A SECOND-YEAR REPORT TO THE CALIFORNIA ALMOND BOARD

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Abstract:
From small-plot experiments conducted in 2004 half a dozen *Prunus* rootstocks were identified to have vigor levels and nematode resistance equivalent to or better than Nemaguard. These include Empyrean #1, Cornerstone, Monegro, Atlas, Viking, and perhaps Nickels. These trees are still in the ground as we conduct additional confirmatory samplings for *Pratylenchus vulnus* and *Meloidogyne incognita*. Our listing of nematode susceptible rootstocks can be just as informative as the listing of those with resistance. In addition to the 38 selections of *Prunus* evaluated last year we planted three additional sources in 2005. In 2004 we also planted 18 sources of *Prunus* into sand soil infested with ring nematode, *Mesocriconema xenoplax*. Resistance evaluation for this nematode requires collection of nematode samples every 6 months for two full years. We will have ring nematode data available for Atlas, Viking, and Nickels by next year but the other three listed above have not even been planted because this special field setting is completely utilized. Ring nematode development among the 18 rootstocks can at this time be divided into three categories as we compare their host status as greater, poorer, or similar to that of Nemaguard. Lovell and Guardian are two of the poorest ring nematode hosts. Throughout spring 2005 we have focused on Farm Advisor conducted almond rootstock trials in Kern, San Joaquin, and Butte counties. Several of these trials have been underway for more than 7 years and intensive soil samplings can confirm or reject findings that come from our small plot experiments listed above. In one Kern County site there were good and poor growing trees on eight different rootstocks in the presence of *M. xenoplax* and occasionally *Meloidogyne* spp on Bright's hybrid. In the San Joaquin County site there were seven rootstocks in the presence of *Mesocriconema xenoplax* and *Pratylenchus vulnus*. In Butte County the dominant nematode was pin nematode with occasional dagger nematode and *M. xenoplax*. This latter site is not currently in need of extensive sampling. The *Pratylenchus vulnus* population in San Joaquin is behaving differently from our own captive population at the Kearney Ag Center (originally from Winters, CA), as indicated by its differential reproduction on Viking and Atlas. At Kearney Ag Center the San Joaquin Co (Escalon) population has now been placed onto several of the rootstocks listed above. The ring nematode population at the Kern County site is morphologically distinct from populations in Escalon and Parlier. These differences with ring nematode are the subject of a current but separate study involving scientists at UCR and KAC.

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

Evaluation of the first 38 rootstocks has already been conducted and results were reported at last year's almond Conference in the form of a single chart (see Table 1). Three additional rootstocks are receiving evaluation this year. As our results have come in they have been compared to findings elsewhere in the world and differences between our data and the work of others is noteworthy.

First, there is the notion that our root knot nematode (this is an *M. incognita* common to Kearney Ag Center but at one time 40 years ago was referred to as *M. thamesei*) is now thought to be a very aggressive form of root knot because it is reproducing on Guardian and numerous European rootstocks that were supposed to be resistant to root knot.

Second, it is thought that our population of *Pratylenchus vulnus* is only moderate in aggressiveness because there are rootstocks which we report to be resistant that are not resistant when the *P. vulnus* is more aggressive, such as those populations originally from Georgia or Argentina. Our *P. vulnus* is originally from walnut near Winters, CA, and was grown axenically for several years at the Davis campus and was from 1976 to 1992 reared on peach and plum rootstocks at Kearney Ag Center where it caused damage.

The point is that there are differences in the aggressiveness of our root knot and root lesion populations compared to these same species when collected worldwide. What we now need to know is the aggressiveness of *P. vulnus* from different almond orchards around California. We will report in Objective 4 that there is a root lesion population in a San Joaquin County (Escalon) rootstock trial that is developing on Viking and Atlas but our root lesion population did not. We now have the Escalon population and a native Fresno County population of *P. vulnus* growing in the presence of several of these rootstocks. Additionally, we have not discontinued our original screening of the 38 rootstocks. We await the passage of time to determine if some of these rootstocks we originally referred to as resistant may eventually become susceptible.

Objective 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.

