Annual Report to the Almond Board of California **May 1, 2003**

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, harvest maturity, yield, and nut quality. Another continuing aspect of this project includes preliminary investigations into alternative rootstocks for almond.

Objectives:

1. Collect Regional Rootstock Trial data in Butte, Colusa, Kern, and San Joaquin counties.
   1a. Summary report of the additional 1996 Tejon Rootstock Trial in Kern County.
   1b. San Joaquin County: recent performance of almond rootstocks in sandy soil.
   1c. Merced County Rootstock Trial – revisited in 2003 for long term observations.
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 tarp fumigated 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 in these ongoing trials include rootstock influence on tree establishment, growth, height, yield, and tree survival. For a more in-depth discussion of each of the trials listed above and the results of the trial to date, contact the farm advisor located in the county where the trial is planted.

Overall, tree trunk circumference on 'Hansen 2168', 'Hansen 536', and 'Nickels' was frequently larger than for trees on the other rootstocks. In Butte County, '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 1) 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 2)

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 1. 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 2. 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.

Tree height measurements (Table 3) 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 3. 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.

Table 4. Mean yield (pounds kernel/tree) in Colusa County.

	4th Season	5th Season	6th Season
Rootstock	2000	2001	2002
Bright's Hybrid	4.75 cd[z]	8.6 cd[z]	26.8
Hansen 536	5.94 ab	9.5 abc	27.9
Nickels (1-82)	5.65 bc	8.8 bcd	25.4
Viking	6.47 ab	9.8 abc	24.4
Atlas	6.96 a	10.2 ab	26.6
Nemaguard	4.55 cd	8.4 cd	25.9
Lovell	6.51 ab	10.3 a	24.7 ns

Values followed by the same letters are not statistically different as measured by:
[z] Fishers Protected LSD at $P < 0.05$.

Yields in the Colusa County orchard (Table 4) were high this year considering the age and tree density in this planting. Differences measured between the 7 rootstocks in both tree development and yields were not significant this year. Frequent application of irrigation water, nitrogen and potassium fertilizers via dual micro sprinklers may be moderating the differences in

growth rates between the rootstocks. Tree canopies need further expansion to fill the 24 X 22 ft spacing.

In the Butte County trial this year, the yield on 'Hansen' and 'Nemaguard' was significantly greater than the yield on other rootstocks (Tables 5). The yield of trees on 'Lovell' rootstock was significantly lower than on other rootstocks. Nonpareil bloom on Hansen and Nickels rootstocks appeared heavier and possibly slightly ahead of bloom on other rootstocks this year. Nonpareil on Atlas and Lovell seemed to be lighter in bloom than on other rootstocks and may also have been slightly behind the others. Bright's, Viking, Guardian, and Nemaguard appeared intermediate in both bloom density and timing. No obvious rootstock effects were observed in nut maturity or nut removal.

Table 5. Mean yield (pounds kernel/tree) Butte County.

	3rd Season	4th Season	5th Season
Rootstock	2000	2001	2002
Bright's Hybrid	0.72 c[y]	8.10 c[y]	18.54 b[y]
Hansen 536	1.24 ab	9.28 c	22.04 a
Nickels (1-82)	1.00 b	9.39 bc	19.36 b
Viking	1.24 ab	8.59 c[x]	17.72 b[x]
Atlas	1.45 a	10.95 a	19.35 b
Guardian	1.26 ab	8.40 c	17.52 b
Nemaguard	1.16 ab	10.64 ab	21.51 a
Lovell	1.09 b	8.34 c	15.40 c

[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 nuts from trees one year younger than others represented as a percent of the older trees yield.

Discussion

The results on tree mortality, growth, height, yield, tree survival, and nut quality are site specific during these early years of tree development. Yield is often the horticultural characteristic that determines commercial rootstock selection. 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. 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

1b. San Joaquin County: performance of almond rootstocks in sandy soil

Roger Duncan, UC Farm Advisor Stanislaus County; Paul Verdegaal, UC Farm Advisor, San Joaquin County; Bruce Lampinen, Dept. of Pomology, UC Davis; Darpinian and Sons, grower, October, 2002

There are two main objectives in this trial:

1. To document growth and yield characteristics of the Nonpareil almond scion on eight rootstocks growing in sandy soil.

2. To evaluate rootstock tolerance to the bacterial canker complex.

In the fall prior to trial establishment, a second generation peach orchard with a history of bacterial canker was removed and the soil was fumigated with a solid, tarped application of methyl bromide (400 lbs. per acre). On March 12, 1998, fifty Nonpareil almond trees on each of eight rootstocks were planted with Carmel and Sonora as pollinators. Presumably due to cold storage sensitivity, twenty-one of the fifty trees on Viking rootstock (42%) failed to grow and were replaced in February 1999. Replacement trees have grown well. We experienced no problems establishing trees on the other rootstocks.

