Development of Nematode/Rootstock Profiles for 40 Rootstocks with the Potential to be an Alternative to Nemaguard

Project No.: **07-PATH2-McKenry**

Project Leader: Michael McKenry
Kearney Ag Center
2940 S Riverbend Ave.
Parlier, CA 93648
(559) 646-6550
McKenry@uckac.edu

Project Cooperators: Roger Duncan, Paul Verdegaal, Joe Grant, Mario Viveros, Joe Connell, John Ireland

Interpretive Summary:

In this final report we summarize five years of study characterizing the host status of more than 40 different Prunus rootstocks grown in the presence of three important nematode genera. All data were developed from 2 or 3-yr controlled field settings. Where possible, our field data were compared to data collected at 6 different 3 to 7 yr-old farm advisor established rootstock trials located throughout the Central Valley. For each of the different nematode genera we included Lovell, Nemaguard and Pistachio rootstocks because of the varying nematode resistances they possess.

A dozen of the rootstock profiles involved peach x almond hybrids. These stocks tend to impart greater vigor than Nemaguard, provide resistance to root knot nematode and provide more protection than Nemaguard against root lesion nematode. With the exception of Atlas and Viking this grouping usually hosted more ring nematodes than Nemaguard. Viking does provide Bacterial Canker relief on par with Lovell but its resistance mechanism to ring nematode is “fleeting”. As compared to Lovell seedlings, ring nematode population levels around roots of Viking and Atlas increase or decrease over the timeframe of months or years. Additional breeding could improve the resistance mechanisms within Viking but the root knot nematode protection it also provides can make it more useful than Lovell in sandy textured soils where Bacterial Canker is rampant. In our evaluations of tolerance to nematode feeding and/or the rejection component of the replant problem Viking always benefited from pre-plant soil fumigation so at minimum, strip fumigation is warranted.

Ten of the tested plants can be grouped as having predominantly peach parentage. This grouping includes Empyrean 1 and Cadaman that impart high vigor compared to Nemaguard while Okinawa and some of the HBOK series provided less vigor. The peach grouping, including Lovell, Okinawa and Guardian, offer 40 to 60% relief from

ring nematode build-up. None of these were completely resistant to ring nematode but in fact HBOK-1 and HBOK-17 exhibited even better resistance to ring nematode in a single 6-year field trial. Additional field evaluations of these and other members of the HBOK series are warranted and an additional goal is to search for “stable” rather than “fleeting” resistance mechanisms against ring nematode.

Twenty of the rootstocks involved selections or crosses having varying Prunus parentage not grouped above. The only source of resistance to root lesion nematode came with *Prunus tomentosa.* This cherry plum parentage tends to impart less vigor than Nemaguard and can be associated with sucker formation. From a nematode perspective most of the rootstocks within this latter grouping did not appear to give new breeding direction, at least for California conditions. An exception might be Mirobac. This rootstock had been mislabeled during our tests and a new series of 2-year tests is currently underway for purposes of clarification.

Our nematode-*Prunus* profiles provide information about *Prunus* parentages to avoid, those that provide resistance and a ranking of those that fall between these two host status levels. Particularly with regard to ring nematode, we experienced discrepancies between our findings and those from farm advisor field trials or other literature reports. We believe these differences now have reasonable explanations. In the case of *Meloidogyne incognita*, our local Parlier, CA population and the population from San Joaquin Co. were both aggressive to Guardian SC17 rootstock. These root-knot nematodes reproduced on Guardian but as roots aged beyond 60 days older tissues appeared to provide protection. Assessments of ring nematode were complicated because:

- No *Prunus* spp, including Lovell, exhibits complete resistance to this nematode.
- The best resistance mechanisms, such as those in Lovell, do not appear to be the same as those in Viking, Atlas and Guardian.

