Journal of the American Pomological Society 65(1): 26-41 2011

Six-Year Performance of 14 *Prunus* Rootstocks at 11 Sites in the 2001 NC-140 Peach Trial

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Abstract

Fourteen *Prunus* rootstock cultivars and selections budded with either 'Redtop', 'Redhaven' or 'Cresthaven' peach [*Prunus persica* (L.) Batsch] were planted at 11 locations in North America in 2001 in a randomized block design with a tree spacing of 5 by 6 m and 8 replicates. This test planting was an NC-140 Cooperative Regional Rootstock Project (www.nc140.org). There were 14 rootstocks in total, which included three peach seedling rootstocks: Lovell, Bailey, and Guardian® 'BY520-9' [selection SC-17]. Clonal rootstocks included the peach × almond hybrids BH-4 and SLAP (Cornerstone); peach × plum hybrids K146-43 (Controller 5), K146-44, and P30-135 (Controller 9); interspecific plum hybrids Hiawatha, Jaspi and Julior; interspecific *Prunus* hybrids Cadaman® and VVA-1 (Krymsk® 1); and *Prunus pumila* L. selection Pumiselect®. Final tree size was largest in California, Georgia, Maryland, and South Carolina. BH-4, SLAP, SC-17, Lovell, and Cadaman® were the most vigorous rootstocks. Jaspi, K146-43, K146-44 and VVA-1 were the least vigorous, having trunk cross-sectional areas 20-50% of Lovell-rooted trees. No rootstock had a significantly higher survival rate than Lovell at all locations, but Bailey, K146-44, and P30-135 had good survival at all test sites. Julior and Jaspi consistently produced root suckers. Pumiselect® had anchorage problems at several locations. Cumulative fruit yields were highest on the peach seedling, peach × almond, and Cadaman® rootstocks. Lowest cumulative yields were from the small trees on Jaspi, VVA-1 and K146-44 rootstocks. Fruit weight did not differ much among rootstocks though cultivars on Pumiselect® and K146-43 often had smaller fruit. Cumulative yield efficiency was not consistently related to tree size. Rootstocks influenced dates of bloom and harvest, but not in a consistent manner across locations/cultivars.

Peach production in North America has relied on peach seedling rootstocks since the mid-1800s. Entering the 21st Century, peach growers are having to confront replant problems, the loss of registration for soil fumigants and agricultural chemicals, increased production costs, and reduced yields due to shortened tree longevity. To increase orchard productivity and efficiency, growers are looking for solutions via new rootstocks that are more resistant to abiotic (winter cold damage, drought stress, soil anaerobic conditions, etc.) and biotic stresses (root pathogens, soil nematodes, bacterial and fungal cankers, etc.) as well as dwarfing (5, 14, 16). The NC-140 project, a United States, Mexican and Canadian group of cooperating researchers, was organized to test new rootstocks over a wide range of sites in North America. Previous reports (11, 13, 15) from this group have provided information on the performance of mostly peach seedling rootstocks in multiple environments throughout the United States and Canada.

In recent years, clonally propagated, interspecific *Prunus* rootstocks for peach have been licensed and propagated by nurserymen in the United States. These rootstocks had limited field-testing in North America, and thus were good candidates for an NC-140 rootstock trial. To determine the horticultural merits of these rootstocks under North American edaphic and climatic conditions, an NC-140 trial was initiated with the objective to evaluate clonal peach rootstocks compared to current commercial peach seedling rootstocks for survival,

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tree vigor, yield, fruit quality, cold hardiness, nematode or disease tolerance and replant performance in peach production regions.

Materials and Methods

Authorization was obtained to test 12 proprietary rootstocks and selections. Eleven of these were clonal rootstocks, including: peach × almond hybrids BH-4 and SLAP (Cornerstone; Burchell Nursery, Modesto, Calif.); peach × plum hybrids K146-43 (Controller 5, U.C. Davis, Calif.), K146-44, and P30-135 (Controller 9, U.C. Davis, Calif.); interspecific plum hybrids Hiawatha, Jaspi and Julior; interspecific *Prunus* hybrids Cadaman® and VVA-1 (Krymsk® 1, Tree Connection, Oregon); and *Prunus pumila* L. selection Pumiselect®. Three peach seedling rootstocks were also tested: Lovell and Bailey (as controls) and Guardian® 'BY520-9' [selection SC-17]. The origin and characteristics of these rootstocks have been previously summarized (16). Liners or seed of each virus-indexed rootstock were collected in 1999 and sent to Burchell Nursery (Oakdale, Calif.) for nursery propagation and budding. Rootstocks were budded with virus-indexed 'Cresthaven', 'Redhaven' and 'Redtop' peach in 2000, and one cultivar budded on 12-14 rootstocks was selected and shipped to each cooperator in January 2001 for planting in Spring 2001.

