Annual Report to the Almond Board of California **May 1, 2002**

Project: Field Evaluation of Almond Rootstocks

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Four Regional Rootstock Trials were established in Butte, Colusa, Kern, and San Joaquin counties. Rootstock effects evaluated in these ongoing trials include rootstock influence on growth, height, bloom timing, harvest maturity, yield, and nut quality. Another continuing aspect of this project includes preliminary investigations into alternative rootstocks for almond. Evaluation of Deep Purple and Hiawatha plum rootstocks, compatibility studies of newer varieties on Marianna 2624 plum and performance of other hybrid rootstocks is continuing.

Objectives:

1. Collect and summarize data from Regional Rootstock Trials in Butte, Colusa, Kern, and San Joaquin counties.

1A. Summary report of the additional 1996 Tejon Rootstock Trial in Kern County.

2. Evaluate the compatibility and field performance of Deep Purple, Hiawatha, and other plum rootstocks for almond, study the compatibility of newer almond varieties on Marianna 2624 plum, and evaluate other new hybrid rootstocks.

Results:

1. Regional Rootstock Trials

Each regional rootstock trial site was selected for a specific challenge to the rootstocks such as the need for better anchorage, bacterial canker resistance, and tolerance to shallow soils or high rainfall environments. Desirable rootstock characteristics will be evaluated in these ongoing trials as the trees mature. Observations will include influence on growth, size, yield, bloom timing, harvest maturity, nut quality, and tree survival as opportunities for evaluation occur. Information developed will be useful in adapting orchards to the diverse environments where California almonds are grown.

Although not all rootstocks are in all trials, the peach rootstocks; 'Nemaguard', 'Lovell', and 'Guardian', the peach x almond hybrids; 'Hansen 536', 'Hansen 2168', 'Bright's' and 'Nickels' (UC 1-82), and the interspecific (peach x almond x plum x apricot) hybrids; 'Viking' and 'Atlas' are included.

Methods

Trees for these trials were grown by commercial nurseries and were planted bare root in cooperators fields as conditions permitted. The scion variety in the Kern trial is 'Butte' while the scions in the other three trials are 'Nonpareil'. All orchards are managed under normal commercial irrigation, fertilization, pruning, disease and pest control practices.

Due to a very wet spring, the Butte County trial was planted with dormant trees from cold storage in May 1998. 'Bright's', 'Hansen 536', 'Nickels', 'Atlas', 'Viking', 'Guardian', 'Nemaguard', and 'Lovell' rootstocks are included. The block is planted on a deep loam soil in a high rainfall area and is irrigated with solid set sprinklers. Sixty trees of each rootstock were planted in 10 replications of six trees with the exception of the 'Nickels' stock where 10 replications of 3 trees were used.

The Colusa County trial was planted in March 1997. 'Bright's', 'Hansen 536', 'Nickels', 'Atlas', 'Viking', 'Nemaguard', and 'Lovell' rootstocks are included. The block is on shallow soil with a hardpan that was slip plowed prior to planting. It is irrigated with dual microsprinklers. Sixty-four trees of each rootstock were planted in 8 replications of 8 trees each.

The Kern County orchard was established in February 1997. It includes, 'Bright's', 'Hansen 536', 'Hansen 2168', 'Nickels', 'Viking', 'Atlas', and 'Nemaguard' rootstocks. 'Nickels' was planted a year later in 1998. The orchard is irrigated with solid set sprinklers. Large plots designed to evaluate the resistance of each rootstock to "Santa Ana" windstorms were planted on very deep sandy soils a few miles north of the Tehachapi Mountains. The trial was planted at 30 trees per plot each replicated six times with the exception of 'Nemaguard' and 'Nickels' which are replicated five times and 'Hanson 2168' replicated three times.

Planted in March 1998, the San Joaquin County trial included: 'Bright's', 'Hansen 536', 'Nickels', 'Atlas', 'Viking', 'Guardian', 'Nemaguard', and 'Lovell' rootstocks. Designed to document relative rootstock tolerance to the bacterial canker complex, a second-generation peach orchard with severe bacterial canker was removed the year prior to trial establishment and the sandy soil was solid fumigated (tarped) with methyl bromide. Fifty trees of each rootstock were planted in a commercial orchard with 'Carmel' and 'Sonora' as pollinators.