The rootstocks of greatest concern with regard to our 2-year ring nematode data sets were Hansen 536 and Viking. Our reports on Hansen 536 and several peach almond hybrids underestimate their hostability to ring nematode while counts from Viking were mixed. More than two years of field evaluation are necessary to determine ring nematode host status. These studies also provide information on the growth of rootstocks in adjacent fumigated versus non-fumigated soils. There can be tolerance or intolerance to nematode feeding as well as to the rejection component of the replant problem, thus nematode resistance or the ability of nematodes to reproduce on the host is a first step evaluation but tests must also be run in fumigated and non-fumigated replant sites.

Objectives:

1. Establish a 150-day screen in field settings using 40 Prunus rootstocks against root-lesion nematode*, Pratylenchus vulnus,* and root-knot nematode, *Meloidogyne incognita* race 3.

2. Establish a three to five month greenhouse screen to determine the sensitivity of approximately 40 Prunus rootstocks to the rejection component that remains after nemaguard rootstock.

3. Evaluation of approximately 40 rootstocks against the rejection component in sand with or without ring nematode. This evaluation is expected to require two to three years.

4. Quantify nematode population levels present in various field settings where some of these rootstocks are already receiving horticultural evaluation.

Materials and Methods:

<u>Objective 1</u> - One to 150 days is all that is needed to screen for resistance to the most common population of root lesion nematode or root knot nematode. This field evaluation can be accomplished with 10 individual trees and the scion choice is unimportant. Ten of the trees were exposed to *P. vulnus* and five of these same trees also received inoculation with *Meloidogyne incognita* race 3. The inoculum was applied to each tree soon after planting. At 150 days after inoculation the root systems are dug and at least 20 grams of finer roots placed in a mist chamber for five days for collection and counting of nematodes. Resistance means we detected fewer than 0.2 nematodes per gram of root.

Incidence of root galls was noted because Nemaguard, for example, can develop galls but the nematodes within do not reproduce. Nemaguard and Lovell were included in the test as standard comparisons. In following years we repeated the experiment adding rootstocks that were not available the first year. For rootstocks that exhibit resistance to both *P. vulnus* and *M. incognita* race 3, we then screened those stocks against other root knot populations including *M. javanica*, *M. arenaria*, *M. hapla* and aggressive populations of Meloidogyne that we have gathered from grape. From this, each rootstock is eventually be categorized as *resistant, moderately resistant, susceptible*, or *highly susceptible* based on nematode counts.

We have also completed two-year evaluations against ring nematode, *Criconemoides xenoplax*. A specialized field site for ring nematode was used. Our focus was to plant those rootstocks already known to be most useful against root lesion and root knot nematodes. Ring nematode requires a full two-year evaluation. This evaluation includes nematode re-sampling from each tree every 6 months.

Objectives 2 and 3 - The rejection component of the replant problem is believed to be a result of the general competitive nature of microbes within the established ecosystem around the old rootstock. The old ecosystem is not the same group of organisms in one site as the next. It is also not in the same abundance from one tree to the next within an orchard. This rejection component is transportable to the greenhouse by mixing one pound of it into a normal five-gallon bucket that supports the candidate tree. Nemaguard trees exposed to the soil from an old Nemaguard orchard grow 1/7 the size if that soil is not fumigated. We plant 10 trees into 10 buckets from a variety of field settings. One soil is pure sand that has the rejection component (three buckets). Another is the same sand with the rejection component plus ring nematode (three buckets). A third soil is sandy loam soil with the rejection component but without other nematodes (three buckets). A fourth soil is a mixture of the above three soils that has been fumigated or autoclaved to destroy the rejection component (one bucket minimum). Tree growth is quantified 150 days after planting. The three buckets with rejection component plus ring nematode are not sacrificed but are be sampled for ring nematode at 150, 300, and 450 days after planting to determine the ring nematode host status of the different rootstocks.