Yield, trunk circumference and height for trees on the various rootstocks are listed in Table 1

below. Yield and trunk circumference are similar for most rootstocks. Trees on Nickels had the largest mean trunk circumference and numerically the highest yields. Viking had the lowest numerical yield, although these data are misleading because many Viking trees are one year younger than other rootstocks due to high mortality at planting.

Table 1. Yield and tree size of fifth-leaf Nonpareil almond on various rootstocks. Escalon, CA, 2002.

	Yield (meat lb / tree)	Trunk circumference (cm)	Tree Height (ft) March 1, 2002 (4th leaf)
Nickels	18.0 a*	55.2 a	14.7 bc
Atlas	16.7 ab	50.6 b	14.4 c
Nemaguard	16.4 ab	51.2 b	14.8 bc
Hansen 536	15.8 ab	52.3 b	15.0 b
Guardian	15.6 ab	50.8 b	15.0 b
Brights'	15.6 ab	51.9 b	14.8 bc
Lovell	14.2 ab	50.6 b	15.8 a
Viking**	13.3 b	50.9 b	14.7 bc

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

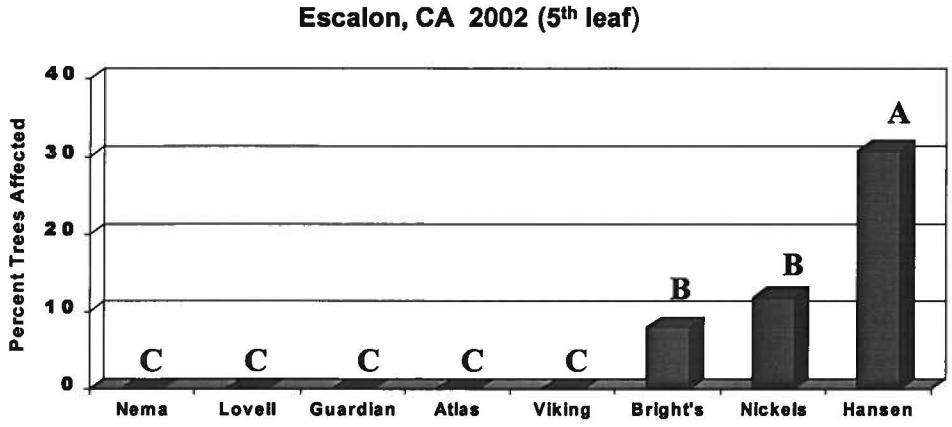
**Due to the high mortality rate of Viking at planting, yield data for Viking include many trees one year younger than trees of other rootstocks. Trunk circumference data does not include replant trees.

Bacterial canker. Signs of bacterial canker have become evident for the first time in this trial. In mid-late March, well after bloom, leaves and shoots began to collapse and typical gumming and bark staining began to appear. On April 29, trees were rated for incidence and severity of bacterial canker symptoms. A scale of 0-4 was used:

0 = no signs of bacterial canker
1 = shoot tip death, some small shoots killed
2 = die back of some large limbs
3 = At least one entire scaffold dead, majority of tree affected
4 = Whole tree dead.

Results are shown in Fig. 1 below. Bacterial canker symptoms were observed only in the three peach-almond hybrid rootstocks (30.8%, 11.8%, & 8.0% of Hansen, Nickels, and Bright's hybrid trees, respectively.) Most affected trees were rated a "1" while two Hansen trees were rated "2" and one Hansen tree received a "3" rating. At this point, yield loss to bacterial canker was minimal, but this may be an indication of more severe problems to come in the next few years.

Fig. 1. A Comparison of Almond Rootstocks for Incidence of Bacterial Canker



Most affected trees limited to death of small limbs.
Three Hansen trees had severe limb die-back.

