Cling Peach

ANNUAL REPORT 2006

EVALUATION OF ROOTSTOCKS FOR TOLERANCE TO BACTERIAL CANKER AND ORCHARD REPLANT CONDITIONS.

T. DeJong[1], A. Almehdi[1], J. Grant[2] and R. Duncan[3]

[1]Department of Pomology; University of California, Davis CA 95616

[2]University of California Cooperative Extension, San Joaquin County, Stockton, CA

[3]University of California Cooperative Extension, Stanislaus County, Modesto, CA

Summary

The objective of this project is to select rootstocks that are tolerant or resistant to the canker disease caused by the bacterium *Pseudomonas syringae.* Twenty-three rootstocks, including the two controls, Nemaguard and Lovell, were grafted with "Ross" and planted in a field site near the Stanislaus River that has very course sandy soil and a history of bacterial canker problems.

Symptoms of canker started to show on some of the rootstocks in 2003. Generally, the symptoms started to be apparent in late March and were more pronounced in Mid April. Data on tree lethality due to the canker disease, taken from 2003 through 2006, showed that few rootstocks conveyed the avoidance, to the tree, of any lethality due to canker. These rootstocks were Guardian, Nemaguard, Viking, *P. mira*, Lovell, Compass, Flordaguard, HBOK15, HBOK 1, HBOK 17 and Weeping peach. Data from samples of soils and roots, from which live ring, root-knot and lesion nematodes were extracted, showed that the highest number of ring nematodes was found in Nickles, K119-50, Hansen 536, Hiawatha *P. subhirtella* P30-135 and K146-43. These data, generally, correlated with the data of tree lethality, taken from 2003 through 2006, where the rootstocks that harbored high numbers of ring nematodes also showed high numbers of tree lethality.

If one depends on the dormant pruning weight as indication of whether a rootstock is size controlling or not, it was clear from this year's data that Nickles exceeded the control, Nemaguard, in vigor. On the other hand, K146-43, St. Anthony, P30-135, K119-50, Weeping

Peach and Compass were the most size controlling. Trees on Hansen 536, *P. ferganensis*, and OKHB15 were similar to the control Nemaguard. The rootstocks, St. Anthony, Cadaman, Guardian and the control Nemaguard had the highest number of suckers (2.3 to 4.1 suckers per tree). The rest of the rootstocks had zero to one suckers per tree.

Trees on the majority of the tested rootstocks were similar to the control with regard to the traditional measure of yield efficiency (Yield/Trunk Sectional Area). Yield efficiencies of trees on the Weeping peach, HBOK 1, Cadaman, HBOK 17, Atlas, K119-50, K146-43, , and Lovell rootstocks were higher than the control. Trees on the rootstocks Nickles had lower efficiency than the control.

Trees on the HBOK 32 (Harrow Blood peach x Okinawa peach) rootstock, planted in 2002 to replace trees on Deep Purple, showed size control, significantly higher yield efficiency and less suckers when compared with Lovell.

Problem and Significance

Loss of peach trees to the "bacterial canker" disease is a serious problem, particularly in the sandy soils of the central valleys of California. This problem appears to be related to the susceptibility of the current peach rootstocks to infection by ring and lesion nematode as well as a complex of several other factors. The problem is similar to the malady termed PTSL (Peach Tree Short Life) in the southeast of the United States. Recently, researchers in Georgia and South Carolina have reported the discovery of a series of seedling rootstocks that have reduced susceptibility to PTSL in the Southeast. When early selections of these rootstocks were tested under bacterial canker conditions in California, they failed to perform any better than current California rootstocks. However the fact that certain rootstocks appear to confer some benefit in PTSL conditions in the Southeast indicates that it would be beneficial to screen a broad range of rootstock genotypes for potential tolerance to bacterial canker conditions in California. In addition, identification of rootstocks that are more tolerant to bacterial canker conditions would probably also be beneficial for use where the more general "orchard replant problem" exists, as use of soil fumigants become more limited.