Original Objective 4 - This portion of the proposal was determined to be of greatest interest to the almond project review board. We have analysed soil samples from rootstock trials in several locations: Stanislaus/San Joaquin County, Butte County, Kern County (multiple sites). Other existing rootstock trials will also be sought for useful field information. We are aware of one more site in Kern County and another in Stanislaus County. We will also be searching for field sites of any age that contain Viking as well as Nemaguard rootstock in an effort to compare data from our nematode rootstock profile with data from existing field trials. This Objective will receive greater attention and Objectives 2 and 3 almost no new attention.

Results and Discussion:

Objective *1 & 3. Resistance (= Halting of Nematode Reproduction): Root-Knot Nematode* - Table 1 depicts the relative host status of these rootstocks against root-knot nematode. Most notable is that resistance to this nematode (<0.2 nematodes/gram of root after 2 years), is available to the first 30 rootstocks listed. Rootstock Empyrean 101 exhibits moderate resistance (0.21 to 0.6 nematodes / gram of root after 2 years). The remaining 9 rootstocks we refer to as susceptible (0.61 to 180 nematodes / gram of root). However, we also note there is a root-knot resistance mechanism in at least 2 of the 9 susceptible rootstocks that can, in specific instances, be counted upon for useful resistance. Rootstocks Krymsk 1 and Guardian exhibit susceptibility to root-knot at their root terminus but as roots age (60 to 80 days), galls are not found on older wood, thus this resistance mechanism has value if the field is relatively free of nematodes when the young trees are planted. For example, if these two rootstocks were replanted following Nemaguard in a relatively weed-free setting, they would not receive much root-knot nematode pressure and in sandy loam soil can be expected to perform quite well relative to this genus of nematodes. By comparison, Lovell rootstock when attacked by root-knot nematode will support nematodes on younger and older wood thus resulting in much higher nematode build-up and tree damage. In fact, one can find active root galls on Lovell roots that are five years of age.

Beyond direct damage by root-knot nematode, we are interested in root-knot resistant rootstocks that gain their resistance from parentage other than Nemaguard. To this end, rootstocks such as Hansen 536, Bright's Hybrid-5, Empyrean 1, Viking, Lovell and Nemaguard were tested for their tolerance to the rejection component of the replant problem. This is evaluated by replanting one year after Nemaguard has been treated with Roundup and the land then fumigated or not. It is Hansen 536 that grows the same whether fumigated or not. These findings on tolerance to the rejection component of the replant problem were presented in the 2006 -2007 07 Final Report and are also found at http://www.uckac.edu/nematode. We currently refer to this overall strategy of starving the soil ecosystem then replanting different rootstock parentage as "Starve and Switch". This approach can be an alternative to fumigation.

Root-Lesion Nematode - Depicted in Table 2 are three rootstocks with resistance to *P. vulnus* including Krymsk 1, Krymsk 2 and Pistachio. None of these three is suitable as a rootstock for almond. The next three to five rootstocks listed exhibit moderate resistance. This means the protection they offer may eventually be broken in field settings but their parentage should receive attention in future breeding programs. It is noteworthy from the position of Nemaguard in Table 2 that there are *Prunus* rootstocks that support 5 to 10 times as many *P. vulnus* / gram of root. With regard to this nematode, the almond and stone fruit industries of California have been provided a modicum of relief against *P. vulnus* through their use of Nemaguard.

In Table 2 we compare the host status of various rootstocks that farm advisors have planted out in randomized replicated trials elsewhere in the state and *P. vulnus* happened to be present. One example comes from a 3-year old planting and the other from a 7-year old planting. It is apparent that among this grouping of rootstocks, Nemaguard typically supports fewer *P. vulnus* per gram of root than many other selections under study. Root systems that are pronounced resistant, the first three listed, tend to stay that way in field settings but we currently have only one five-year example to verify this resistance in field settings. Unfortunately, none of the three top rootstocks against *P. vulnus* is suitable for almond production and the next few listed are peach x almond hybrids that generally have the failing of being quite susceptible to ring nematode, thus Bacterial Canker Complex when planted to highly porous soils.

