

Annual Report to the Almond Board of California

May 1, 2004

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. Butte County: performance of rootstocks in a high rainfall environment.
 - 1b. Colusa County: performance of rootstocks on a shallow, hardpan soil.
 - 1c. Kern County: performance of rootstocks vs. 'Santa Ana' winds.
 - 1d. San Joaquin County: performance of almond rootstocks in a sandy replant location.
2. Alternative Rootstocks: evaluate the compatibility and field performance of Hiawatha and other plum rootstocks for almond; study the compatibility of newer almond varieties on Marianna 2624 plum; and, evaluate other new European rootstocks.

Results:

1. Regional Rootstock Trials

Trial sites were selected for specific challenges 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 'Hansen 2168' replicated two times. Tree spacing is 24' x 24'.

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.

1a. Butte County: rootstock performance in a high rainfall environment

Joe Connell, UC Farm Advisor Butte County; Rick Buchner, UC Farm Advisor, Tehama County; Almont Orchards, Chico.

Observations were made in spring 2003 in the Chico trial looking for any effects of rootstock on bloom density and bloom timing. Trees were subjectively rated on a 1-5 scale for differences in bloom density. Trees with few flowers were rated as a "1" and a rating of "5" would indicate trees with dense bloom. The Nemaguard rooted trees appeared to have a heavier bloom while bloom on Lovell rooted trees appeared to be lighter (Table 1). Bloom timing was

estimated by rating bloom stage and estimating the percentage of flowers that were open. Bright's Hybrid rooted trees appeared to be slightly ahead in bloom timing compared to trees on other stocks while trees on Lovell rootstock may have been slightly behind at this early bloom stage (Table 2).

Table 1. Bloom density rating*

Rootstock	2/7/2003	2/19/2003	2/19/2003	Average Density
	Row 9	Row 13	Row 15	
Bright Hybrid	4	3	3	3.33
Hansen 536	5	3	2	3.33
Nickels Hybrid	4	4	3	3.67
Viking	3	3	3	3.00
Atlas	4	3	4	3.67
Guardian	4	3	3	3.33
Nemaguard	5	4	4	4.33
Lovell	3	2	2	2.33

* Trees were subjectively rated for bloom density on a scale of 1-5, with 1 = poor bloom and 5 = dense bloom.

Table 2. Bloom stage at early bloom timing: February 7, 2003

Rootstock	Row 9	Row 11
Bright Hybrid	Variable PT-1%	PB, 1%
Hansen 536	PT-PB, Few	PT-PB, Few
Nickels Hybrid	PT-PB, Few	PT-PB, Couple
Viking	PB, Variable-Few	PT-PB, Couple
Atlas	PT-PB, Couple	PB, Few
Guardian	PT-PB, Couple	PT-PB, Few
Nemaguard	PB, Few-1%	PB, Few
Lovell	PT-PB, Couple	PT, Couple

PT = pink tip, PB = pink bud, Couple = a couple flowers open per tree
 Few = a few flowers open per tree, 1% = 1% of flowers open

Differences between early bloom timing observations and the late bloom timing observations may also suggest that the rootstock has some effect on the rate at which bloom progresses. Some rootstocks may stretch out the bloom while others may have an influence on condensing bloom once it starts. For example, at early bloom, Bright's hybrid rooted trees were somewhat ahead of others in the trial but by late bloom on February 19 they had the least amount of petal fall. Nemaguard and Guardian had been at a similar stage to most other rootstocks at early bloom, but later, were more advanced than most others, both averaging 40 percent petal fall by February 19 (Table 3).

Table 3. Bloom stage at late bloom timing: February 19, 2003

Rootstock	Row 13		Row 15		Average %	Average %
	% Bloom	% Petal Fall	% Bloom	% Petal Fall	Petal Fall	Bloom
Bright Hybrid	80	10	90	20, LO	15	85
Hansen 536	95	30	95	40,LO	35	95
Nickels Hybrid	90	20	95	30	25	92.5
Viking	80	30	90	20	25	85
Atlas	90	10	80	10	10	85
Guardian	95	40	95	40	40	95
Nemaguard	95	40	95	40, LO	40	95
Lovell	90	20	95	30, LO	25	92.5

LO = leaf out, leaves emerging.

