IMPROVED ROOTSTOCKS FOR PEACH AND NECTARINE

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SUMMARY

The objective of this project is to develop genetically improved rootstocks for peach and nectarine that combine tree size control and resistance to important diseases and pests including nematodes.

Seventeen rootstocks, one from North American Plants and sixteen from our program, were grafted with O'Henry and planted in a replicated trials at Kearney Agricultural Center (KAC) in February, 2004. This brings the total selected rootstocks being tested in replicated trials - planted in 2003 and 2004 at KAC - to thirty-one (twenty-five from our program and six from North American Plants). Replications of eight additional rootstocks will be planted, at KAC, in February, 2005. All of these rootstocks are root-knot nematode resistant and have the potential for tree size control.

Data from a previous replicated trial at (KAC) identified that three rootstocks from a Harrow Blood peach x Okinawa peach cross have significant size-controlling potential (selections HBOK32, HBOK10 and HBOK50, in descending order of apparent size-controlling effect). These rootstocks are resistant to root knot and tolerant to lesion nematodes. Selection HBOK32 was re-replicated in spring of 2002 with Ross clingstone peach at Escalon in a site that has a history of canker and at KAC with O'Henry peach and the early nectarine, Mayfire, in spring 2003. Selection HBOK10 was re-replicated, at KAC, with O'Henry peach and Mayfire nectarine in spring 2003. Both of these rootstocks were also grafted with Springcrest peach and Summer Fire nectarine and planted in the replicated trial at KAC in February 2004. Selection HBOK50 was re-replicated at KAC with O'Henry peach in spring 2003.

In 2004 the rootstock selection (HBOK32) grafted with Ross peach and growing in the bacterial canker site, continued to show size control and no trees showed any canker symptoms.

Tests of the rootstocks HBOK32, HBOK10 and HBOK50 for root-knot and lesion nematodes showed that HBOK32 was tolerant to lesion alone and the combination of lesion and root-knot nematodes, HBOK10 was tolerant to lesion alone and resistant to the combination of lesion and root-knot nematodes and HBOK50 was resistant to lesion alone and to the combination of lesion and root-knot nematodes.

Thirteen additional rootstocks from our program that showed size controlling potential were inoculated with root-knot nematodes in mid July 2004. The examination of their roots showed that six of them were resistant, one was tolerant and six were susceptible.

PROBLEM AND ITS SIGNIFICANCE:

Many high quality scion varieties of peach and nectarine are available to producers, but relatively few rootstocks have been developed for the changing demands of the industry. In recent years there has been increasing interest in the development of size-reducing rootstocks for peaches and nectarines to reduce the labor costs involved in management and harvest of the orchard. As the future availability of soil fumigants becomes increasingly uncertain, there is also increased need for rootstocks with resistance/tolerance to soil borne pests and diseases. To develop improved rootstocks that combine several Elite® traits, hybridization followed by selection is required. Within segregating seedling populations, it is possible to identify individuals that can be clonally propagated, thus developing considerable flexibility in rootstock options for growers.

The control of tree growth of peach and nectarine is usually accomplished by judicious use of management practices, i.e., planting density and pruning. However, even with the best management practices, the resultant large trees usually require large maintenance equipment for tree care and the use of ladders for pruning, fruit thinning and harvest. An attractive alternative would be the management of tree growth by size-controlling rootstocks, such as are available for apple. This would allow trees to be managed from ground level with no resultant loss of per acre yield or reduction in fruit quality while using current scion cultivars.

Several peach varieties and inter-specific hybrids are reported to have growth controlling ability (e.g., Layne and Jui, 1994), but its inheritance is unknown. Some peach cultivars, including Harrow Blood, Siberian C, and Rubira, have shown growth controlling ability but these rootstocks are either not well adapted to California or are nematode susceptible.

Concomitant with growth control in improved rootstocks is the need for resistance to nematodes and important diseases since the diminished availability of approved chemical control agents is likely to continue. New rootstocks should have nematode resistance similar to the levels found in current rootstocks, i.e., Nemaguard and Nemared. Additionally, resistance to bacterial canker and crown gall would be desirable. None of the rootstocks currently in wide use has these combined attributes.