Field trials in all counties were planted using a randomized complete block design. To provide uniform pollination and maximum yield potential pollenizer rows are planted on both sides of the scion cultivar used for data collection and beehives are moved into all orchards during bloom. Analyses of variance and mean separation was done by using either Duncan's multiple range test, the least significant difference test, or Fishers protected LSD.

Results

Rootstock effects evaluated so far in these ongoing trials include rootstock influence on tree establishment, growth, height, yield, and tree survival.

Tree mortality at planting, shown in Table 1, indicates significant tree losses occurred initially on 'Viking' and 'Atlas'. Mortality of trees on all other rootstocks was commercially acceptable. The 'Bright's', 'Hanson 2168' and 'Nemaguard' rootstocks had similar mortality. When replanted directly from the nursery in February 1999 and 2000 both 'Viking' and 'Atlas' established successfully.

Table 1. Percent mortality: tree losses at planting in various locations.

Rootstock	Planted in Butte Co. May 1998	Planted in San Joaquin Co. March 1998	Planted in Kern Co. February 1997	Planted in Colusa Co. March 1997
Bright's Hybrid	0	0	6.1	1.6
Hansen 536	0	0	0	0
Hansen 2168	***	***	4.5	***
Nickels (1-82)	3.3	0	*	0
Viking	58.3	42.0	13.3	3.1
Atlas	25.0	0	0	0
Guardian	0	0	***	***
Nemaguard	0	0	5.6	0
Lovell	1.7	0	***	1.6

* Planted one year later. *** Rootstock not in the trial.

Overall, tree trunk circumference on 'Hansen 2168', 'Hansen 536', and 'Nickels' was frequently larger than for trees on the other rootstocks. In Butte County (Table 2), 'Hansen 536' was largest in circumference followed by 'Nickels' and 'Nemaguard'. There was little difference in tree size between the seven rootstocks in the Colusa trial (Table 3) with the 'Hansen 536' significantly larger than the others. In Kern County, the 'Atlas', 'Hansen 2168', and 'Hansen 536' were significantly larger than 'Bright's' and 'Nemaguard' for the first three years (Table 4) but by the fourth season there were no significant differences in trunk growth among any rootstocks. After the fifth season the Hansen 536 rooted trees were larger while the Bright's and Nemaguard rooted trees were smaller.

Table 2. Butte County mean trunk circumference (cm).

Following: Rootstock	Planting June 1998	1st Season April 1999	2nd Season October 1999	3rd Season October 2000	4th Season October 2001
Bright's Hybrid	4.07 bc*	9.77 bc	20.75 c	35.88 c	47.90 cd
Hansen 536	4.34 b	11.31 a	24.50 a	41.32 a	54.12 a
Nickels (1-82)	5.22 a	10.79 ab	23.17 ab	38.79 b	51.34 b
Viking	4.50 b	9.11 c	21.24 c	36.35 c	47.82 cd
Atlas	4.33 b	10.06 bc	21.98 bc	36.16 c	46.33 d
Guardian	3.52 c	10.01 bc	22.02 bc	36.42 c	47.01 d
Nemaguard	3.74 c	10.79 ab	23.17 ab	38.45 b	49.76 bc
Lovell	3.94 bc	9.67 bc	21.33 c	35.86 c	46.58 d
LSD P< 0.01	0.53	1.11	1.33	1.79	2.01

* Values followed by the same letters are not statistically different as measured by Duncan's Multiple Range test.

Table 3. Colusa County mean trunk circumference in centimeters.

Following:	2nd Season	3rd Season	4th Season	5th Season
Rootstock	August 1998	Fall 1999	Fall 2000	Fall 2001
Bright's Hybrid	19.7	32.4	45.3 ab*	53.6 b
Hansen 536	21.2	35.1	47.9 a	56.2 a
Nickels (1-82)	20.4	33.9	44.6 b	52.6 bcd
Viking	20.7	33.4	42.8 b	51.7 bcd
Atlas	20	32.4	42.2 b	50.5 d
Nemaguard	19.9	33.5	42.2 b	52.0 bcd
Lovell	20.5 ns	33.6 ns	42.2 b	51.1 cd

* Values followed by the same letters are not statistically different as measured by Fishers Protected LSD at $P < 0.05$.
ns - Not significantly different

Table 4. Kern County mean trunk circumference in centimeters.