In 2002, Nonpareil bloom on Hansen and Nickels rootstocks appeared heavier and possibly slightly ahead of bloom on other rootstocks. 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.

In the Butte County trial, the yield per tree on 'Hansen' and was greater than the yield on other rootstocks (Table 4) while the yield per tree on 'Lovell' rootstock was lower. When yield data is presented on the basis of pounds per tree space it takes into account the "real world"

Table 4. Butte County mean yield, pounds of kernel per tree and per tree space.

Rootstock	2001 4th leaf		2002 5th leaf		2003 6th leaf	
	lbs.kernel per tree*	lbs.kernel per tree space**	lbs.kernel per tree*	lbs.kernel per tree space**	lbs.kernel per tree*	lbs.kernel per tree space**
Bright Hybrid	8.10	7.14	18.54	13.89	19.24	12.33
Hansen 536	9.28	7.17	22.04	16.68	26.06	18.35
Nickels (I-82)	9.39	8.51	19.36	17.58	23.20	18.26
Viking	8.59	5.62	17.72	13.68	19.73	17.22
Atlas	10.95	8.32	19.35	13.95	23.77	17.04
Guardian	8.40	8.10	17.52	16.54	20.32	18.52
Nemaguard	10.63	9.47	21.51	16.56	23.65	16.60
Lovell	8.34	8.34	15.40	15.40	18.19	18.19

* Missing trees and replants are not included in the calculations when determining per tree yields.

** Planting density is 64 trees per acre and the "lbs. kernel per tree space" columns take this into account. These columns reflect trees lost due to planting problems and those lost subsequently due to splitting and broken limbs. Tree losses have a marked effect on yield.

effect on per acre yield of trees lost due to planting problems, splitting, and broken limbs. The

productivity of some rootstocks changes substantially when data is considered in this way. In this trial, there have been major yield reductions due to splitting and loss of trees on the Bright's hybrid rootstock. Results on Lovell appear substantially better when compared in this way since no trees have been lost on this rootstock.

In Butte County, 'Hansen 536' was largest in tree trunk circumference followed by 'Nickels' and 'Nemaguard'.

1b. Colusa County: performance of rootstocks on a shallow, hardpan soil.

J. Edstrom, UC Farm Advisor, Colusa Co., Nickels Estate Trustees.

Differences in tree size are apparent between the seven rootstocks in the Colusa trial (Table 1) with the 'Hansen 536' and 'Nickels' larger than the others.

Table 1. Colusa County mean trunk circumference in centimeters.

	Following: 2 nd Season	3 rd Season	4 th Season	5 th Season	7 th Season
<u>Rootstock</u>	<u>August 1998</u>	<u>Fall 1999</u>	<u>Fall 2000</u>	<u>Fall 2001</u>	<u>April 2004</u>
Bright's Hybrid	19.7	32.4	45.3 ab*	53.6 b	67.4
Hansen 536	21.2	35.1	47.9 a	56.2 a	71.5
Nickels (1-82)	20.4	33.9	44.6 b	52.6 bcd	76.9
Viking	20.7	33.4	42.8 b	51.7 bcd	65.8
Atlas	20	32.4	42.2 b	50.5 d	63.4
Nemaguard	19.9	33.5	42.2 b	52.0 bcd	64.5
Lovell	20.5 ns	33.6 ns	42.2 b	51.1 cd	64.0

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

ns - Not significantly different

Yields in the Colusa County orchard (Table 2) were down a little last year. Kernel size was equal for all rootstocks. Peach/almond hybrid rootstock yield showed less variation between plots than peach or intra-specific hybrid root yields.

Table 2. Mean yield (pounds kernel/tree) in Colusa County.