This portion of our trial was initiated but did not yield remarkable negative plant growth. We have four to eight trees of each of the 38 rootstocks that we continue to leave in the ground for long-term evaluation against the two nematode population *P. vulnus* and *M. incognita*. Meanwhile, our 38 trees did not pass uniformly through the windy winter months and we have logged differences in the presence of wind damage (limb breakage) as well as the presence of *Taphrina deformans*, or peach leaf curl. It was Okinawa rootstock and its crosses that were highly susceptible to peach leaf curl. It was the peach x almond hybrids that tend to break their limbs in heavy winds, but not all peach x almond hybrids. Also, we now have several of these second-leaf rootstocks that are showing serious plant growth reduction due to root knot nematode attack. This portion of our study will continue at least through 2005.

Objective 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.

In 2004 we planted 18 of the rootstocks into sand infested with ring nematode. We have only enough room to study 40 rootstocks at one time. This experiment is underway and the first results from a 2-year evaluation are included in Table 2. These trees are sampled for nematodes every six months for two years and their population peaks graphed to determine the breadth and height of the peak for each rootstock. These data are premature but we can perhaps separate out

three groupings of the rootstocks in the presence of ring nematode. This ring nematode (Parlier population) is among the most aggressive populations of which we are currently aware.

Build-up of ring nematode is currently least on Lovell and Guardian. It can currently be stated that among our first 18 selections we do not so far have a rootstock offering greater ring nematode resistance than Lovell. Other rootstocks in this grouping include Pumiselect, Viking, Cadaman, Ishtara and 9494-32. There is also a grouping of rootstocks that exhibited about the same host status as Nemaguard. Interestingly Citation rootstock was in that grouping but all four Citation trees died this spring and it appeared to be a Bacterial Canker-like event. Six of the 18 rootstocks produced more than twice as many ring nematode as Nemaguard. Rootstocks that appear to be very good hosts for ring nematode include Garnem, Julior, Hiawatha, Atlas, Nickels and Empyrean #2.

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

During the winter and spring we received soil samples from several existing almond rootstock trials.

In Kern County preliminary samples of two trials were received from MarioViveros plus samples from an unreplicated commercial field. The commercial field was not adequately designed for data collection and nematodes were generally absent. One of Mario's RCB designed trials did not exhibit adequate nematode presence. A second RCB designed site of Mario's received extensive sampling with collections from good growing and poor growing trees infested with *Mesocriconema xenoplax*. Poor growth of the trees did not appear to be associated with nematode presence and no Bacterial Canker was present in the block. This ring nematode is slightly smaller in size than the ring nematode from Escalon, but we currently do not know if this difference has any implications relative to tree damage.

In San Joaquin County (Escalon) samples were received from a 7-year-old RCB designed bacterial canker site involving eight rootstocks. This site developed by Paul Verdegaal and Roger Duncan supported two nematode species including *P. vulnus* and *Mesocriconema xenoplax*. Where ring nematode populations were low the population levels of *P. vulnus* were high. These nematodes do compete for feeding sites but to date Bacterial Canker is still thought to be a disease predisposition caused by feeding of ring nematode not *P. vulnus*. In this site *P. vulnus* was hosted by Atlas and Viking rootstocks but these rootstocks did not host our *P. vulnus* population from Kearney Ag Center as screened in Objective 1. The source of these differing responses is being explored with funding from the California Tree Fruit Agreement.

In Butte County a RCB-designed trial involving eight rootstocks and established by Joe Connell received a preliminary sampling from several replicates but there were no species except pin nematode that were well distributed across the field. Abundance of pin nematode is oftentimes a good indication of abundant root development. This field trial did not receive further, more extensive soil sampling. We continue to search for additional field trials involving various almond rootstocks. Results of this work will be reported directly by the cooperating farm advisors but we have summarized nematode findings in charts 1-3 below.