Furthermore, several rootstocks have recently been identified that confer varying degrees of size-control on the scion cultivar propagated on them. Availability of these rootstocks for commercial purposes could significantly reduce grower costs by decreasing pruning costs and reducing orchard ladder work. However, none of these rootstocks has been tested for tolerance/susceptibility to "bacterial canker" or "orchard replant" conditions.

Goal and Objectives

The goal of this project is to evaluate a range of *Prunus* species that come from various parts of the world along with several inter-specific hybrid genotypes that have backgrounds that may confer some unique tolerance characteristics to bacterial canker. Several of the potential rootstocks also impart varying degrees of size-control to the scion.

Progress during 2006

In February, 2000, trees on a broad range of rootstocks grafted with Ross cling peach were planted in a field site near the Stanislaus River that has very course sandy soil and has had a history of bacterial canker problems (Table 1). Dormant pruning weights were measured in the first week of February and summer pruning weights in late spring. The dormant pruning was done earlier in the winter season, instead of March starting in 2003, to enhance the likelihood of canker disease infection. The crop was harvested in one pick in the third week of August. Tree yield data were taken on five tree replications of each rootstock. Data on the weight and number of fruits per one representative box, for every five trees, were also taken to calculate the average fruit weight (size). Tree height and trunk circumference were determined in mid-October.

Symptoms of canker started to show on some of the rootstocks in spring of 2003. Generally, the symptoms started to show in late March and became more pronounced in mid April. Data on the percentages of dead trees from the start of taking data in 2003 through this year (2006) are shown in Table 2. Few rootstocks conveyed the avoidance of any lethality due to canker. These rootstocks are Guardian, Nemaguard, Viking, *P. mira*, Lovell, Compass, Flordaguard, HBOK15, HBOK 1, HBOK 17 and Weeping peach. Table 2 also shows that trees on the rootstocks *P. subhirtella*, Nickles and P30-135 were the hardest hit and *P. mira*, Lovell, Compass, HBOK32, Flordaguard, HBOK15, HBOK1, Weeping peach and HBOK17 were the least hit by the canker

disease in 2006. Figure1 shows dead trees, due to the canker disease, on the Nickels rootstock. Figure 2 shows the symptoms of canker on Ross grafted on the *P. subhirtella* rootstock after stripping the bark from the tree. Samples of soils and roots were taken from each tree in October 2006 and live ring, root-knot and lesion nematodes were extracted and counted by Mike McKenry, UC Riverside and the data are shown in Table 3. The highest number of ring nematodes was found in Nickles, K119-50, Hansen 536, Hiawatha *P. subhirtella*, P30-135, Nemaguard and K146-43. Except of Nemaguard, this is consistent with the % of dead trees, due to the disease, shown in Table 2 where rootstocks that harbored high numbers of ring nematodes are also the ones that had the highest percentages of trees died from canker.

Results regarding vegetative growth parameters were summarized as follows:

A. Table 4: The mean values of four measurements (height, dormant pruning weight and summer pruning weight) and how each of these values ranked as a % of the Nemaguard control.

1. Height: Trees on Nickles, *P. ferganensis,* Viking, Hansen 536, Guardian, *P. mira,* Atlas, Lovell, Flordaguard, and OKHB 1 rootstocks were similar to trees on Nemaguard (control). The rest of the rootstocks reduced the height of the tree significantly compared to the control.
2. Dormant Pruning Weight: Trees on Nickles had significantly greater pruning weights than the control. On the other hand, pruning weights of trees on Hansen 536, *P. ferganensis* and HBOK15 rootstocks were similar to the control. Trees on the rest of the rootstocks had significantly less pruning weights than the control.
3. Summer Pruning Weight: Trees on Nickles, Hansen 536 and Gardian had significantly greater pruning weights than the control. Trees on OKHB 15, *P. ferganensis*, Atlas, Viking, *P. mira*, OKHB 17, Cadaman, HBOK1, Flordaguard and Lovell rootstock were similar to that of the control Nemaguard. Trees on the rest of the rootstocks had significantly less pruning weights than the control.