For each of the desired traits, there are several available sources of genetic materials that are potentially valuable for rootstock improvement. Resistance to root knot nematode is well defined and materials such as Okinawa, Nemared, Nemaguard, Flordaguard, etc. can be used as parents for hybridization (Sharpe, 1957; Sherman et al., 1991). However, genetic variability for growth control, crown gall and bacterial canker resistance is less well defined. Therefore,

systematic screening is needed to identify the most useful materials. We have done an extensive screening of *Prunus* germplasm and have identified candidate genotypes to be used as sources of resistance to crown gall disease (Bliss et al, 1999). We also have screened a large number of *Prunus* genotypes for their resistance/susceptibility to the bacterial canker disease and root knot nematode.

GOAL AND OBJECTIVES

The goal of this project is to develop new rootstocks with pest resistance and tree size controlling ability that can be propagated economically by commercial nurseries for use with a wide range of California peach and nectarine varieties.

The specific objectives of this project are to:

1) Screen *Prunus* populations for i) compatibility and growth controlling potential with peach and nectarine, ii) nematode resistance, initially root knot nematode race 1, iii) crown gall resistance and iv) bacterial canker resistance,
2) Develop Elite® individual plants that can be used for clonal rootstocks; and
3) Assess the potential of the best materials for commercial peach and nectarine production in California.

PROGRESS DURING 2004

PLANTING OF REPLICATED TRIALS

Seventeen rootstocks, one from North American Plants and sixteen from our program, were grafted with O'Henry and planted in a replicated trial at Kearney Agricultural Center (KAC) in February, 2004 (Table 1). The rootstocks Hiawatha-OP, VSV-1 and Cirpac were pulled out from the 2003 trial because of their excessive suckering and/or incompatibility with O'Henry peach. They were replaced with the rootstocks Hiawatha, HBOK29, K146-43 and Tetra in February 2004 (Table 1). This brings the total selected rootstocks being tested in replicated trials - planted in 2003 and 2004 at KAC - to thirty- one (Tables 1 and 2). An additional eight rootstocks have been propagated and will be planted, at KAC, in February, 2005. All of these rootstocks are root-knot nematode resistant or tolerant and have the potential for tree size control.

DATA FROM THE 2003 REPLICATED TRIAL

1. Rootstocks grafted with O'Henry peach:

Table 3 shows the mean values and % of the control of height, trunk circumference and dormant pruning weights of the O'Henry peach trees grafted on fifteen rootstock selections.

A. Height: Trees on HBOK1, HBOK2, and HBOK8 were similar to the control (Nemaguard). Trees on the following rootstocks: HBOK10, HBOK18, two Sapalta-OP

selections, HBOK32, Adesoto and Ishtara, were the shortest (with heights ranging from 73.6% to 79.5% of the control).

B. Trunk circumference: Trees on HBOK50 had trunk circumferences similar to the control (Nemaguard). On the other hand, trees on the rootstocks, Cadaman, one Sapalta-OP selection, Adesoto, HBOK18, Ishtara, HBOK10 and HBOK32, had the lowest trunk circumferences among all of the tested rootstocks.

C. Dormant Pruning Weight: Dormant pruning weights of trees on all of the tested rootstocks were less than the control. Trees on the rootstocks, HBOK32, Adesoto, Ishtara and the two selections of Sapalta-OP had the lowest dormant pruning weights among all of the tested rootstocks. Their dormant pruning weight ranged from 27.3% to 38.6% of the control.

2. Rootstocks grafted with Mayfire nectarine:

Data from a replicated trial at KAC taken from 2000 to 2003 showed that three rootstocks of the Harrow Blood x Okinawa cross (HBOK32, HBOK10 and HBOK50), grafted with O'Henry, had significant size-controlling potential. These rootstocks were re-replicated with O'Henry and the trees were planted, at KAC, in February 2003. The first and the second rootstocks (HBOK32 and HBOK10) were also re-replicated, at KAC, with Mayfire nectarine in spring 2003.