Ring Nematode - Depicted in Table 3 is the mean nematode counts collected from two separate two-year tests. Each tree of each rootstock listed received nematode sampling at 6-month intervals or at least three different times during each 2-year study. This may not be enough sampling because there are examples where the data from our 2-year examinations do not correlate well with farm advisor examinations collected 3 to 7 years after planting (see Obj. 4). Specifically, our 2-year counts appeared to overestimate the anticipated ring nematode counts associated with Viking and Atlas while the counts of Hansen 536 appear to be underestimates. We also noted there appeared to be variability in our results with Viking compared to Lovell. In 2004-2005 we were aware that our 2-year tests might be overestimating Viking counts so we repeated our work with Viking in 2006-08 only to come up with similar counts in 2007, both appearing to be an apparent overestimate. We continued sampling into 2008 and also returned to the San Joaquin Co. field trial for a re-assessment of nematode counts.

When examining the host status of grape rootstocks against ring nematode we have obtained rather useful predictive value using the mean count from a 2-year test, but tree roots do grow differently, for example larger distances from root tip to root tip, particularly on vigorous rootstocks such as peach x almond hybrids. In addition, there may be some resistance mechanisms at work in Viking and Atlas that demand longer evaluation periods.

It is more difficult to identify plant resistance to ectoparasitic nematodes compared to those endoparasitic. Finding and counting of higher nematode populations within roots is a good indicator that one specific plant is a better host for the nematode than some other plant. In addition, nematode absence from roots is a good indicator of resistance. With ectoparasites our only tool is counts from soil and roots which may or may not be in close proximity. In extensive studies with grape rootstocks we learned that for ectoparasitic nematodes, resistance is associated with population levels that are approximately 5% of that achieved on own-rooted susceptible plants. At population levels of 10% of the own-rooted, we term the interaction as moderate resistance. In an 8-year field study those plants with moderate resistance to ectoparasitic nematodes can occasionally show high populations throughout the annual soil sampling periods. By contrast, population levels of ectoparasitic nematodes that are actually resistant do not fluctuate very much from one year to the next. In the data sets that make up Table 3 (not shown), there are population fluctuations from one sampling period to the next. Lovell rootstock gives us the most consistent population readings from sampling to sampling but at levels of about 40% of those of Nemaguard. Population levels of 40% are much too high to be referred to as resistant (see Table 4). At this juncture, Lovell, in our 2-year tests is the closest of 36 *Prunus* rootstocks to consistently exhibit ring nematode population levels lower than those from Nemaguard. However, based on field evaluations where Lovell, Viking and sometimes Atlas can be compared together, the latter two rootstocks occasionally exhibit population levels of 5 to 10% that of Nemaguard. In Tables 4 and 5 we depict ring nematode population fluctuations in a field setting.

<u>Objective 2a Tolerance to Nematodes (= Minimal Damage due to Nematode Feeding</u>*)* - The 2006-07 Final Report compared first-year growth of ten rootstocks planted into fumigated or adjacent nematode-infested soil (see Table 6, this report). Rootstocks that had not benefited by fumigation included Krymsk 1 and Myrobalan 29C. At the other end of the spectrum three rootstocks were identified as intolerant of first-year feeding by *P. vulnus* and *M. incognita* and they included Viking and Marianna 2624. Growth of the latter two usually benefited by fumigation, and this was not in a replant site. Readers are referred to 2006-07 Final Report for more on this subject.

<u>Objective 2b Tolerance to the Rejection Component of RP (= Excellent 1st yr Growth) -</u> The 2006-07 Final Report compared first-year growth of 6 rootstocks planted into fumigated strips within a replant site devoid of nematodes. Our question: is fumigation beneficial if the rejection component of the replant problem is prevalent across the site? First-year growth of Hansen 536 was not benefited by fumigation. By comparison, growth of Viking and Nemaguard was benefited by fumigation thus providing good examples of intolerance to the rejection component of the replant problem. Readers are referred to the 2006 - 2007 Final Report for more details.