1c. Merced Co. Rootstock Trial – Revisited 2003 for long-term observations.

Lonnie Hendricks, Roger Duncan

A rootstock trial was established in 1989 in the Atwater area of Merced County. Although data was recorded during the establishment period of this orchard (results published in previous Almond Conference Proceedings), yield data was again collected in 2002, the fourteenth growing season, to determine if yield dynamics changed as the trees grew older. Two scions (Nonpareil and Carmel) were tested on four peach rootstocks (Nemaguard, Red-leafed Nemaguard, Lovell, & Halford) and two peach-almond hybrids (Bright's Hybrid and Hansen 536). The orchard was established in a sandy loam soil with moderate ring and root lesion nematode populations and irrigated with sprinklers.

Yield Results.

Trees on peach-almond hybrid rootstocks (Bright's and Hansen) had significantly higher per tree yields than the peach rootstocks. Nonpareil kernel size was larger from Bright's trees than those on Lovell, red-leafed Nemaguard or Halford trees. Although tree size was not measured in 2002, trees on Bright's and Hansen had larger truck circumference in all previous years and visually appeared much larger this year. Larger tree size leads to a dramatic per acre yield advantage because trees were spaced far apart (24' x 24', 75.6 trees per acre). See Table 2 for yield data.

Table 2. Almond yield in 2002, the 14th leaf of a 1989 Merced Co. Rootstock Trial.

	Nonpareil		Carmel	
Rootstock	**Meat lb / acre**	**Weight / kernel (g)**	**Meat lb / acre**	**Weight / kernel (g)**
Bright's Hybrid	3256 a	1.15 a	3701 a	0.97 a
Hansen 536	3044 a	1.10 ab	3098 ab	0.94 a
Nemaguard	2466 b	1.13 ab	2203 bc	0.95 a
Lovell	1944 bc	1.04 b	1458 c	0.89 a
Red-leaf Nema	1350 c	1.03 b	1350 c	0.91 a
Halford	1216 c	1.03 b	1216 c	0.94 a

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. Our previous report indicated that DP is incompatible with almond and will not be a viable rootstock for us. 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 variety compatibility and tolerance of alternative rootstocks to oak root fungus. (J. Connell, Jim Floyd, California State University Chico Farm)

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 on a 'Padre' interstem 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'.

At the CSUC Farm, Duarte nursery provided 'Nonpareil', 'Sonora', 'Carmel', 'Butte', and 'Peerless' trees on 'Deep Purple' plum in December 2000 that unfortunately proved incompatible with almond. In 2002, Fowler nursery provided 'Nonpareil' and 'Carmel' on

'Ishtara' for evaluation of their compatibility and oak root fungus resistance. Additional alternative rootstock trees were planted in this and other oak root fungus spots in Butte County in spring 2003. These include Nonpareil, Sonora, and Carmel on Hiawatha, Nonpareil on Tetra, and some additional Nonpareil trees on Ishtara.

Results

A) Nickels

After three years in the field, Hiawatha continues to show great promise as a compatible plum rootstock for Nonpareil and Butte. The use of an inter-stem of Padre between Nonpareil scion and M2624 rootstock also looks very promising producing the largest tree size of any almond combination on M2624 rootstock. Deep Purple plum has again failed to show compatibility with Nonpareil (all trees have died) and is also failing with Mission. The European peach/almond hybrid rootstock, GF677 continues to perform similarly to Hansen 536 when combined with Nonpareil or Butte. Both new almond varieties, 'Kochi' and 'Durango' are developing well with growth rates similar to Nonpareil when planted on Lovell. 'Winters', 'Avalon' and 'Sonora' are all growing well on M2624 while 'Plateau' trees are noticeably smaller and may not be compatible. As expected, most Nonpareils on M2624 defoliate prematurely and grow very poorly with many dead.

B) CSUC Farm

Unfortunately, trees on 'Deep Purple' plum rootstock are 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 nearly all trees on this stock are dead. The 'Nonpareil' and 'Carmel' trees planted on 'Ishtara' in spring grew well in the 2002 season. There is still hope that this stock may prove useful.

Acknowledgement

The principal investigators in each of these trials wish to thank the Almond Board of California for their continued support. Industry 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.