The first rootstock (HBOK 32) showed significantly smaller height, trunk circumference and dormant pruning weight than the control Nemaguard (Table 4). Trees on HBOK 10 were significantly shorter than trees on than the control but the trunk circumference and dormant pruning weight were similar to that of the control (Table 4).

ROOTSTOCK TESTED WITH THE PEACH ROSS

One of the rootstocks (HBOK 32) that showed tree size control potential was grafted with Ross peach at Escalon in a site that has a history of bacterial canker. At this site trees on this rootstock had significantly less height, trunk cross sectional area (TCA) and dormant and summer pruning weights than trees on the control rootstock, Lovell. The number of suckers was similar (non-significant) to the control. The crop and weight per fruit were similar but the efficiency (crop per trunk sectional area) was higher for the trees on the rootstock HBOK 32 than the control. No trees, of this rootstock, showed any canker symptoms in this plot.

TESTING ROOTSTOCKS FOR REACTION TO NEMATODES:

Thirteen rootstocks, from our program, that showed size control potential were inoculated with root-knot nematodes in mid July 2004. The examination of their roots showed that six of them were resistant, one was tolerant and six were susceptible.

The rootstocks HBOK10, HBOK32 and HBOK50 were also tested by Dr. Michael McKenry for root-knot and lesion nematodes. HBOK10 was found to be tolerant (small bumps on the roots but no galls) to lesion alone and resistant (no sign of infection) to the combination of lesion and root-knot nematodes. HBOK32 was found to be tolerant to lesion alone and the combination of lesion and root-knot nematodes. HBOK50 was found to be resistant to lesion alone and to the combination of lesion and root-knot nematodes.

REFERENCES

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Table 1. List of rootstocks that have size-controlling potential being tested in replicated trials . The trees were grafted with the appropriate scion and planted, at Kearney Ag. Center, in February 2004.

Rootstock	Genotype	Scion	Description
HBOK5	Harrow Blood x Okinawa-5	O'Henry Peach	Size controlling; resistant to RKN.
HBOK9	Harrow Blood x Okinawa-9	O'Henry Peach	Size controlling; resistant to RKN.
HBOK10	Harrow Blood x Okinawa-10	Springcrest Peach	Size controlling; tolerant to LN and resistant to RKN.
HBOK10	Harrow Blood x Okinawa-10	Summer Fire Nectarine	Size controlling; tolerant to LN and resistant to RKN.
HBOK27	Harrow Blood x Okinawa-27	O'Henry Peach	Size controlling; resistant to RKN.
HBOK28	Harrow Blood x Okinawa-28	O'Henry Peach	Size controlling; resistant to RKN.
HBOK29	Harrow Blood x Okinawa-29	O'Henry Peach	Size controlling; resistant to RKN.
HBOK32	Harrow Blood x Okinawa-32	Springcrest Peach	Size controlling; resistant to RKN and LN.
HBOK32	Harrow Blood x Okinawa-32	Summer Fire Nectarine	Size controlling; resistant to RKN and LN.
HBOK36	Harrow Blood x Okinawa-36	O'Henry Peach	Size controlling; resistant to RKN.
HBOK138	Harrow Blood x Okinawa-138	O'Henry Peach	Size controlling; resistant to RKN.
HBOK160	Harrow Blood x Okinawa-160	O'Henry Peach	Size controlling; resistant to RKN.
Hiawatha	P. besseyi x P. salicina	O'Henry Peach	Size controlling; resistant to RKN.
K146-43	P. salicina x P. dulcis	O'Henry Peach	Size controlling; resistant to RKN.
KV84068-S	KV84068-Selfed	O'Henry Peach	Size controlling; resistant to RKN.
Nemaguard	Control	O'Henry Peach	Vigorous; resistant to RKN and tolerant to LN
Nemaguard	Control	Springcrest Peach	Vigorous; resistant to RKN and tolerant to LN
Nemaguard	Control	Summer Fire Nectarine	Vigorous; resistant to RKN and tolerant to LN
Rubira	Rubira-OP	O'Henry Peach	Size controlling; resistant to RKN.
Tetra	Prunus domestica selection	O'Henry Peach	Size controlling; resistant to RKN.
Weeping peach	Weeping peach-OP	O'Henry Peach	Size controlling; resistant to RKN.
Weeping peach	Weeping peach-OP	O'Henry Peach	Size controlling; resistant to RKN.