Objective 4 Soil Samples from Existing Farm Advisor Trials - Results from soil samples collected at various farm advisor rootstock trials have generally been reported directly to the farm advisors involved for addition within their annual reports. This information has been generally helpful in several regards but inadequate distribution of nematodes and the presence of fewer rootstocks in each study has been a limitation. One exception to this has been the San Joaquin field trial developed by Joe Grant and Roger Duncan. Results from that site are presented here in Tables 4 and 5 and Figure 1 because those data help to explain some of the discrepancies we have incurred between our 2-year data sets compared to multi-year studies. Our difficulties have primarily been associated with ring nematode data. In addition the San Joaquin Co trial contains several of the HBOK (Harrow Blood x Okinawa) rootstock series. Two of those, HBOK-1 and HBOK-17, appear to provide ring nematode relief that is at least on par with Lovell. More studies are needed with these two selections. They are of interest because of relief from ring nematode but also Okinawa is the root knot resistant parentage present in Hansen 536 and partially responsible for tolerance to the rejection component of the replant problem. Note from the decline in number of replicates shown in Table 4 that numerous rootstock choices did not survive or were uneconomical by the sixth year at this Bacterial Canker site.

The exact parentage of Viking and Atlas has not been reported. Guardian SC-17 is reported to be one of several selections out of Nemaguard in 1954. These three rootstocks appear to posess a ‘fleeting’ resistance mechanism when compared to Lovell rootstock. Levels of resistance we see in fall months may be better than those we see in spring months. Also, nematode levels observable on Viking in the third spring year appear lower than those detected the first two years. In some manner, populations of ring nematode are cycling from high to low on Viking, Atlas and perhaps Guardian, compared to those on Lovell rootstock. The discrepancy in population levels during two different samplings in San Joaquin Co depicts this impact. Most importantly, breeders are likely to find stronger resistance to ring nematode in Lovell sources compared to other sources. Table 7 was developed with the assistance of Greg Reighard.

Recent Publications:

McKenry, M. V. March 2007. Management of the replant problem utilizing minimal soil fumigation. www.uckac.edu/nematode

McKenry, M. V., T. Buzo and S. Kaku. Jan 2008. Replanting vineyards without soil fumigation. UC Plant Protection Quarterly Vol 18 (1) 4-6. www.uckac.edu/ppq

Table 1. Ranking of *Prunus* rootstocks against root-knot nematode *M. incognita:*

	A 2 year study nematodes/gr root	
Pistacia atlantica	0	
Nemaguard	0	
Garnem	0	
Bright's Hybrid-4	0	
Julior	0	
Bright's Hybrid-1	0	
Hansen 536	0	
Flordaguard	0	
Torinel	0	
Empyrean 2	0	
Hiawatha	0	
Cornerstone	0	
Viking	0	
Empyrean 1	0	
Okinawa	0	
Cadaman	0	
Pumiselect	0	
Ishtara	0	
Monegro	0	
Atlas	0	
Nickels	0	
Flordaguard x Alnem	0	
Krymsk 8	0	
RedGlow	0	
Citation	0	
MRS 2-8	0	
HBOK 50	0	
Flor x weeping peach	0	
Bright's Hybrid-5	0	a
HBOK-10	0.08	a
Empyrean 101	0.29	a
Empyrean 3	0.91	ab
CONTROLLER 9	11.6	bc
Guardian SC-17	12.1	bc
Krymsk 1	15.9	bc
Paramount	17	bc
Lovell	31	d
Krymsk 2	31.4	d
CONTROLLER 5	42.9	e
Krymsk 86	51.6	e