B. Table 5:

Number of Suckers: The rootstocks St. Anthony and Cadaman had the largest number (about four) of suckers per tree. The Nemaguard control and Guardian had the second

largest number (about three) of suckers. The rest of the rootstocks had few (0 to 0.9) suckers.

Fruit yield results were summarized as follows (Table 6):

1. Yield: Trees on OKHB1, Cadaman, HBOK17, Lovell, HBOK15, Flordaguard, *P. ferganensis*, Viking, Atlas, *P. mira*, Guardian, Hansen 536 and Nickles had yields similar to the Nemaguard control. The remaining rootstocks had lower yields per tree but many had yield efficiencies that were similar to Nemaguard (see yield efficiency below).
2. Yield Efficiency: Yield efficiency (crop divided by TCA) takes the size of the tree into account. Trees on Weeping Peach, HBOK1, Cadaman, HBOK17 and Atlas exceeded the yield efficiency of trees on the Nemaguard control. Trees on K119-50, Lovell, *P. mira*, Compass, Flordaguard, HBOK 15, K146-43, *P. ferganensis*, Viking, Hansen 536, Guardian, *P. subhirtella*, P30-135 and St. Anthony had similar efficiencies to the control. Trees on the rootstock Nickles had lowest efficiencies than the control and the rest of the tested rootstocks. Nickles had the lowest value.
3. Weight per Fruit (Size): Trees on the majority of the rootstocks had similar fruit size to that of the control Nemaguard. Trees on *P. subhirtella*, Compass, P30-135, HBOK1, St. Anthony and HBOK17 had the smaller fruits than the control.

C. Table 7. The rootstock HBOK 32 (Harrow Blood peach x Okinawa peach), that was planted in 2002 to replace trees on Deep Purple, showed size control when compared with the Lovell control. Trees on this rootstock had significantly smaller height, trunk sectional area (TCA) and dormant and summer pruning weights than trees on the control rootstock, Lovell, that were of the same age.

D. Table 8 The yield efficiency of HBOK32 was significantly higher than Lovell. No significant difference was found for the weight per fruit (size) between the two rootstocks.

Table 1. List of the rootstocks being tested. RKN = Root-knot nematode; LN = Lesion nematode.

Prunus Species	**Parents**	**Vigor**
P. ferganensis		very vigorous
P. subhirtella		vigorous
P. mira		vigorous

Inter-specific hybrids

St. Anthony	*P. besseyi x P. salicina*	size controlling, resistant of RKN*
Compass	*P. besseyi x P. hortulana*	size controlling, resistant of RKN
K119-50	*P. salicina x P dulcis*	size controlling
P30-135	*P. salicina x P. persica*	size controlling, resistant of RKN, tolerant to LN**
K146-43	*P. salicina x P. persica*	size controlling, some susceptibility to RKN & LN
Nickels	*P. persica x P. dulcis*	Vigorous, resistant to RKN & LN
Hansen 536	*P. persica x P. dulcis*	Vigorous, resistant to RKN & tolerant to LN
Cadaman	*P. persica x P. dividiana*	Vigorous, resistant to RKN & LN, tolerant to high soil pH
Hiawatha	*P. besseyi x P. salicina*	size controlling, resistant to RKN & LN
Viking	*Inter-specific of peach, plum & apricot*	Very vigorous, may have resistance to RKN& LN
VVA-1 (removed)	*Prunus tomentosa x P. cerasifera*	Size controlling
Deep Purple(removed)	*P. besseyi x P. salicina*	size controlling, resistant of RKN

Prunus persica

Lovell	control	Vigorous, susceptible to RKN& LN
Nemaguard	control	Vigorous, resistant to RKN& tolerant to LN
Flordaguard	(low chill Florida Stock)	Vigorous, resistant to RKN& tolerant to LN
Guardian	(PTSL Georgia stock)	Vigorous, tolerant to peach short life, susceptible to RKN& LN
HBOK 1	Okinawa x Harrow Blood	size controlling, resistant to RKN
HBOK 15	Okinawa x Harrow Blood	size controlling, resistant to RKN
HBOK 17	Okinawa x Harrow Blood	size controlling, resistant to RKN
HBOK 32	Okinawa x Harrow Blood	size controlling, resistant to RKN& tolerant to LN
Weeping Peach	Seedling of ornamental weeping peach	size controlling, resistant to RKN
Atlas		resistant to RKN& LN

Table 2. Percentges of trees showing canker symptoms in Escalon plot for the years 2003 through 2006 and all years combined**.