Following:	.1st Season	2nd Season	3rd Season	4th Season	5th Season
Rootstock	Fall 1997	Fall 1998	Fall 1999	Fall 2000	Fall 2001
Bright's Hybrid	9.34 c*	22.24 b	34.57 d	48.91	54.1 b
Hansen 536	12.71 a	27.73 a	41.85 a	48.10	63.0 d
Hansen 2168	12.41 a	27.61 a	41.65 ab	51.41	61.8 cd
Nickels (1-82)	**	12.79 c	26.17 e	46.36	50.4 a
Viking	11.08 b	25.50 a	37.72 c	51.35	59.1 c
Atlas	12.38 a	26.11 a	38.85 bc	52.47	58.3 c
Nemaguard	8.95 c	21.81 b	34.10 d	48.01 ns	54.2 b

* Values followed by the same letters are not statistically different as measured by the least significant difference test at $P< 0.05$ or, are ns, not significantly different.
** This rootstock was planted in 1998, one year later than the others.

Although San Joaquin trees are larger on 'Nickels' and are smallest on 'Guardian', size differences between rootstocks are still small at this point (Table 5). Prior to harvest in 2000, five trees on 'Hansen 536' rootstock began defoliating prematurely. Excavation around the crowns revealed significant crown gall on two of the five trees. In 2001, leaf symptoms were more widespread and involved rootstocks other than 'Hansen 536'. On September 4, 2001, trees with leaf symptoms and significant defoliation were counted. Twenty-eight percent of trees on 'Hansen 536' were affected, as were 15% on 'Nickels' and 4% on 'Lovell'. A few trees on 'Lovell' outside of the trial showed similar leaf symptoms. Excavation around several affected trees did not reveal more crown gall. Soil samples indicated very low levels of parasitic nematodes on affected trees. At this point, the cause of the foliar symptoms is unknown. To date, no signs of bacterial canker are evident in the trial.

Table 5. San Joaquin County mean trunk circumference (cm).

Following:	2nd Season	3rd Season	4th Season
Rootstock	October 1999	October 2000	October 2001
Bright's Hybrid	25.7 b[x]	36.1 c[y]	44.1 abc
Hansen 536	29.0 a	38.9 ab	43.5 abcd
Nickels (1-82)	28.9 a	39.8 a	45.3 a
Viking	25.4 b	35.3 c	44.6 ab
Atlas	26.2 b	36.0 c	43.0 bcd
Guardian	25.2 b	35.1 c	41.6 d
Nemaguard	25.3 b	35.8 c	43.3 abcd
Lovell	26.4 b	36.9 bc	41.9 cd

Values followed by the same letters are not statistically different as measured by:

[x] the least significant difference test at $P< 0.05$.

[y] Duncan's Multiple Range test at $P< 0.05$.

Tree height measurements (Table 6) made following the second or fourth growing seasons showed significant differences between rootstocks. Trees on 'Hansen 536' or 'Hansen 2168' were taller than trees on other rootstocks in three of the four trials. Trees on 'Bright's', 'Viking', and 'Nemaguard' were often shorter than trees on other stocks. Tree height averaged five meters following the 5th growing season in the Kern trial, and, there were no significant differences between rootstocks.

Table 6. Mean tree height (meters) at various ages and locations.

Following:	2nd Season San Joaquin Co.	4th Season Butte Co.	4th Season Colusa Co.	4th Season Kern Co.
Rootstock	October 1999	February 2002	Fall 2000	Fall 2000
Bright's Hybrid	3.1 d[x]	4.77 b[y]	5.18 ab[z]	4.76 abc[x]
Hansen 536	3.4 ab	5.09 a	5.27 a	4.93 a
Hansen 2168	***	***	***	5.06 a
Nickels (1-82)	3.5 a	4.65 b	5.06 bc	4.47 c
Viking	3.1 d	4.80 b	5.09 bc	4.83 ab
Atlas	3.3 bc	4.72 b	5.06 bc	4.94 a
Guardian	3.3 bc	4.65 b	***	***
Nemaguard	3.2 cd	4.80 b	5.03 c	4.57 bc
Lovell	3.3 bc	4.71 b	5.18 ab	***

Values followed by the same letters are not statistically different as measured by:

[x] the least significant difference test at $P< 0.05$.