The trial's experimental design consisted of 8 single-tree plots (replicates) of each rootstock planted in a randomized complete block design at all 11 locations in the U.S. and Canada. Trees were spaced 5 m within rows and 6 m between rows. Trees were headed at planting to a height of approximately 70-80 cm and trained to an open center system. Supplemental irrigation was available and applied when necessary. Application of pesticides, herbicides and fertilizer followed local recommendations for each state.

'Cresthaven' was planted in Colorado, Texas and Washington. 'Redhaven' was planted in Missouri, New Jersey, Ontario and Utah. 'Redtop' was planted in California, Georgia, Maryland and South Carolina. Data collected

Table 1. State cooperators, affiliations and locations of the 2001 NC-140 peach rootstock test.

State/Province	Location	Cooperator	Affiliation
California	Parlier	R. Scott Johnson	U.C. Davis
Colorado	Grand Junction	Ron Godin	Colorado State University
		Harold Larsen	Colorado State University
		Ramesh Pokharel	Colorado State University
Georgia	Byron	Kathryn Taylor	University of Georgia
		Thomas Beckman	USDA-ARS, Byron, Georgia
Maryland	Wye Mills	Christopher Walsh	University of Maryland
		Mike Newell	University of Maryland
Missouri	Mountain Grove	Martin L. Kaps	Missouri State University
		Patrick L. Byers	University of Missouri
New Jersey	Bridgeton	Robert D. Belding	Rutgers University
		Winfred Cowgill, Jr.	Rutgers University
		Dan Ward	Rutgers University
Ontario	Vineland	John Cline	University of Guelph
South Carolina	Clemson	Gregory Reighard	Clemson University
		David Ouellette	Clemson University
Texas	Stonewall	Larry Stein	Texas A&M University
		Jim Kamas	Texas A&M University
Utah	Kaysville	Brent Black	Utah State University
		Thor Lindstrom	Utah State University
Washington	Prosser	Matthew Whiting	Washington State University

annually on each tree from each location included tree survival, trunk circumference, number of root suckers, full bloom date (90% of flowers open), fruit maturity date (10% of fruit mature), fruit size (a random 20-fruit sample per tree), fruit yield per tree, and yield efficiency (yield divided by trunk cross-sectional area). In the final year, tree height and canopy spread (mean of across-row and in-row measurements) were also recorded. Not all rootstocks were available for all sites. Cooperators and the test locations are listed in Table 1.

Data for each of the three cultivars were analyzed separately using PROC GLIMMIX (SAS, Cary, NC). Like PROC MIXED, PROC GLIMMIX handles unequal sample sizes, missing data, heterogeneous error variances, and random effects. In addition, it enables linear model analysis of response variables that are non-normal or non-continuous, such as the binomial tree survival data.

All data presented in the tables are least squares means adjusted for missing cells. Because of significant rootstock x site interaction, PROC GLIMMIX was used to determine differences among the rootstocks present at each site. The SAS macro PDMIX612 was used to convert pairwise differences between least squares means to letter groupings using Tukey's HSD (α=0.05) for all response variables.

Results and Discussion

Tree survival. In general, tree mortality was lowest in California, Washington and New Jersey, where at least 50% of the trees on all rootstocks survived after 6 years (Table 2). Although mortality of a given rootstock varied greatly with site, the control rootstocks (Lovell and Bailey), P30-135 and K146-44 had among the highest survival at every location. Trees on VVA-1, Pumiselect®, SLAP, Hiawatha and Jaspi had ≤25% survival at 2 or 3 locations. In Georgia and Missouri, short term rainfall events of 16 cm (April) and 21 cm (July), respectively, created waterlogged soil conditions that contributed to 50 to 100% mortality of trees on SC-17, BH-4 and SLAP (K. Taylor and M. Kaps, personal communication). In addition, VVA-1 had noticeably increased tree death after this excessive precipitation, but the cause was unknown. VVA-1 had mortality from bacterial canker (*Pseudomonas syringae* pv. *syringae* van Hall), incompatibility, or unknown causes. Hiawatha showed symptoms of delayed incompatibility (i.e., off color, cupped leaves) in South Carolina (G. Reighard, personal observation). Cadaman® initially grew very well in South Carolina, but developed stem pitting symptoms (unknown cause, no ringspot virus was detected) on the root shank in year 4 and subsequently trees began dying. In Missouri, a similar lower trunk necrosis was found on several dying trees on Cadaman® (M. Kaps, personal communication).