	2006	2006		2006	2005	2004	2003	All Years
Genotype	Canker Rating	Canker Rating % Control		% Dead Trees	% Dead Trees	% Dead Trees	% Dead Trees	Total % Dead Trees
P30-135*	3.0	146	abc	22	15	6		43
K146-43*	2.6	126	cdef	11	3	5	16	34
Hiawatha *	2.8	134	bcde	19	15			34
Nickles*	3.5	166	ab		15	5	5	25
P. subhirtella*	3.6	171	a	3	14	3		21
K119-50*	2.5	120	cdef		13	5		18
Hansen 536*	2.7	131	cde	11	5			16
St. Anthony*	2.9	139	abcd	8	3	5		15
Atlas*	3.0	145	abc	3	9			12
HBOK 32*	2.1	100	efgeh	9				9
P. ferganensis*	2.3	111	cdefg	7				7
Cadaman*	2.0	98	efgeh			3		3
Guardian	2.3	112	cdefg					0
Nemaguard	2.3	110	cdefg					0
Viking	2.2	107	defg					0
P.mira	2.1	104	defgeh					0
Lovell (control)	2.1	100	defgeh					0
Compass	2.1	100	defgeh					0
Flordaguard	1.8	88	fgeh					0
HBOK 15	1.6	78	gh					0
HBOK 1	1.6	77	gh					0
Weeping peach	1.4	68	h					0
HBOK 17	1.4	65	h					0

* = rootstock has some dead trees (see last column also).

**Canker rating:

1= no symptoms

2 = symptoms on few shoots = lightly affected.

3 = symptoms on many shoots = affected

4 = symptoms on all shoots = severely affected.

5 = symptoms on scaffolds and shoots = dead.

Table 3. Number or percentages of live ring, root-knot and lesion nematdes extracted from 250 cc of soil, with occational roots, of the tested rootstocks.

Rootstock	***Ring (M. xenoplax)***	***Root-knot (Meloidogyne)***	***Lesion (P. vulnus)***	***Lesion (P. penetrans)***	***Lesion (P. neglectus)***
P. ferganensis	66	153	4		
Viking	163	1	14	mostly	
OKHB 1	163	0	61	some	
OKHB 15	171	0	434	67%	
Lovell	**215**	**12**	**101**	6%	19%
Compass	249	5	172	10%	70%
P. mira	272	0	5		
Guardian	275	67	3		
Atlas	281	18	106	50%	
OKHB 32	413	5	108	some	mostly
St. Anthony	463	50	27		mostly
Cadaman	521	0	4		
Flordaguard	587	0.1	107		
K146-43	656	161	82		all
Nemaguard	**676**	**0.8**	**218**	29%	
P30-135	860	125	38	some	mostly
P. subhirtella	895	426	12		all
Hiawatha	937	4	35		all
Hansen 536	1239	0.3	148	25%	
K-119-50	1347	165	6		all
Nickles	1704	11	24		

Table 4. Mean values and % of height, and dormant and summer pruning weights of the tested rootstocks for the year2006