Table 1. Nematode Profile for selected *Prunus* rootstocks

	Nematodes per gram of root			Nemas/250cc soil		vigor	
Rootstock	P. vulnus	P. vulnus +	M. incognita	M. xenoplax	Field BCC	S	SL
Cadaman	0	0.01	0				
Viking G. S.	0.01	0	0				
Empyrean #1	0	0.02	0				
Hiawatha	0.03	0	0				
Cornerstone	0.02	0.06	0.01				
UCB-1 Pistachio	0.06	0.06	0				
9494-50	0.16	0.35	0				
Monegro	0	0.23	0				
Atlas G. S.	0	0.23	0.03				
Nickels	0.03	0.29	0				
Empyrean #2	0.03	0.52	0				
Torinel	0.33	0.3	0				
Garnem	0.32	0.46	0				
Hansen 536	0.4	0.9	0.01				
9494-32	0	0.91	0.77				
BH-1	1.43	0	0				
BH-4	1.59	0.13	0				
9494-10	0.43	0.03	0.09				
BH-5	0.64	1.43	0.11				
Nemaguard	**1.95**	**0.72**	**0**				
Flordaguard	0.49	4.74	0				
Pumiselect	6.43	5.82	0.11				
Ishtara	0.23	22.5	0.02				
P30-135	0.06	3.48	26				
Citation	25.5	1.21					
Guardian	9.47	0.14	19.9				
Krymsk 1	0.17	0.06	30.9				
Okinawa	31.2	0.95	0				
MRS 2-8	29.4	16.7	0				
Paramount	0.15	2.73	55.8				
Krymsk 8	43.9	17.6					
Empyrean 101	59.1	3	1.32				
Krymsk 86	0	5.3	64				
Lovell	16.7	3.3	50.6				
Julior	28.1	52.9					
Krymsk 2	51.2	0	36.9				
Empyrean #3	92.3	7.2	2.08				
K 146-43	63.4	8.4	65.2				

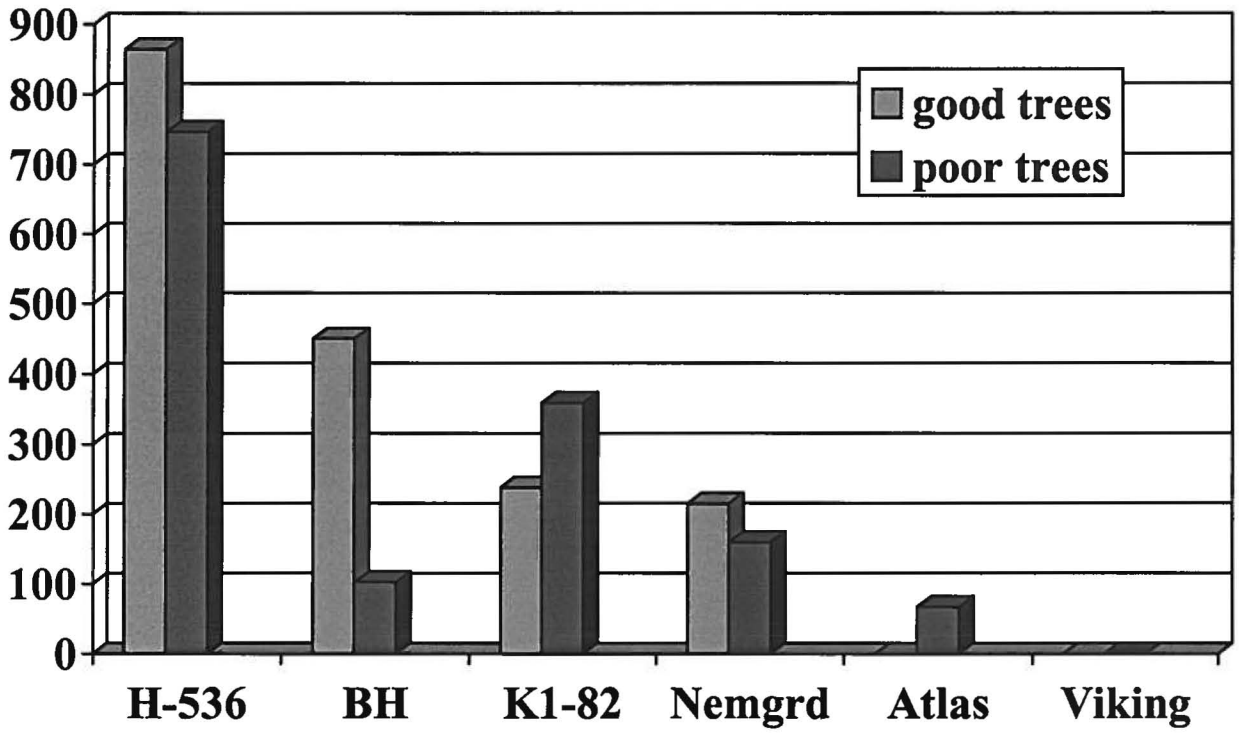
Table 2. Eighteen Prunus rootstocks against *Mesocriconema xenoplax*