Table 2. Ranking of *Prunus* rootstocks against root lesion nematode*P. vulnus:*

	2-year test nematodes/ gr root	Soil counts reported as a % of those on Nemaguard: 2-year test soil counts	3-year old rootstock trial soil counts	7-year old rootstock trial soil counts
Krymsk 2	0.03	0.40%		
Krymsk 1	0.17	2.4		
Pistacia atlantica	0.2	2.8		
Garnem	0.3	4.2		
Bright's Hybrid -4	0.5	7		
Bright's Hybrid -5	0.6	8.4		
Hansen 536	0.61	8.6	22	187
Bright's Hybrid-1	0.63	8.9		189
Paramount	1.2	16.9		
CONTROLLER 9	1.6	22.5		
Flordaguard	1.6	22.5		
HBOK-10	3.3	46		
Empyrean 2	5	70.4	294	
Torinel	5.3	75		
Guardian SC-17	6.2	87.3	111	138
Hiawatha	6.8	96		
Nemaguard	**7.1**	**100**	(actual # 1.8) **100**	(actual # 305) **100**
Lovell	**7.4**	**104**	**411**	**247**
Cornerstone	8.5			
Viking	8.9		211	100
Empyrean 1	9		1133	
Okinawa	9.7			
Cadaman	10.8		1344	
Krymsk 86	11			
Pumiselect	11.7			
Ishtara	13.7			
Citation	17.4			
Monegro	17.7			
Atlas	23.9		1177	204
Nickels	26.3		22	183
Flordagrd x Alnem	27.2			
Krymsk 8	28.9			
Redglow	32.3			
MR.S. 2-8	37.7			
HBOK-50	39			
Flor x Weep peach	40			
CONTROLLER 5	51.6			
Empyrean 101	57.6			
Julior	71.4		38,611	
Empyrean 3	72.8			

P=0.05

Table 3. Ranking of Prunus rootstocks against ring nematode *Criconemoides xenoplax*:

	2-yr test soil counts expressed as a % of Nemaguard	Values reported as a % of that on Nemaguard		
		3-year old rootstock trial soil counts	7-year old rootstock trial soil counts	7-year old rootstock trial soil counts
Lovell 04-05	**48**	1	26	
Lovell 06-08	**34**			
Flordaguard	40			
Hiawatha	56			
UCB1 Pistachio	58			
Guardian SC-17	61	111	44	
Pumiselect	63			
Bright's Hybrid -1	67		153	147
Bright's Hybrid-5	68			
Torinel	71			
Hansen 536	73	7300	119	430
E54-043	75			
Viking 06-08	78			
Krymsk 1	94			
Viking 04-05	95	0	13	0
Cadaman	96	94		
Nemaguard 04-07	**100**	(38.1) **100**	(423) **100**	(375) **100**
Del Rey Plum	108			
MR.S. 2-8	109			
Marianna 2624	113			
Empyrean 1	117	13		
Cornerstone	117	6200		
D63-182	118			
Nickels	119	578	104	159
Krymsk 86	121			
E54-043	130			
Monegro	140			
Ishtara	148			
Garnem	193			
Atlas	234	0	95	9
Empyrean 2	323	92		
Julior	406	4870		

No significant differences (P = 0.05).
Experimental selections E54-043, E54-047, and D63-182 are from Burchell Nursery
Experimental selection 'Del Rey Plum' is a sport from Del Rey CA.

Table 4. San Joaquin Co. rootstock trial of Joe Grant and Roger Duncan. Soil counts of ring nematode expressed as a % of those on Nemaguard

	10/1/2006		2/14/2008	
Rootstock	reps	% of Nemaguard*	reps	% of Nemaguard*
HBOK-17	1	1%	1	2%
HBOK-1	4	24	4	16
Lovell	8	**32**	8	**43**
P. mira	2	40	2	61
Viking	8	24	8	68
P. ferganensis	6	10	6	69
Guardian SC-17	8	41	8	94
Nemaguard	8	**(676) 100**	**8**	**(453) 100**
HBOK-15	2	25	2	104
CONTROLLER 9	7	127	3	119
Compass	4	37	4	156
Atlas	8	41	7	174
K119-50	8	199	4	197
Nickels	4	252	2	199
Flordaguard	8	87	8	251
HBOK-32	6	61	4	283
Cadaman	7	77	7	315
Weeping Peach	1	25	1	317
Hansen 536	4	183	3	379
Hiawatha	7	139	0	
CONTROLLER 5	6	97	0	
St Anthony	7	68	1	30
P. subhirtella	4	132	0	