Genotype	Height (cm)*	% Control		Genotype	Dormant pruning weight (Kg)*	% Control		Genotype	Summer Pruning Weight(Kg)*	% Control	
Nickles	661	100	a	Nickles	20.2	116.8	a	Nickles	7.7	183.3	a
Nemaguard	660	100	ab	Hansen 536	17.8	102.9	b	Hansen 536	6.0	142.9	b
P. ferganensis	656	99	abc	Nemaguard	17.3	100.0	bc	Guardian	6.0	142.9	b
Viking	650	98	abc	P. ferganensis	17.1	98.8	bc	HBOK 15	5.2	123.8	bc
Hansen 536	649	98	abc	HBOK 15	15.8	91.3	cd	P. ferganensis	5.2	123.8	bc
Guardian	642	97	abcd	Viking	14.6	84.4	de	Atlas	5.1	121.4	bc
P.mira	632	96	abcde	Guardian	14.3	82.7	de	Viking	4.7	111.9	c
Atlas	627	95	abcde	Cadaman	14.0	80.9	e	P.mira	4.6	109.5	cd
Lovell	626	95	abcde	Atlas	13.9	80.3	e	Nemaguard	4.2	100.0	cde
Flordaguard	625	95	abcde	P.mira	13.9	80.3	e	HBOK 17	4.1	97.6	cde
HBOK 1	624	95	bcde	Lovell	12.7	73.4	ef	Cadaman	3.6	85.7	de
Cadaman	623	94	cde	Flordaguard	12.1	69.9	f	HBOK 1	3.5	83.3	de
HBOK 15	611	93	de	HBOK 17	11.8	68.2	f	Flordaguard	3.5	83.3	e
HBOK 17	605	92	e	HBOK 1	11.4	65.9	f	Lovell	3.2	76.2	e
P. subhirtella	571	87	f	P. subhirtella	8.1	46.8	g	K119-50	1.7	40.5	f
K119-50	532	81	g	Compass	7.6	43.9	gh	P30-135	1.6	38.1	f
Compass	516.0	78	gh	Weeping pea.	6.7	38.7	gh	Weeping pea.	1.2	28.6	fg
Weeping pea.	512.0	78	gh	K119-50	6.5	37.6	gh	Compass	1.1	26.2	fg
P30-135	506.0	77	gh	P30-135	5.8	33.5	h	P. subhirtella	0.9	21.4	fg
K146-43	494.0	75	h	St. Anthony	3.8	22.0	i	K146-43	0.6	14.3	fg
St. Anthony	460.0	70	i	K146-43	3.3	19.1	i	St. Anthony	0.5	11.9	g

* = numbers followed by the same letter(s) are not significantly different.

Table 5. Mean values of the number of suckers of the tested rootstocks.

Genotype	No. Suckers	% Control		Genotype	No. Suckers	% Control		Genotype	No. Suckers	% Control	
St. Anthony	4.1	170.8	a	Nemaguard	2.4	100.0	b	K146-43	0.9	37.5	c
Cadaman	3.8	158.3	a	Guardian	2.3	95.8	b	Lovell	0.8	33.3	c
								Compass	0.7	29.2	c
								K119-50	0.5	20.8	c
								HBOK 1	0.3	12.5	c
								Viking	0.3	12.5	c
								Nickles	0.3	12.5	c
								Flordaguard	0.3	12.5	c
								Hansen 536	0.3	12.5	c
								P30-135	0.3	12.5	c
								HBOK 15	0.2	8.3	c
								P. subhirtella	0.1	4.2	c
								P. ferganensis	0.0	0.0	c
								Atlas	0.0	0.0	c
								HBOK 17	0.0	0.0	c
								P.mira	0.0	0.0	c
								Weeping pea.	0.0	0.0	c

* = numbers followed by the same letter(s) are not significantly different.

Table 6. Mean values and % of control of yield, yield efficiency, weight per fruit and fruit weight (size) of the tested rootstocks for 2006.

