, with the other two rootstocks being intermediate (Table 4). With Carmel, while there was no significant differences in yield, trees on Bright's were significantly larger than those on the four peach rootstocks, with trees on Hansen being intermediate.

As indicated in last years report, yield data is no longer being collected from a 1982 planting at the Nickels Soil Laboratory in Colusa County to evaluate the compatibility of thirteen varieties on Marianna 2624. However, for reference, table 5 lists average yield from these trees for the eight year period from 1985 through 1992. Tree size as measured by trunk circumference is also shown, but is not necessarily a good measure of delayed compatibility. Tree size characteristics of the variety and cropping potential may be as important as delayed compatibility on tree size. Varieties, such as Jeffries, that did not survive the early years are the most incompatible on Marianna 2624. In addition some trees of Mono, Dottie Won, Livingston and Sauret 2 did not survive the early years.

Early defoliation is one indication of incompatibility. On November 21 all varieties except Norman, LeGrand and Ruby had moderate to complete defoliation (Table 5). Another indication of possible incompatibility is overgrowth at the graft union. Dottie Won, Livingston, Ruby and Norman had trees with the largest overgrowth at the union. Regardless of their compatibility on Marianna 2624, LeGrand, Monarch, Planada and Ripon have undesirable characteristics that limit their usefulness in commercial plantings.

In 1986 a planting was established at the Nickels Soil Laboratory to determine the compatibility of nine newer varieties on Marianna 2624. In this planting in 1994 Sonora, Wood Colony and Butte were the

highest yielding, while Aldrich, Butte and Monterey had the highest accumulated production for the four previous years (Table 6). On the other hand, Grace, Valenta and Solano have consistently had the lowest production. Butte, Sonora and Solano have made the largest trees (based on trunk circumference), while Monterey and Aldrich were the smallest.

Monterey and Valenta were almost completely defoliated on November 21 with Solano and Bonita also showing considerable defoliation (Table 6). Trees of Wood Colony and Bonita had the largest overgrowth at the graft union, while Aldrich, Valenta, Grace and Monterey trees had the least overgrowth. All trees of Pearl, a tenth variety originally in this planting, died when the trees were young.

As with the 1982 planting, various measures of possible graft incompatibility are not consistent -- some varieties rate good by one index and poor by another -- which complicates trying to classify varieties as to their compatibility on Marianna 2624. Another complicating factor can be virus and MLO disorders, some of which have been reported to cause incompatibilities. Thus, it is hard to accurately determine which varieties will do well on this rootstock.

Several selections of Marianna and other plum rootstocks were planted in 1989 at the Nickels Soil Laboratory to determine their compatibility with Nonpareil and Mission. With Nonpareil none of these experimental rootstocks were any better, if as good, than Marianna 2624 (a known incompatible combination). Thus, the Nonpareil portion of this trial has been discontinued and the trees removed.

With Mission several of the experimental rootstocks have shown promise. In growth and vigor ratings selection 40 was equal to Marianna 2624 and these two were followed closely by selections 69, 65, 64 and Corrotta Marianna (Table 7). Selections 30 and 9 and P. salicina showed poor to fair vigor and growth. Selections 75, 58, 30 and P. salicina had a high percentage of trees with a large overgrowth at the graft union, while selections 30 and 58 also had several trees showing gumming at the union. Twenty-five percent of the trees on Corrotta Marianna died when they were young. The largest trees in the planting are on Marianna 2624, Corrotta Marianna, and selections 58, 40 and 65. The smallest trees are on selection 30, P. salicina and selection 9, probably a result of poor compatibility with Mission almond.

At this time the most promising selections appear to be 40, 65, 69 and possibly 64. However, none of these appeared to be much superior to Marianna 2624, unless they produce few root suckers -- root suckers are a major disadvantage of Marianna 2624. Sucker production needs to be further evaluated with almond on these rootstocks.

Trials were initiated in 1989 in both Colusa and Butte Counties to determine if longer interstocks (8 to 10 inches or scaffold budding) of Havens 2B plum between Nonpareil and Marianna 2624 improved compatibility over shorter (4 inch) interstocks. A second objective was to determine if a long interstock of a compatible almond variety would work as well or possible even better than Havens 2B.