[y] Duncan's Multiple Range test, $P< 0.05$.

[z] Fishers Protected LSD at $P < 0.05$.

*** Rootstock not in the trial.

The initial harvest of trials in the third and fourth growing seasons found that yield on 'Atlas' was often significantly greater than the yield on other rootstocks (Tables 7 & 8). The yield of trees on 'Bright's' hybrid rootstock was often significantly lower than on other rootstocks. There were no significant differences between rootstocks in kernel weight or in percent open suture. Likewise, no obvious rootstock effects were observed in nut maturity or nut removal.

In the San Joaquin trial, 2001 'Nonpareil' bloom was very light. Although no data were recorded, observations indicated trees on 'Hansen 536' also had particularly light bloom, especially in the sandiest areas of the trial. Overall, yields in this orchard were relatively low compared to most other 4th leaf orchards in the area with similar tree size. 'Atlas' and 'Guardian' rootstocks had the highest yields while 'Viking' and 'Hansen 536' had the lowest yields (Table 8). Yield information may be misleading for 'Viking' due to the high number of replanted trees that are one year younger than the rest of the trial.

Kernel quality effects were also noted this year in the San Joaquin trial (Table 9). This orchard had a usually high rate of wrinkled kernels, a problem not uncommon in flood-irrigated orchards grown in sandy soil. Trees on 'Guardian' rootstock had the most wrinkled kernels (44.2%) and 'Hansen 536' had the least (29.0%). Trees on 'Bright's' had the most doubles (7.6%).

Table 7. Mean yield (pounds kernel/tree) at various ages and locations.

Rootstock	3rd Season Kern Co. '99	4th Season Kern Co. '00	4th Season Colusa Co. '00	5th Season Colusa Co. 2001
Bright's Hybrid	2.60 c[x]	6.64 b[x]	4.75 cd[z]	8.6 cd[z]
Hansen 536	5.03 ab	9.59 b	5.94 ab	9.5 abc
Hansen 2168	5.56 [xx]	10.55 [xx]	****	****
Nickels (1-82)	[yy]	3.68 [yy]	5.65 bc	8.8 bcd
Viking	3.04 c	7.95 b	6.47 ab	9.8 abc
Atlas	6.06 a	12.55 a	6.96 a	10.2 ab
Nemaguard	3.79 bc	8.62 b	4.55 cd	8.4 cd
Lovell	****	****	6.51 ab	10.3 a

Values followed by the same letters are not statistically different as measured by:

[x] the least significant difference test at $P < 0.05$.

[z] Fishers Protected LSD at $P < 0.05$.

[xx] not included in analysis, only two replicates.

[yy] not included in analysis, trees one year younger.

**** Rootstock not in the trial.

Table 8. Mean yield (pounds kernel/tree) at various ages and locations.

	3rd Season 2000	4th Season 2001	4th Season 2001
Rootstock	Butte Co.	Butte Co.	San Joaquin Co.
Bright's Hybrid	0.72 c[y]	8.10 c[y]	7.1 bc[y]
Hansen 536	1.24 ab	9.28 c	6.4 c
Nickels (1-82)	1.00 b	9.39 bc	7.5 bc
Viking	1.24 ab	8.59 c[x]	5.7 c[x]
Atlas	1.45 a	10.95 a	9.7 a
Guardian	1.26 ab	8.40 c	9.3 a
Nemaguard	1.16 ab	10.64 ab	8.4 ab
Lovell	1.09 b	8.34 c	8.8 ab

[y] Values followed by the same letters are not statistically different as measured by Duncan's Multiple Range test, $P \leq 0.05$.

[x] Due to high mortality at original planting, yield includes many 3rd leaf trees.

Table 9. Nonpareil Kernel quality on various rootstocks. San Joaquin Co., 2001.