Loss of trees on Pumiselect® was partly due to weak rooting or poor anchorage. Pumiselect® experienced significant tree blow downs by wind at two locations (South Carolina and Utah) due to below ground root breakage from the root shank below the graft union. Trees on Pumiselect® also leaned (i.e., uneven anchorage) more than other rootstocks at some locations. In New Jersey after a storm, trees on Pumiselect® and Hiawatha had significant lean of 50° and 20° from vertical, respectively (R. Belding, personal communication). Several trees on K146-43, K146-44, Julior and SC-17 also were affected (<15° from vertical). Black et al. (2) reported significant differences in total root biomass and root distribution among 5 multispecies rootstocks in the 2001 NC-140 peach rootstock trial. Scion dwarfing rootstocks (e.g., Controller 5, Krymsk® 1) had smaller root biomass and less lateral spread than vigorous rootstocks (e.g., Cadaman®, Lovell). Thus, possible differences in tree anchorage between peach rootstocks might be revealed under specific soil (wet) or site conditions (exposed to wind).

Tree size. After 6 years, trunk cross-sectional area (TCSA) tended to be greatest in states that had longer growing seasons and 'Redtop' as the scion (Table 3). Trees on BH-4, SLAP, SC-17, Lovell, and Cadaman® were

Table 2. Survival (%) by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	CA		GA		MD		SC	
BH-4	100.0	a	71.4	abc	0.0	b	100.0	a
SLAP (Cornerstone)	75.0	a	62.5	abc	37.5	ab	87.5	ab
SC-17 (Guardian®)	100.0	a	0.0	c	50.0	ab	87.5	ab
Bailey	100.0	a	62.5	abc	62.5	ab	87.5	ab
Julior	99.4	a	12.5	bc	62.5	ab	37.5	bcd
P30-135 (Controller 9)	99.6	a	85.7	ab	100.0	a	78.8	abc
Jaspi	87.5	a	50.0	abc	87.5	a	25.0	cd
Pumiselect®	66.3	a	100.0	a	16.7	ab	0.0	d
Hiawatha	100.0	a	62.5	abc	75.0	ab	75.0	abc
K146-43 (Controller 5)	99.4	a	50.0	abc	100.0	a	96.8	ab
K146-44	100.0	a	87.5	a	75.0	ab	100.0	a
VVA-1 (Krymsk®1)	75.0	a	25.0	abc	37.5	ab	12.5	d
Lovell	100.0	a	87.5	a	75.0	ab	87.5	ab
Cadaman®	99.0	a	--[y]		75.0	ab	39.0	a-d
Cresthaven								
	CO		TX		WA			
BH-4	65.8	a	31.9	a	66.7	a		
SLAP (Cornerstone)	100.0	a	62.5	a	100.0	a		
SC-17 (Guardian®)	87.5	a	37.5	a	87.5	a		
Bailey	99.1	a	81.9	a	100.0	a		
Julior	100.0	a	56.0	a	100.0	a		
P30-135 (Controller 9)	87.5	a	87.5	a	100.0	a		
Jaspi	--[y]		31.9	a	--[y]			
Pumiselect®	--[y]		--[y]		75.0	a		
Hiawatha	50.0	a	12.5	a	87.5	a		
K146-43 (Controller 5)	47.6	a	71.5	a	50.0	a		
K146-44	72.6	a	96.5	a	100.0	a		
VVA-1 (Krymsk®1)	47.6	a	60.3	a	100.0	a		
Lovell	57.0	a	62.5	a	100.0	a		
Cadaman®	97.6	a	--[y]		--[y]			
Redhaven								
	MO		NJ		ONT		UT	
BH-4	50.0	abc	100.0	a	87.5	a	100.0	a
SLAP (Cornerstone)	0.0	c	100.0	a	12.5	b	100.0	a
SC-17 (Guardian®)	87.5	ab	87.5	a	87.5	a	100.0	a
Bailey	100.0	a	87.5	a	75.0	ab	100.0	a
Julior	50.0	abc	50.0	a	75.0	ab	100.0	a
P30-135 (Controller 9)	100.0	a	87.5	a	87.5	a	100.0	a
Jaspi	87.5	ab	75.0	a	25.0	ab	100.0	a
Pumiselect®	62.5	ab	87.5	a	87.5	a	25.0	b
Hiawatha	100.0	a	100.0	a	37.5	ab	12.5	b
K146-43 (Controller 5)	100.0	a	83.3	a	87.5	a	100.0	a
K146-44	100.0	a	100.0	a	87.5	a	87.5	a
VVA-1 (Krymsk®1)	24.8	bc	75.0	a	--[y]		100.0	a
Lovell	100.0	a	100.0	a	87.5	a	100.0	a
Cadaman®	50.0	abc	100.0	a	87.5	a	100.0	a