*RKN = Root Knot Nematode
**LN = Lesion Nematode

Table 2. List of rootstocks that have size-controlling potential being tested in replicated trials. The trees were grafted with the appropriate scion and planted, at Kearney Ag. Center, in February 2003.

Rootstock	Genotype	Scion	Description
Adesoto	P. isititia selection	O'Henry	From NAP*; 80% of the standard size of peach; early entry in production; productive; induces larger fruit size and earlier ripening in peaches; good adaptation to poor or saline soils.
Barrier	P. persica x P. davidiana	O'Henry	From NAP; adaptive to a wide array of soils, was selected for longevity and performance on replant sites.
Cadaman	(P. persica x P. dulcis) x P. dividiana	O'Henry	From NAP; high becoming less vigorous with age; highly recommended for re-plant situations or warm sandy soils where high populations of nematodes are present; has a high yield efficiency. Resistant to RKN** and LN***.
HBOK 1	Harrow Blood x Okinawa-1	O'Henry	Size controlling; resistant to RKN.
HBOK 2	Harrow Blood x Okinawa-2	O'Henry	Size controlling; resistant to RKN.
HBOK 8	Harrow Blood x Okinawa-8	O'Henry	Size controlling; resistant to RKN.
HBOK 10	Harrow Blood x Okinawa-10	Mayfire	Size controlling; tolerant to LN and resistant to RKN.
HBOK 10	Harrow Blood x Okinawa-10	O'Henry	Size controlling; tolerant to LN and resistant to RKN.
HBOK 18	Harrow Blood x Okinawa-18	O'Henry	Size controlling; resistant to RKN.
HBOK 32	Harrow Blood x Okinawa-32	Mayfire	Size controlling; resistant to RKN and LN.
HBOK 32	Harrow Blood x Okinawa-32	O'Henry	Size controlling; resistant to RKN and LN.
Pumiselect	P. pumila selection	O'Henry	From NAP; dwarfing to semi-dwarfing (70% of 'Nemaguard'); high resistance to plum pox (sharka) virus; precocious and very cold hardy. Resistant to RKN and moderately susceptible LN.
Ishtara	Belsiana plum (P. cerasifera x P. salicina) x (natural hybrid of P. ceracifera x P. persica)	O'Henry	From NAP; semi dwarfing to slightly smaller than peach seedling; shows high productivity; rapid entry in production and induces larger fruit size in peach. Resistant to RKN and LN but susceptible to LN if both RKN and LN are present in the soil.
Spalta	Spalta-OP 3	O'Henry	Size controlling; resistant to RKN.
Spalta	Spalta-OP 12	O'Henry	Size controlling; resistant to RKN.
Spalta	Spalta-OP 24	O'Henry	Size controlling; resistant to RKN.
Nemaguard	Control	Mayfire	Vigorous; resistant to RKN and tolerant to LN
Nemaguard	Control	O'Henry	Vigorous; resistant to RKN and tolerant to LN

*NAP = North American Plant
**RKN = Root Knot Nematode.
LN*** = Lesion nematode.

Table 3. Mean values and % of the control of height, trunk circumference and dormant pruning weight of the rootstocks grafted with O'Henry peach. The trees were planted, in a replicated trial, in 2003.