In the Colusa plot trees of Nonpareil directly on Marianna 2624 and those with a 10 inch Mission interstock have performed poorly giving weak growth with off-colored foliage and have been the earliest to defoliate. The best treatments have been the scaffold and 10 inch interstocks of Havens 2B and the scaffold interstock of Jordanolo. Other interstocks have been intermediate in performance. In the Butte plot differences have been much less pronounced; although, trees of Nonpareil directly on Marianna 2624 have done the poorest as would be expected.

Dissemination of Information:

In an effort to make information developed from this project available to almond growers and others associated with the almond industry, at least ten presentations were made at grower/industry meetings during 1994. Several articles or reports were also published. Two chapters for the revised almond manual (Almond Orchard Management) are in press. These chapters covering varieties and rootstocks, contain a large amount of information developed from this project.

Table 1 **1994 Yield Summary for the Almond Regional Variety Trial at California State University, Chico**

Variety	No. of Nuts/Tree	Average Kernel Weight(g)	Kernel Pounds Per Tree	Kernel Pounds Per Acre
1976 Planting				
Early Bloom Varieties				
Sonora	18,140	1.09	43.6	3,266
Ne Plus Ultra	11,426	1.35	34.0	2,548
Mid Blooming Varieties				
Price	18,673	0.90	37.0	2,776
Carmel	14,959	1.08	35.6	2,669
Fritz	16,490	0.97	35.2	2,642
Nonpareil	11,641	1.23	31.4	2,358
Norman	12,246	0.94	25.4	1,902
Late Blooming Varieties				
Butte	20,127	0.93	41.2	3,092
Padre	18,009	0.92	36.5	2,737
Carrion	14,584	1.12	36.0	2,698
Mission	11,872	1.08	28.2	2,116
1987 Planting				
Aldrich	12,511	0.93	25.6	1,922
Mono	10,611	1.05	24.5	1,840
Ruby	8,309	1.20	22.0	1,647
Rosetta	8,064	1.22	21.7	1,625

Table 2 **1994 Yield Summary for the Almond Regional Variety Trial at San Joaquin Delta College, Manteca**

Variety	No. of Nuts/Tree	Average Kernel Weight(g)	Kernel Pounds Per Tree	Kernel Pounds Per Acre
1978 Planting				
Early Blooming Varieties				
Sonora	22,633	1.06	52.8	3,963
Ne Plus Ultra	11,776	1.21	31.4	2,354
Peerless	10,714	1.08	25.5	1,911
Jordanolo	7,728	1.44	24.5	1,838
Mid Blooming Varieties				
Nonpareil	17,936	1.16	45.8	3,431
Sauret 2	16,359	1.23	44.3	3,324
Monterey	14,702	1.33	43.1	3,230
Carmel	16,746	1.08	39.8	2,988
Sauret 1	13,289	1.17	34.2	2,569
Price	15,061	1.01	33.5	2,513
Fritz	13,348	1.02	30.0	2,249
Late Blooming Varieties				
LeGrand	20,837	1.14	52.3	3,924
Ruby	19,682	1.16	50.3	3,772
Livingston	18,929	1.18	49.2	3,690
Mono	21,634	1.00	47.7	3,574
Butte	22,237	0.97	47.5	3,563
Padre	22,663	0.92	45.9	3,444
Mission	16,403	1.07	38.7	2,906
Thompson	16,269	1.08	38.7	2,903
Tokyo	12,755	1.18	33.2	2,486
1984 Planting				
Valenta	16,973	1.00	37.4	2,804
Rosetta	13,472	1.24	36.8	2,760
Dottie Won	16,036	1.04	36.7	2,755
Jeffries	11,020	1.21	29.4	2,203
Aldrich	13,276	0.97	28.4	2,127
Wood Colony	8,899	1.32	25.9	1,940
Pearl	6,998	0.97	15.0	1,121

Table 3 **1994 Yield and Tree Growth Data for Almond Rootstock Trial Planted in 1986, Harris Ranch, Coalinga, CA**

	Nonpareil Variety	
Rootstock	**Yield Kernel Pounds/Ac.**	**Trunk Circumference (cm)**
Bright's Hybrid	3,756 a[1]	71.2 a
Hansen Hybrid	3,305 b	72.3 a
Lovell	2,886 b	63.9 b
Nemaguard	3,168 b	61.7 c

[1]Numbers within columns followed by the same letter are not significantly different at the 5% level

Table 4 **1994 Yield and Tree Growth Data for Almond Rootstock Trial Planted in 1989, Arnold Farms, Atwater, CA**