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] This rootstock was not planted at this site

Table 3. Trunk cross-sectional area (cm^2) by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	CA		GA		MD		SC	
BH-4	384	a	178	c-f	--[y]		230	abc
SLAP (Cornerstone)	325	ab	226	abc	110	cd	265	a
SC-17 (Guardian®)	323	ab	--[y]		289	a	293	a
Bailey	211	cd	215	a-d	209	abc	239	abc
Julior	104	efg	86	fg	84	cd	121	de
P30-135 (Controller 9)	278	bc	253	ab	147	bcd	247	ab
Jaspi	80	fg	84	fg	91	cd	47	e
Pumiselect®	168	def	151	d-g	224	abc	--[y]	
Hiawatha	176	de	129	efg	150	bcd	146	cde
K146-43 (Controller 5)	95	efg	118	efg	145	bcd	148	cde
K146-44	108	efg	198	b-e	121	cd	172	bcd
VVA-1 (Krymsk®1)	57	g	75	g	65	d	85	e
Lovell	286	bc	259	a	241	a	231	abc
Cadaman®	401	a	--[x]		234	ab	201	a-d
Cresthaven								
	CO		TX		WA			
BH-4	78	ab	138	a	93	a		
SLAP (Cornerstone)	85	a	127	ab	97	a		
SC-17 (Guardian®)	75	ab	123	abc	89	a		
Bailey	76	ab	64	de	86	a		
Julior	75	ab	68	cde	74	ab		
P30-135 (Controller 9)	21	e	111	abc	21	d		
Jaspi	--[x]		41	e	--[x]			
Pumiselect®	--[x]		--[x]		65	abc		
Hiawatha	45	bcd	60	de	72	ab		
K146-43 (Controller 5)	36	cd	71	b-e	38	bcd		
K146-44	24	e	61	de	18	d		
VVA-1 (Krymsk®1)	29	de	32	e	34	cd		
Lovell	80	ab	109	a-d	97	a		
Cadaman®	85	a	--[x]		--[x]			
Redhaven								
	MO		NJ		ONT		UT	
BH-4	143	ab	102	ab	95	a-d	101	ab
SLAP (Cornerstone)	--[y]		99	abc	97	a-d	94	b
SC-17 (Guardian®)	161	a	93	a-d	104	abc	89	b
Bailey	89	cd	70	de	77	bcd	63	cde
Julior	90	cd	67	de	71	cd	81	bc
P30-135 (Controller 9)	120	bc	75	cde	60	d	52	def
Jaspi	63	d	59	e	58	d	37	fg
Pumiselect®	90	cd	99	abc	89	a-d	47	d-g
Hiawatha	105	bc	86	b-e	78	bcd	92	b
K146-43 (Controller 5)	61	d	63	e	64	d	45	d-g
K146-44	59	d	72	de	70	cd	41	efg
VVA-1 (Krymsk®1)	63	d	58	e	--[x]		21	g
Lovell	138	ab	107	ab	106	ab	88	b
Cadaman®	170	a	119	a	124	a	122	a

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] No trees of this rootstock survived at this site

[x] Indicates the rootstock was not planted at this site

among the largest at most (but not all) sites. Trees on Jaspi, K146-43, VVA-1 and K146-44 tended to have among the smallest TCSA at most locations.

Rootstock affected tree height and canopy spread at all locations except Colorado (Tables 4 and 5). SC-17 and Lovell produced among the tallest trees at all other locations. Trees on BH-4, SLAP and Cadaman® were also among the tallest at the sites where they were planted, except for SLAP and Cadaman® in ONT and SC, respectively (Table 4). These same five rootstocks also produced trees with larger canopy spread at many (but not all) sites (Table 5). Trees on Bailey also tended to be large, except in Texas and Utah. Trees on VVA-1 were among the smallest at all locations, and those on Jaspi were also small, with some exceptions.