Genotype	Yield (Kg)	% Control		Genotype	Efficiency (Kg/cm2)*	% Control		Genotype	Weight per Fruit (g)*	% Control	
HBOK 1	130.1	114.1	a	Weeping pea.	1.00	166.7	a	Nickles	221.2	111.9	a
Cadaman	121.8	106.8	ab	HBOK 1	0.92	153.3	ab	Hansen 536	209.6	106.0	ab
HBOK 17	115.4	101.2	abc	Cadaman	0.83	138.3	bc	P.mira	205.2	103.8	ab
Lovell	115.2	101.1	abc	HBOK 17	0.78	130.0	cd	Cadaman	199.7	101.0	abc
Nemaguard	114.0	100.0	abc	Atlas	0.74	123.3	cde	Nemaguard	197.7	100.0	abc
HBOK 15	113.6	99.6	abc	K119-50	0.72	120.0	cdef	Viking	195.9	99.1	bc
Flordaguard	103.5	90.8	abcd	Lovell	0.72	120.0	cdef	Guardian	195.2	98.7	bc
P. ferganensis	102.5	89.9	bcd	P.mira	0.68	113.3	defg	Atlas	194.8	98.5	bc
Viking	102.4	89.8	bcd	Compass	0.66	110.0	defgh	K146-43	193.1	97.7	bcd
Atlas	102.0	89.5	bcd	Flordaguard	0.65	108.3	defghi	K119-50	191.1	96.7	bcd
P.mira	102.0	89.5	bcd	HBOK 15	0.64	106.7	defghi	P. ferganensis	187.2	94.7	bcde
Guardian	99.0	86.8	bcde	K146-43	0.64	106.7	efghi	HBOK 15	178.9	90.5	cdef
Hansen 536	96.6	84.7	bcdef	Nemaguard	0.60	100.0	fghi	Lovell	178.2	90.1	cdef
Nickles	87.9	77.1	cdefg	P. ferganensis	0.56	93.3	ghi	Flordaguard	178.0	90.0	cdef
Compass	78.4	68.8	defgh	Viking	0.55	91.7	ghi	Weeping pea.	175.2	88.6	cdef
Weeping pea.	74.9	65.7	efgh	Hansen 536	0.55	91.7	ghi	P. subhirtella	168.3	85.1	def
P30-135	70.6	61.9	fgh	Guardian	0.55	91.7	ghi	Compass	162.7	82.3	ef
P. subhirtella	69.1	60.6	gh	P. subhirtella	0.54	90.0	hi	P30-135	159.9	80.9	f
St. Anthony	55.1	48.3	hi	P30-135	0.53	88.3	hi	HBOK 1	156.2	79.0	f
K119-50	53.7	47.1	hi	St. Anthony	0.52	86.7	i	St. Anthony	133.3	67.4	g
K146-43	37.5	32.9	i	Nickles	0.41	68.3	J	HBOK 17	116.3	58.8	g

* = numbers followed by the same letter(s) are not significantly different.

Table 7. Mean values and % of control of height, trunk sectional area (TCA), number of suckers and dormant and summer pruning for HBOK32 compared with Lovell rootstocks for 2006. The trees were planted in 2002.

Genotype	Height (cm)*	% Control	
Lovell	634	100.0	a
HBOK 32	538	84.9	b

Genotype	TCA (cm2)*	% Control	
Lovell	93.8	100.0	a
HBOK 32	62.2	66.3	b

Genotype	Dormant pruning weight (Kg)*	% Control	
Lovell	5.8	100.0	a
HBOK 32	4.7	81.0	b

Genotype	Summer Pruning Weight(Kg)*	% Control	
Lovell	2.3	100.0	a
HBOK 32	1.7	73.9	b

Genotype	Suckers	% Control	
Lovell	1.2	100.0	a
HBOK 32	0.2	16.7	b

* = numbers followed by the same letter(s) are not significantly different.

Table 8. Mean values and % of control of yield, yield efficiency and weight per fuit (size) for HBOK32 compared with Lovell rootstocks for 2006. The trees were planted in 2002.

Genotype	Yield (Kg)	% Control	
Lovell	65.2	100.0	a
HBOK 32	54.8	84.0	b

Genotype	Efficiency (Kg/cm2)*	% Control	
HBOK 32	0.95	131.9	a
Lovell	0.72	100.0	b

Genotype	Weight per Fruit (g)*	% Control	
Lovell	219.8	100.0	a
HBOK 32	196.6	89.4	a

* = numbers followed by the same letter(s) are not significantly different.

Figure1. Three dead trees, due to the canker disease, on the Nickels rootstock.

Figure 2 Symptoms of canker on Ross grafted on the rootstock *P. subhirtella* after stripping the bark from the tree.