	Wrinkled kernels(%)	Double kernels (%)
Bright's Hybrid	39.0 ab[x]	7.6 a
Hansen 536	29.0 b	2.6 b
Nickels (1-82)	40.8 a	4.0 b
Viking**	43.4 a	1.6 b
Atlas	41.4 a	2.8 b
Guardian	44.2 a	2.0 b
Nemaguard	38.0 ab	2.4 b
Lovell	38.6 ab	2.2 b

[x] Data followed by the same letters are not significantly different as measured by Duncan's Multiple Range Test ($P \leq 0.05$).

At the beginning of the fourth growing season in the Butte County trial, North winds blew for three days with gusts averaging 20 to 30 miles per hour. With the weight of the first substantial crop on the limbs, this wind resulted in splitting of primary scaffolds and loss of entire trees. Table 10 shows the percent of trees on various rootstocks that split and were lost. Substantial tree losses occurred especially on 'Hansen 536' but trees were also lost on 'Bright's', 'Nemaguard', 'Nickels', and 'Atlas' rootstocks. Yield per TREE SITE shown in this table provides a realistic illustration of the impact of both tree losses at planting and splitting losses in the 4th leaf. Compare this to Butte County yield per tree shown in Table 8.

Table 10. Effects of tree losses at planting and during 4th leaf windstorm on the average yield per TREE SITE (Butte County Rootstock Evaluation).

Rootstock	% Split & Lost[1] May 2001	Pounds of kernel per Tree Site[2] 2001 -- 4th growing season
Bright's Hybrid	12.4	7.14
Hansen 536	22.6	7.17
Nickels (1-82)	8.0	8.51
Viking	0	5.62
Atlas	6.3	8.32
Guardian	3.1	8.10
Nemaguard	10.6	9.47
Lovell	0	8.34

[1] Tree losses during May 2001 are due to splitting in the 4th growing season. North wind blew for three days with gusts averaging 20 to 30 miles per hour.
[2] Provides a comparison between rootstocks on the real effects on production following the tree losses experienced at both planting and in the 4th leaf.

Discussion

The results on tree mortality, growth, height, yield, tree survival, and nut quality are site specific during these early years of tree development. The mortality of trees at planting was higher on 'Viking' and 'Atlas' than on any other rootstocks possibly due to sensitivity to drying during planting or cold storage. In Colusa County, trees on 'Atlas', 'Bright's' and 'Nickels' rootstocks were initially slightly delayed in flowering but there were no differences in bloom timing between any of the rootstocks by full bloom and petal fall. No measurable differences in crop maturity were found. Possibly tree vigor on all rootstocks in these young orchards has minimized differences. As observations continue, consistent trends among the four sites may become more apparent.

Yield is often the horticultural characteristic that determines commercial rootstock selection. Another important evaluation is tree loss after establishment. This factor is especially significant since tree attrition can reduce or eliminate the profitability of an entire orchard. Rootstocks that contribute to this problem may not be commercially viable even if other factors such as yield per tree appear positive. Rootstock selection for a new orchard should consider the factors that go along with site selection rather than the standard in a particular region.

1A. **1996 Tejon Rootstock Trial - Mario Viveros, Farm Advisor, Kern County**

This trial was planted at a density of 90 trees per acre in 1996 with the Atlas and Hansen 2168 rootstocks planted a year later in 1997. It uses a completely randomized block design with four replications of the 'Butte' almond variety planted on six rootstocks. This plot was planted in a location where 'Santa Ana' windstorms have occurred in the past and have caused substantial tree losses. This trial was designed to test the anchorage provided by the various rootstocks and their ability to withstand the 'Santa Ana' winds. Trunk circumference, tree height, kernel weight, open suture, yield, and anchorage have been evaluated.

	Trunk Circumference (cm)			
Rootstock	After 3rd Season 1998	After 4th Season 1999	After 5th Season 2000	After 6th Season 2001
Bright's	36.29 d	45.95 c	56.79 c	63.5 c
Hansen 536	38.92 e	49.84 d	59.52 d	66.8 d
Hansen 2168	25.66 b	40.26 b	53.28 b	61.8 c
Viking	34.44 c	44.51 c	55.92 c	60.6 bc
Atlas*	22.35 a	34.28 a	43.26 a	54.2 a
Nemaguard	34.06 c	45.02 c	53.50 b	58.1 b

* Trees are one year younger than trees on other rootstocks.