	4 th Season	5 th Season	6 th Season	7 th Season
<u>Rootstock</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
Bright's Hybrid	4.75 cd ^z	8.6 cd ^z	26.8	25.7
Hansen 536	5.94 ab	9.5 abc	27.9	30.1
Nickels (1-82)	5.65 bc	8.8 bcd	25.4	29.5
Viking	6.47 ab	9.8 abc	24.4	22.2
Atlas	6.96 a	10.2 ab	26.6	26.6
Nemaguard	4.55 cd	8.4 cd	25.9	24.5
Lovell	6.51 ab	10.3 a	24.7 ns	22.8

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

^z Fishers Protected LSD at P < 0.05.

1c. Kern County: performance of rootstocks vs. 'Santa Ana' winds

Mario Viveros, UC Farm Advisor, Kern Co., Peggy Schrader, Field Assistant & Dosanjh Bros. Farm.

In 2003, the Kern County yield on 'Atlas' was significantly greater than yields on 'Viking' or 'Nemaguard' (Table 1) while yield on 'Nemaguard' was significantly less than yields on 'Hansen 536'. 'Santa Ana' winds did not cause tree losses in this plot during 2003.

Table 1. Kern Co. mean yield (pounds kernel/tree) at various ages.

Rootstock	3rd Season 1999	4th Season 2000	6th Season 2002	7th Season 2003
Bright's Hybrid	2.60 c ^x	6.64 b ^x	29.3 ^z	30.5 abc ^z
Hansen 536	5.03 ab	9.59 b	31.5	34.2 ab
Hansen 2168 ^{xx}	5.56	10.55	28.0	22.3
Nickels (1-82)	^{yy}	3.68 ^{yy}	25.2	31.1 abc
Viking	3.04 c	7.95 b	25.3	28.4 bc
Atlas	6.06 a	12.55 a	31.3	36.2 a
Nemaguard	3.79 bc	8.62 b	26.1 ns	28.0 c

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

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

^z Duncans Multiple Range Test at $P < 0.05$.

^{xx} not included in analysis, only two replicates.

^{yy} not included in analysis, trees one year younger.

Yield for 2001 is unavailable due to malfunctioning scales.

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 2. Kern County mean trunk circumference in centimeters.

Following:	1 st Season	2 nd Season	3 rd Season	4th Season	5 th Season	6 th Season	7 th Season
Rootstock	Fall 1997	Fall 1998	Fall 1999	Fall 2000	Fall 2001	Fall 2002	Fall 2003
Bright's Hybrid	9.34 c*	22.24 b	34.57 d	48.91	54.1 b	62.43 ab	69.56 ab
Hansen 536	12.71 a	27.73 a	41.85 a	48.10	63.0 d	68.75 c	77.01 c
Hansen 2168	12.41 a	27.61 a	41.65 ab	51.41	61.8 cd	69.78 c	77.21 c
Nickels (1-82)	**	12.79 c	26.17 e	46.36	50.4 a	58.55 a	67.10 a
Viking	11.08 b	25.50 a	37.72 c	51.35	59.1 c	65.72 bc	73.35 bc
Atlas	12.38 a	26.11 a	38.85 bc	52.47	58.3 c	62.50 ab	69.97 ab
Nemaguard	8.95 c	21.81 b	34.10 d	48.01 ns	54.2 b	59.42 a	66.50 a

* 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) show significant differences between rootstocks through the 2000 (4th) growing season. Trees on 'Nemaguard' were shorter than trees on 'Hansen 536'. Tree height averaged five meters following the 5th growing season in the Kern trial, and, there were no significant differences between rootstocks thereafter.

Table 3. Kern County Tree Height in meters.

Rootstock	1999	2000	2001	2002	2003
Brights Hybrid	3.79 b	4.76 abc	4.88 a	5.10 a	5.07 a
Hansen 536	4.29 c	4.93 c	5.00 a	5.13 a	5.30 a
Hansen 2168	3.83 bc	5.06 c	5.13 a	5.10 a	5.30 a
Nickels (1-82)	3.04 a	4.47 a	4.94 a	5.07 a	5.05 a
Viking	3.83 bc	4.83 bc	4.99 a	5.14 a	5.09 a
Atlas	3.78 bc	4.94 c	5.04 a	5.18 a	5.23 a
Nemaguard	3.71 b	4.57 ab	4.90 a	4.93 a	4.94 a

1d. San Joaquin County: performance of almond rootstocks in a sandy replant location.