	Nonpareil		Carmel	
Rootstock	**Yield Kernel Pounds/Ac.**	**Trunk Circumference (cm)**	**Yield Kernel Pounds/Ac.**	**Trunk Circumference (cm)**
Bright's Hybrid	851 b[1]	56.4 a	764 a	55.6 a
Hansen Hybrid	1,086 a	54.4 a	847 a	52.8 ab
Nemaguard	896 b	54.0 a	787 a	49.0 b
Red-leafed Nemaguard	1,004 ab	53.2 a	813 a	50.6 b
Halford	1,105 a	52.7 a	679 a	49.8 b
Lovell	938 ab	51.4 a	670 a	48.7 b

[1]Numbers within columns followed by the same letter are not significantly different at the 5% level.

Table 5 **Tree size, compatibility and yield data from the 1982 planting to study almond variety compatibiity on Marianna 2624. Nickels Soil Laboratory, Arbuckle.**

Variety	1994 Trunk Circ. (cm)	Defoliation Rating[1]	Union Rating[2]	Average Yield Kernel lbs. Per Tree 1985-92	Tree Survival
Ripon	76.9	1.0	1.0	6	8 of 8
Monterey	76.6	1.0	2.0	10	8 of 8
Planada	75.7	1.0	2.0	8	4 of 4
Livingston	74.2	2.0	3.0	8	6 of 8
Mono	71.3	1.0	2.0	7	5 of 8
Norman	70.7	3.0	2.5	6	8 of 8
LeGrand	70.2	3.0	1.8	8	8 of 8
Fritz	69.3	1.0	2.0	10	8 of 8
Monarch	67.9	1.5	1.5	6	4 of 4
Mission	65.7	1.0	1.5	9	8 of 8
Sauret #2	63.2	1.2	2.0	7	10 of 12
Ruby	62.9	3.0	2.8	9	8 of 8
Dottie Won	62.5	1.0	3.0	5	6 of 8

[1]Defoilation Rating on 11-21-94
1 = Mostly defoliation
2 = Moderate defoliation
3 = Little defoliation

[2]Union Rating on 11-21-94
1 = Slight to no overgrowth
2 = Moderate overgrowth
3 = Large overgrowth

Table 6 **Yield, compatibility and tree size data from the 1986 planting to study almond variety compatibility on Marianna 2624. Nickels Soil Laboratory, Arbuckle.**

Variety	No. of Trees	Yield in kernel pounds/tree		1994 Trunk circ. (cm)	Defoliation Rating[1]	Union Rating[2]
		1994	total 1990-93			
Sonora	8	18	25	63.9	2.9	2.2
Wood Colony	6	17	27	58.2	2.8	2.9
Butte	4	15	30	64.0	2.8	2.1
Monterey	5	14	29	55.0	1.0	1.7
Bonita	3	14	25	57.9	2.3	2.5
Aldrich	7	12	33	55.3	3.0	1.2
Solano	3	12	19	63.0	2.0	2.0
Grace	8	10	16	61.9	2.5	1.6
Valenta	7	8	22	59.0	1.0	1.5

[1]Defoliation Rating 11-21-94
1 = Mostly defoliated
2 = Moderate defoliation
3 = Little defoliation

[2]Union Rating 11-21-94
1 = Slight to no overgrowth
2 = Moderate overgrowth
3 = Large overgrowth

Table 7 **Growth and vigor rating, union evaluation and tree size data from 1989 planting to evaluate performance of Mission almond on Marianna selections and other plum rootstocks. Nickels Soil Laboratory, Arbuckle.**

Rootstock	Growth/Vigor Rating[1]	% of Trees With Large Overgrowth at Union	% of Trees With Gumming at Union	Trunk Circ. (cm)	% Tree Survival[2]
9	2.0	11	0	39.4	100
16	2.3	0	0	44.4	100
30	1.0	56	33	24.3	100
40	2.9	0	0	50.4	100
58	2.5	92	25	51.6	100
64	2.6	0	0	46.3	100
65	2.7	0	0	50.3	100
69	2.8	0	8	48.7	100
75	2.4	100	0	48.9	100
Cor. Marianna	2.7	33	11	52.4	75
P. Salicina	1.2	56	11	30.8	100
Marianna 2624	2.9	0	0	52.6	100

[1]Growth/Vigor Rating
1 = Poor growth/vigor
2 = Fair growth/vigor
3 = Good growth/vigor

[2]Started with either 9 or 12 trees of each rootstock.