At the end of the fourth leaf, tree height averaged 4.88 meters, after five growing seasons height averaged 5.45 meters, and after six seasons, 5.3 meters. Tree height between rootstocks was not significantly different by this time. Likewise, the kernel weight and the percent of nuts with open sutures were both unaffected by rootstock selection.

	Yield in Pounds Kernel per Tree					**Yield**
Rootstock	**1998**	**1999**	**2000**	**2001**	**% Tree Loss**	**2001 - lbs/tree site****
Bright's	3.3	17.5 b	15.5 bc	16.0	13	14.4 d
Hansen 536	3.6	17.8 b	18.5 c	16.0	9.3	14.4 d
Hansen	---	8.0*	11.6 a	12.3	4.2	11.8 c
Viking	2.7	11.6 a	13.9 ab	14.0	4.2	13.5 cd
Atlas	---	7.1*	10.4 a	13.7	30	9.2 b
Nemaguard	3.1	16.2 b	13.9 ab	18.9 ns	58	6.8 a

*Atlas and Hansen 2168 are one year younger and are not included in the statistical analysis.
** Yields are based on the number of tree spaces per acre.

On March 4, 2001 this orchard experienced winds from the east gusting at 75 to 84 miles per hour from 12:30 p.m. until 6:00 p.m. with cumulative rainfall of 1.75 inches. Rootstock anchorage was challenged by these strong winds and the effects on 2001 yield per tree vs. yield per tree site are shown above while the effects on the trees themselves are shown below. When tree losses due to wind throw are taken into account the yield per tree site more accurately

reflects the impact of rootstock selection on the actual production in the orchard if indeed the entire orchard had been on the indicated rootstock. The windstorms effect on the trees is shown in the following table. In addition to the percent of trees blown over, damage to the primary scaffolds and the percent of trees leaning is also indicated.

Rootstock	Tree Age	% Trees blown over	% Broken primary scaffolds	% Trees leaning
Bright's	6th Leaf	12.96	0.12	0.58
Hansen 536	6th Leaf	9.26	0.93	0
Hansen 2168	5th Leaf	4.17	0.23	0.81
Viking	6th Leaf	4.17	0.58	0
Atlas	5th Leaf	30.00	0.93	1.85
Nemaguard	6th Leaf	58.00	0.35	0.81

2. Compatibility and field performance of 'Deep Purple', 'Hiawatha', and 'Marianna 2624' Plum, and other Rootstocks for Almonds

The USDA Agricultural Research Service has identified various plum type rootstocks, which show varying degrees of compatibility with Nonpareil. One of these, 'Deep Purple' (DP) (*Prunus besseyi x p.salicina*) has shown resistance to root knot and root lesion nematodes in field trials. The tolerance of this rootstock to oak root fungus is unknown. Another candidate is 'Hiawatha', also a plum type rootstock with similar parentage and characteristics. Researchers in France (INRA) have developed numerous peach/almond hybrid rootstocks with desirable characteristics, such as tolerance to drought, high pH soils and nematodes, and which also impart vigor to the scion. The most successful one of these, 'GF 677', is planted widely in Europe. Many newer almond varieties have not been fully evaluated on 'Marianna 2624'.

Objectives

A) Evaluate the compatibility of almond varieties on 'Marianna 2624', 'Deep Purple' and 'Hiawatha' plum rootstocks, and the performance of 'GF 677'. (J. Edstrom, Stan Cutter, Nickels Estate).

B) Evaluate the tolerance of 'Deep Purple' plum to oak root fungus and to heavy poorly drained soil and evaluate the compatibility of several varieties on this rootstock. (J. Connell, California State University Chico Farm, Hennigan Farms)

At Nickels, 'Nonpareil' trees grafted on 'Deep Purple' were provided by two sources, Fowler(Non F) and Burchell(Non B) nurseries. 'Nonpareil' on 'Marianna 2624', and 'Butte' and 'Nonpareil' on 'Hiawatha' have also been included. Additional evaluations of the newly developed cultivars, 'Durango'(Fowler) and 'Kochi'(Sierra Gold) on 'Lovell' are included. The new almond varieties on 'Marianna 2624' include 'Plateau', 'Winters'(13-1), and 'Avalon'. Varieties planted as standards on 'Marianna 2624' are 'Sonora' and 'Mission'.