Ring populations as % of Nemaguard

	T + 6 mo	T + 12 mo	T + 18 mo	T + 24 mo
Lovell	56%		29%	
Guardian	33		53	
Pumiselect	45		54	
Viking	3400		59	
Cadaman	28	*70		
Ishtara	169		73	
9494-32	small trees		77	
BH-1	38		88	
Krymsk 86	116		91	
MRS 2-8	132		91	
Nemaguard	**100**		**100**	
Citation	64	****107		
Garnem	285		254	
Julior	458		300	
Hiawatha	557		456	
Atlas	10900		460	
Nickels	48		730	
Empyrean #2	1170	*1190		
Torinel	poor innoc	**0		

* indicates number of dead trees at 2nd leaf

Chart 1. Ring nematodes / 250 cc soil sample from a Mario Viveros trial in Kern County.



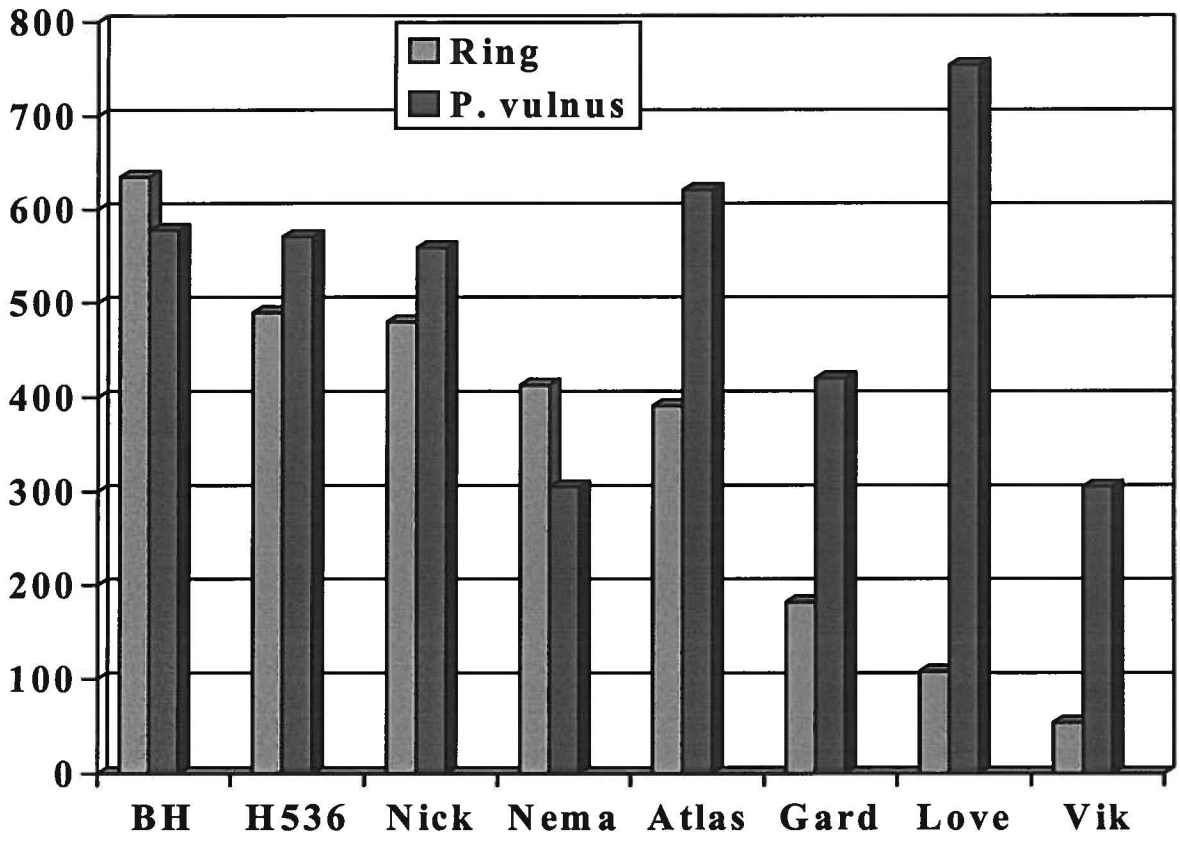
*small-sized *M. xenoplax*

log transformations from mean of good and poor trees:

Hansen's536	a
Bright's Hybrid	a
Kester's1-82	ab
Nemaguard	abc
Atlas	bc
Viking	c

(P = 0.05)

Chart 2. Root lesion and ring nematodes / 250 cc soil sample in the Escalon trial of Paul Verdegaal and Roger Duncan.

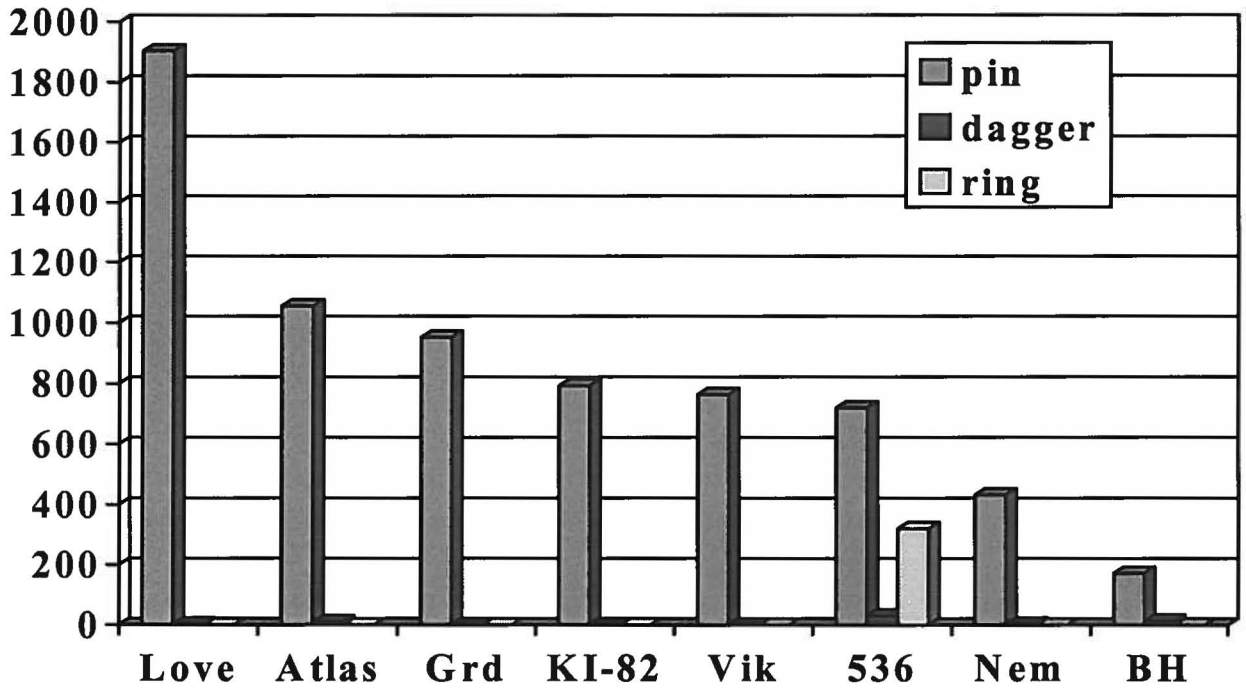


Log transformation of mean population level for each nematode:

	M. xenoplax	*P. vulnus*
Bright's Hybrid	**a**	**ns.**
Nickels	**ab**	
Nemaguard	**ab**	
Guardian	**ab**	
Atlas	**ab**	
Hansen's 536	**ab**	
Lovell	**bc**	
Viking	**c**	

(P = 0.05)

Chart 3. Pin and dagger nematodes / 250 cc soil sample at Joe Connell's trial in Butte County.



Note: Inadequate nematode presence to justify sampling from each replicate