Table 5. Variable population dynamics of ring nematode at the San Joaquin Co rootstock trial as influenced by five rootstocks having various resistance mechanisms.

10/1/2006	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**	**Mean**
Nemaguard	848	1076	383	824	17	576	268	1416	676a
Atlas	177	432	143	150	6	788	13	536	280.6 b
Guardian SC-17	292	408	386	2	844	69	79	121	275.1 b
Lovell	161	382	362	2	377	2	0	432	214.8 b
Viking	71	17	844	66	0	42	143	121	163 b

P=0.05

2/14/2008	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**	**Mean**
Atlas	1412	1012	310	892	832	424	632	**.**	787.7a
Nemaguard	928	306	396	372	171	556	178	716	452.9 b
Guardian SC-17	484	372	350	1	409	314	948	524	425.3 bc
Viking	273	524	375	432	458	67	263	93	310.6 bc
Lovell	5	303	164	117	179	2	6	447	152.9 c

P=0.05

Figure 1. Soil counts of ring nematode at the San Joaquin Co rootstock trial 2006 sample vs. 2008 sample. Data also presented in Table 4.

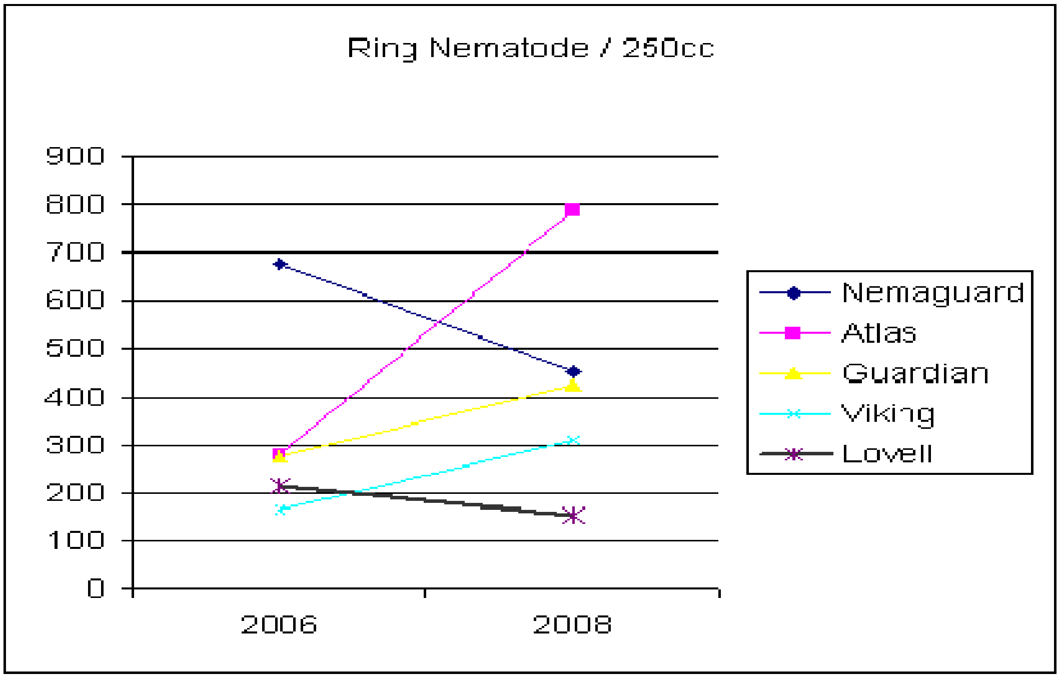

Table 6. First-year tree growth differences in fumigated versus non-fumigated soil test.