Genotype	Height (cm)*	% Control		Genotype	Circumference (cm)	% Control		Genotype	Dormant pruning weight (Kg)*	% Control	
Nemaguard (control)	351.0	100.0	a	Nemaguard (control)	24.5	100.0	a	Nemaguard (control)	4.4	100.0	a
HBOK 1	335.3	95.5	ab	HBOK 50	22.5	91.8	ab	HBOK 50	3.6	81.8	b
HBOK 2	329.1	93.8	abc	Pumiselect	21.5	87.8	bc	HBOK 1	3.6	81.8	b
HBOK 8	329.0	93.7	abc	HBOK 1	21.4	87.3	bc	HBOK 8	3.5	79.5	bc
HBOK 50	325.0	92.6	bc	Barrier	21.3	86.9	bcd	HBOK 2	3.4	77.3	bc
Barrier(N)	304.3	86.7	dc	HBOK 2	20.9	85.3	bcd	Pumiselect	3.3	75.0	bc
Cadaman	299.3	85.3	ed	HBOK 8	20.5	83.7	bcd	Cadaman	3.2	72.7	bc
Pumiselect	287.4	81.9	edf	Spalta-OP	19.8	80.8	cde	Barrier	3.0	68.2	c
HBOK 10	279.0	79.5	edfg	Cadaman	18.8	76.7	def	HBOK 10	2.4	54.5	d
HBOK 18	277.5	79.1	efg	Spalta-OP	17.8	72.7	ef	HBOK 18	2.0	45.5	ed
Spalta-OP	276.8	78.9	efg	Adesoto	17.5	71.4	ef	HBOK 32	1.7	38.6	ef
HBOK 32	271.3	77.3	fg	HBOK 18	17.2	70.2	ef	Adesoto	1.7	38.6	ef
Spalta-OP	269.5	76.8	fg	Ishtara	16.8	68.6	f	Ishtara	1.7	38.6	ef
Adesoto	266.8	76.0	fg	HBOK 10	16.4	66.9	f	Spalta-OP	1.7	38.6	ef
Ishtara	258.4	73.6	g	HBOK 32	16.3	66.5	f	Spalta-OP	1.2	27.3	f

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

Table 4. Mean values of height, trunk circumference and dormant pruning weight of the tested rootstocks, grafted with Mayfire nectarine, of the 2003 replicated trial.

Genotype	Height (cm)*	% Control		Genotype	Circumference (cm)	% Control		Genotype	Dormant pruning weight (Kg)*	% Control	
Nemaguard (control)	456.0	100.0	a	Nemaguard (control)	24.4	100.0	a	Nemaguard (control)	7.0	100.0	a
HBOK 10	375.0	82.2	b	HBOK 10	19.7	80.7	ab	HBOK 10	5.6	80.0	a
HBOK 32	294.0	64.5	c	HBOK 32	16.0	65.6	b	HBOK 32	2.0	28.6	b

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

Table 5. Mean values and % of control of height, trunk sectional area (TCA), number of suckers and dormant and summer pruning, crop, efficiency, and weight per fruit for HBOK32 and Lovell rootstocks grafted with Ross peach planted in Escalon.

Genotype	Height (cm)*	%control		Genotype	TCA (cm2)*	%control		Genotype	No. Suckers*	%control	
Lovell (control)	426.0	100	a	Lovell (control)	61.9	100	a	Lovell (control)	0.2	100	a
HBOK32	341.8	80	b	HBOK32	33.6	54	b	HBOK32	0.0	0	a
Genotype	**Dormant pruning weight (Kg)***	**%control**		**Genotype**	**Summer pruning weight (Kg)***	**%control**					
Lovell (control)	7.7	100	a	Lovell (control)	3.4	100	a				
HBOK32	3.3	43	b	HBOK32	1.4	41	b				
Genotype	**Crop***	**%control**		**Genotype**	**Efficiency***	**%control**		**Genotype**	**Weight per fruit (g)***	**%control**	
Lovell (control)	21.8	100	a	Lovell (control)	0.4	100	a	Lovell (control)	206.0	100	a
HBOK32	22.9	105	a	HBOK32	0.7	175	b	HBOK32	196.0	95	a

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