Duarte nursery provided 'Nonpareil', 'Sonora', 'Carmel', 'Butte', and 'Peerless' trees on 'Deep Purple' plum in December 2000 for the Butte County oak root fungus and heavy soil challenges. Evaluation of the compatibility of some of these varieties on 'Deep Purple' is reported here.

Results

A) Nickels

Trees were evaluated in October 2001 after the second growing season to determine survivability and to rate tree size. Table 11 showing trunk circumference reveals the general performance of the scion rootstock combinations. Note that all 'Nonpareil' on 'Deep Purple' are dead, as are 55% of the 'Mission' trees. Similar poor performance was found at Nickels in a 1998 evaluation of 'Nonpareil' on 'Deep Purple' rootstock. 'Deep Purple' is not graft compatible with 'Nonpareil' in our tests.

'Marianna 2624' compatibility results are emerging. 'Nonpareil' on 'Marianna 2624' is beginning to fail as is the 'Plateau' variety. Several 'Plateau' on 'Marianna 2624' have died and the remaining trees are weak. 'Nonpareil' trees on a 'Padre' interstem on 'Marianna 2624' are all growing well. 'Avalon' and 'Winters'(13-1) are currently performing well on 'Marianna 2624' although they are still young trees as are the 'Sonora' and 'Mission' standards. Results are also promising for 'Nonpareil' and 'Butte' compatibility on the new plum rootstock, 'Hiawatha'.

Table 11. Plum Type Rootstocks - 2001 Trunk Circumference (cm).

Scion / Rootstock	Percent Mortality	Mean Circumference (Cm)
Mission / Marianna 2624	0	15.3
Sonora / Marianna 2624	0	16.6
Avalon / Marianna 2624	0	14.9
Plateau / Marianna 2624	33.3 (3/9)	13.4 *
Winters / Marianna 2624	0	15.9
Nonpareil (F) / Marianna 2624	44.4 (4/9)	14.3 *
Mission / Deep Purple	55.6 (5/9)	14.0 *
Nonpareil (F) / Deep Purple	100 (all)	**
Nonpareil (B) / Deep Purple	100 (all)	**
Nonpareil / Padre / Marianna 2624	0	17.6
Butte / Hiawatha	0	18.4
Nonpareil (F) / Hiawatha	0	17.0

* Dead trees in the plot are not included in measurements.
** All trees in the plot are dead

All 'Nonpareil' and 'Butte' trees on 'GF677', 'Hansen 536', and 'Lovell' rootstocks have continued to grow well this season. 'Kochi' on 'Lovell' is also growing well. 'Durango' on 'Lovell' has not grown as well and appears to be lower in vigor than the others.

B) CSUC Farm

Unfortunately, trees on 'Deep Purple' plum rootstock are not living long enough for oak root fungus to challenge them at the CSUC Farm. Many trees in this plot, planted in December 2000, are also declining and dying from graft union compatibility problems, as has been the case at Nickels. A brown line is visible in the wood at the graft union and as of late October 2001, 32 to 42 percent of the trees are weak, dead, or dying. This occurred on the 'Nonpareil', 'Sonora', and 'Carmel' varieties (Table 12). 'Deep Purple' does not appear to be a compatible rootstock for almond.

Table 12. Mortality of Almond on Deep Purple Plum Rootstock at the end of the first growing season, October 2001.

	Total	Weak		Dead or Dying		Total Weak, Dead, or Dying
	# Trees	(#)	%	(#)	%	%
Nonpareil / Deep Purple	31	(5)	16.1	(8)	25.8	41.9
Sonora / Deep Purple	19	(4)	21.1	(2)	10.5	31.6
Carmel / Deep Purple	10	(0)	0	(4)	40.0	40.0

Acknowledgement

The principal investigators in each of these trials wish to thank the Almond Board of California for their continued support. Your steadfastness is appreciated since it takes considerable time to begin to show differences between rootstocks as environmental conditions favoring one rootstock over another occur sporadically and at uncertain intervals. Observations on other limited rootstock tests are reported here as well when opportunities for their evaluation occur.