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.

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 a sandy, replant site.
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.

Bloom timing. On February 18 & 20, 2003, each tree was rated for stage of bloom (0 – 100% bloom). In general, differences in time of bloom were small between rootstocks. On February 18, Hansen 536 had the largest percentage of open flowers (79%) while Lovell had the lowest percent open (69%). On February 20, Atlas had the most open flowers (91%) and Bright's hybrid the least (85%).

Bloom density. In general, bloom in 2003 was very light in this trial, as was the case in many Nonpareil orchards in the northern San Joaquin Valley. On February 20 (nearly full bloom), trees were subjectively rated on a scale from 1-5 for differences in bloom density. Trees with almost no flowers were rated as a “1”. A rating of “5” was reserved for trees with extremely dense bloom. The majority of trees in our trial were rated as a “3” while many were rated as a “2”. Nemaguard and Atlas had the most dense bloom (average rating of 3.0) while Hansen and Lovell had the least dense bloom (2.3 and 2.4, respectively). Bloom data are shown in Table 1 below.

Table 1. Time of bloom and bloom density ratings for Nonpareil almonds on eight rootstocks. Escalon, CA. February, 2003.

Rootstock	Bloom Density* (Feb. 20, 2003)	Stage of Bloom (%) (Feb. 18, 2003)	Stage of Bloom (%) (Feb. 20, 2003)
Nemaguard	3.0 a	75 abc	89 ab
Atlas	3.0 a	72 c	91 a
Guardian	2.8 ab	73 bc	86 b
Nickels	2.8 ab	78 ab	89 ab
Viking	2.7 ab	72 c	85 b
Bright's Hybrid	2.7 b	72 bc	85 b
Lovell	2.4 c	68 c	88 ab
Hansen 536	2.3 c	79 a	86 b

*Trees were subjectively rated for bloom density on a scale of 1-5. A rating of “1” = very poor bloom; a rating of “5” = very dense bloom.

Yield and kernel quality.

Yields were generally low in this orchard, probably a reflection of the poor bloom density. Guardian, Nemaguard and Atlas had the highest yields while Hansen 536 had the lowest yield (Table 2). The low yield for Hansen is a result of a combination of poor bloom density and decline of many trees from bacterial canker (discussed below, see figures).

Table 2. Yield and quality of sixth-leaf Nonpareil almonds on various rootstocks. Escalon, CA.

Rootstock	2003 Yield (meat lb. / tree)	Shriveled Kernels (%)	Cumulative Yield (4 th through 6 th leaf)
Guardian	17.1 a	8.0 a	41.9
Nemaguard	16.6 a	10.6 a	41.4
Atlas	15.7 a	12.0 a	42.1
Nickels	15.2 ab*	12.2 a	40.7
Lovell	14.5 ab	8.4 a	37.5
Viking**	14.4 ab	8.0 a	33.4
Bright's	14.3 ab	9.0 a	36.9
Hansen 536	12.2 b	11.6 a	34.4

* 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, data for Viking include many trees one year younger than trees of other rootstocks.

Yields for Viking are misleading because many of these trees are one year younger than other rootstocks due to high mortality of the Viking rootstock at planting. Cumulative yields (4th through 6th leaf) are similar for Atlas, Guardian, Nemaguard and Nickels.

Almonds from this orchard had a very high incidence of shriveled kernels. The problem was most severe in the sandiest area of the orchard. There was no significant difference in kernel shrivel between rootstocks.

Bacterial canker. Signs of bacterial canker became evident for the first time in this trial in spring 2002 and progressed in 2003. Trees that had severe scaffold damage in 2002 have now died or are agronomically unacceptable. 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). These rootstocks also support the highest populations of Ring nematode. Results are shown below (Figures 1 & 2).

Figure 1.