First year tolerance to feeding by *P. vulnus* and *M. incognita*--non replant				
		need for fumigation		**First year *P. vulnus***
	rootstock	**was significant P=.05**		**per gram of root**
1	Krymsk 1	0 of 8 replicates		3
2	Myrobalan 29C	0 of 8 reps		19
3	Torinel	1 of 8 reps		111
4	Flordaguard	1 of 8 reps		16
5	Lovell	1 of 8 reps		111
6	Cadaman	2 of 8 reps		76
7	Empyrean 2	3 of 8 reps		72
8	Nemaguard	3 of 8 reps		80
9	Monegro	4 of 8 reps		41
10	Marianna 2624	5 of 8 reps		37
11	Viking	6 of 8 reps		23
12	Krymsk 8	0 of 4 reps		many poor trees 35

Table 7. Parentage of rootstocks evaluated.

<u>Peach x almond hybrids</u>	
Garnem	Garfi Almond x Nemared Peach
Monegro	Nemared Peach x Garfi Almond
Bright's Hybrid-4	Titan almond x Nemaguard
Bright's Hybrid-1	Titan almond x Nemaguard
Bright's Hybrid-5	Titan almond x Nemaguard
Hansen 536	[Okinawa x (*P. davidiana* x peach P. I. 6582)] x almond
Nickels	Selection 5-33 (McLish x Reams) almond x Nemaguard
Cornerstone	= SLAP, a peach x almond hybrid
Viking	Nemaguard x (Jordanolo almond x *P. blireiana*)
Atlas	Nemaguard x (Jordanolo almond x *P. blireiana*)
Flordaguard x Alnem	Peach x Alnem Almond
Paramount	Selection GF 677, a natural peach-almond hybrid
<u>Peach</u>	
Nemaguard	*P. persica x P. davidiana*
Flordaguard	[Shau Thai (P. I. 65821) OP x *P davidiana*] x 3 OP x (Okinawa or Rancho)
Empyrean 1	*P. persica x P. davidiana*
Okinawa	*Prunus persica* selection
Cadaman	*Prunus persica x Prunus davidiana*
Lovell	1882 selection of processing/drying peach cultivar
Guardian SC-17	[FV 235-4 = OP seedling of S-37] x Nemaguard
HBOK-10	seedling of Harrow Blood x Okinawa
HBOK 50	seedling of Harrow blood x Okinawa
Flordaguard x weeping peach	several peach seedlings
<u>Other Prunus species or crosses</u>	
MR.S. 2-8	*P. cerasifera*
Citation	Siberian C x (plum x almond)
Krymsk 8	also known as VSL-1 cv Alab
Hiawatha	*P besseyi x P. salacinia*
Julior	*P. insititia* -x *P. domestica*
Redglow	*P. salicinia* x *P. munsoniana*
Ishtara	Belsiana plum x (*P. persica* x *P. cerasifera)*
Empyrean 2	*P. domestica* OP, (no peach) seedlings of 'Imperial Epineuse'
Pumiselect	*Prunus pumila* selection
Krymsk 2	*P. incana* x *P. tomentosa*
Controller 5	*P. salicina* x *P. persica*
Krymsk 86	*P. cerasifera* x *P. persica*
Mirobac	*P. cerasifera* x almond
Del Rey Plum	unknown *Prunus cerasifera* type
Krymsk 1	*Prunus tomentosa* x *P. cerasifera*
Controller 9	*P. salicina* x *P. persica*
Empyrean 101	*P. insititia*
Empyrean 3	*seedling of* OP *P. domestica* cv Regina Claudia Verde
Torinel	*P. domestica* cross of Reine Claude P 994 x Reine Claude de Bavay
<u>Pistachio Standard</u>	*Pistacia atlantica*