A Comparison of Almond Rootstocks for Incidence of Bacterial Canker April, 2002 (5th leaf)

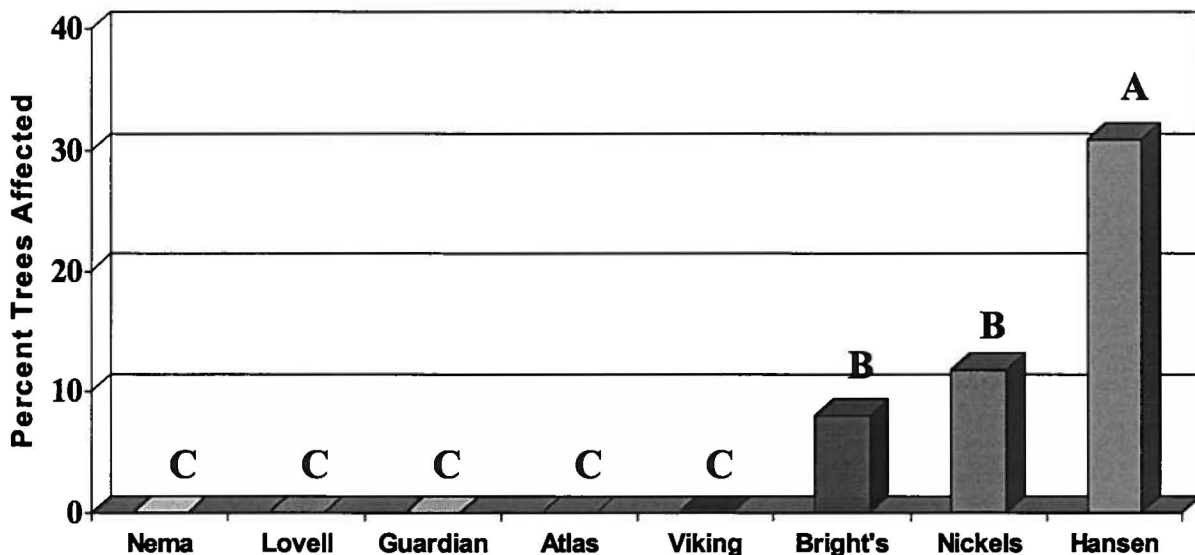
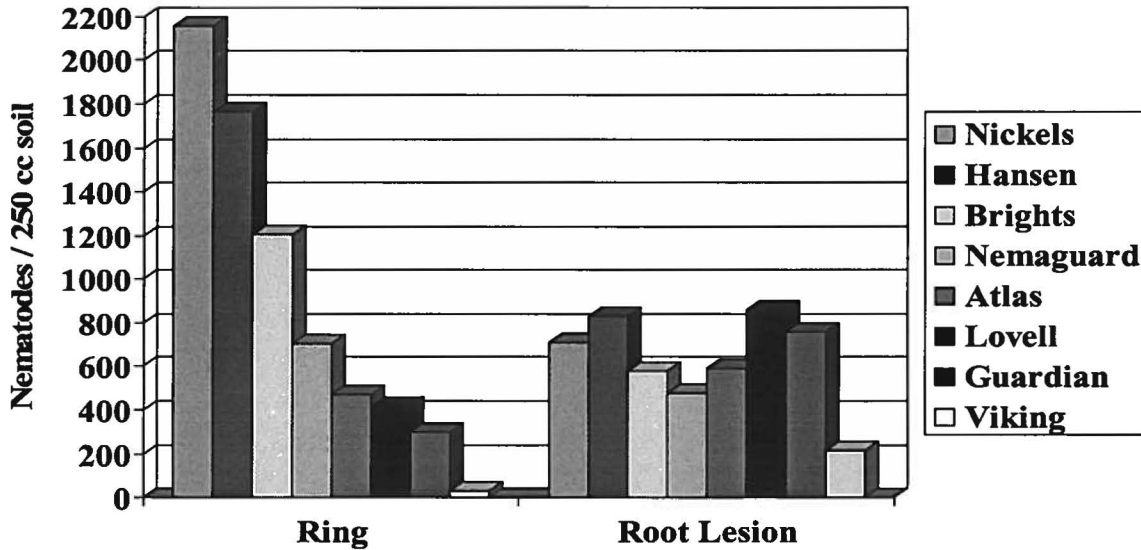


Figure 2. Preliminary nematode analysis of Escalon almond rootstock trial. May, 2004 (7th leaf)



Discussion

The results on tree mortality, growth, height, yield, tree survival, and nut quality are site specific during these early years of tree development. 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 individual orchard site selection rather than the standard rootstock used in a particular region.

2. Alternative Rootstocks: evaluate the compatibility and field performance of 'Hiawatha' and other plum rootstocks for almond; study the compatibility of newer almond varieties on 'Marianna 2624' plum; and, evaluate other new European rootstocks.

The USDA Agricultural Research Service has identified various plum type rootstocks, which show varying degrees of compatibility with Nonpareil. One of these, 'Hiawatha' (*Prunus besseyi* x *p.salicina*) has shown resistance to root knot and root lesion nematodes in field trials. 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' and 'Hiawatha' plum rootstocks, and the performance of European rootstocks; 'GF 677', 'AC952UC1', 'Pumiselect', 'Penta', 'CM7', 'Jaspi', 'Cadaman', 'Ishtara', 'Kuban 86', and 'Julior'.

(J. Edstrom, Stan Cutter, Nickels Estate).

'Nonpareil' grafted on 'Marianna 2624' and on 'Padre' inter-stem on 'Marianna 2624', and 'Butte' and 'Nonpareil' on 'Hiawatha' are being evaluated. Other almond varieties on 'Marianna 2624' include 'Plateau', 'Winters'(13-1), and 'Avalon' with 'Sonora' and 'Mission' planted as standards. Additional evaluations of the newly developed cultivars, 'Durango' and 'Kochi' on 'Lovell' are also included.

B) Evaluate variety compatibility and tolerance of alternative rootstocks to oak root fungus.
(J. Connell, Jim Floyd - CSU Chico Farm, G& N Creekside Farms, Sam Lewis Jr Orchards.)

Fowler nursery provided 'Nonpareil' and 'Carmel' on 'Ishtara' in 2002 to evaluate compatibility and oak root fungus resistance at the CSUC Farm. Additional alternative rootstock trees were planted in this and other oak root fungus spots in Butte County in spring 2003. These included 'Nonpareil', 'Sonora', and 'Carmel' on 'Hiawatha', 'Nonpareil' on 'Tetra', and some additional 'Nonpareil' trees on 'Ishtara'. In spring 2004 additional 'Nonpareil' trees were planted in oak root fungus spots on the 'Empyrean 101' rootstock.

Results

A) Nickels

After four years in the field, 'Hiawatha' continues to show 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. 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 'Nonpareil' on 'M2624' defoliate prematurely and grow very poorly with many dead.

Our new evaluation of European rootstocks showed mixed results. All trees died on two of the candidates, 'AC952UC1' and 'Pumiselect'. Trees on 'Penta', 'CM7', and 'Jaspi' showed weak growth while trees on 'Cadaman' and 'Hiawatha' were quite vigorous. 'Ishtara', 'Kuban 86' and 'Julior' showed moderate vigor.

B) CSU Chico Farm & Butte County

The 'Nonpareil' and 'Carmel' trees planted on 'Ishtara' in spring 2002 grew well that year but growth weakened on the 'Nonpareil' through the 2003 season. 'Carmel' on 'Ishtara' continued to look good through 2003. 'Nonpareil' planted on 'Ishtara' in 2003 started out as small trees and made weak growth in 2003. 'Nonpareil', 'Carmel' and 'Sonora' trees planted on 'Hiawatha' in spring 2003 all grew well the first year. 'Nonpareil' trees planted on 'Tetra' in 2003 are also growing well after one year's growth. In spring 2004 additional Nonpareil trees were planted on 'Empyrean 101' in three different oak root fungus spots. There is no indication yet whether any of these rootstocks will show resistance to oak root fungus.

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 also reported here when opportunities for their evaluation occur.