In summary, these measures of tree size (i.e. dwarfing potential) indicate that the peach seedling rootstocks, peach × almond hybrids and Cadman® usually produced the most vigorous trees. The other rootstocks were more dwarfing and/or less consistent in vigor control across locations or scions.

Root suckers. The propensity to produce root suckers was low for most rootstocks in most locations (Table 6), with Julior and Jaspi being prominent exceptions. VVA-1 and Hiawatha also produced a lot of root suckers at certain locations (SC, MD, TX, UT).

Phenology. Only 6 locations reported data for the calendar days to full bloom (DOFB). Peach trees bloomed earliest in SC and latest in ONT, with more than 50 days separating these two extreme locations (Table 7). Rootstock had no significant influence on scion bloom date in ONT or NJ. At the other locations, rootstock did affect DOFB, but not consistently from site to site, so few generalizations can be made. A delay in bloom time could be important for avoiding frost events, but these influences appear to be site- or cultivar-specific.

Rootstock influenced the date of fruit maturity (Table 8) at all locations except Maryland. The difference between the earliest and latest fruit maturity dates was only about 1-3 days in Georgia, South Carolina, and Missouri, but in Washington, P30-135 advanced fruit maturity by about 9 days relative to the control rootstocks Lovell and Bailey. It is not clear whether this advancement in fruit maturity was a location effect or a scion effect, because Washington was the only site with 'Cresthaven' to report fruit maturity dates. In Utah and Ontario, the range in 'Redhaven' maturity date with rootstock was about 5 days, but P30-135 did not differ significantly from the controls in those locations. K146-44 advanced fruit maturity significantly in both ONT and UT, and VVA-1 also did so in UT.

Fruit size. Rootstock affected mean fruit weight of 'Redtop' in 3 of 4 locations (Table 9), with a range of 31 to 43 g between the largest and smallest values within a location. In CA, Pumiselect®, K146-44 and K146-43 all reduced fruit size relative to Lovell, but in GA and SC, no rootstock differed significantly from Lovell for scion fruit size. 'Redtop' fruit size on Jaspi was inconsistent, being among the largest in GA and among the smallest in SC. Scion fruit size was significantly smaller for trees on K146-44 and K146-43 than trees on Lovell in WA and UT, respectively. With 'Redhaven', mean fruit size for trees on Pumiselect® was never significantly smaller than on Lovell, yet its mean ranked lower than Lovell at all 4 sites. All the other rootstocks produced fruit size similar to Lovell and Bailey regardless of locations.

Productivity and yield efficiency. Yield data were submitted from all locations except Texas. Cumulative yield per tree was usually higher for larger trees (Table 10), as expected. Hence, trees on SLAP, SC-17, Lovell, Bailey, Cadaman® and BH-4 had among the highest yields per tree at most locations. However, SC-17 did not fit this pattern with 'Cresthaven' as the scion in CO and WA where soil pH was neutral or slightly alkaline. Colorado, New Jersey and Ontario tended to have low yields relative to other locations, with some exceptions. Yield differences between some locations could be attributed as much to differ-

Table 4. Tree height (m) by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State					
Redtop						
	GA		MD		SC	
BH-4	3.20	bcd	--[y]		3.61	ab
SLAP (Cornerstone)	3.47	ab	3.10	a-d	3.65	a
SC-17 (Guardian®)	--[y]		3.89	a	3.82	a
Bailey	3.38	abc	3.54	abc	3.65	a
Julior	2.61	de	2.62	de	2.79	cd
P30-135 (Controller 9)	3.38	abc	2.95	b-e	3.62	ab
Jaspi	2.79	cde	2.83	cde	2.31	d
Pumiselect®	2.84	b-e	2.90	b-e	--[y]	
Hiawatha	3.11	b-e	3.08	a-d	3.36	abc
K146-43 (Controller 5)	2.56	de	3.05	a-e	3.38	abc
K146-44	3.04	b-e	3.00	a-e	3.09	bc
VVA-1 (Krymsk®1)	2.40	e	2.03	e	2.32	d
Lovell	3.89	a	3.76	ab	3.43	abc
Cadaman®	--[x]		3.45	a-d	2.81	cd
Cresthaven						
	CO		TX		WA	
BH-4	2.42	a	3.01	abc	3.66	a
SLAP (Cornerstone)	2.38	a	3.13	a	3.69	a
SC-17 (Guardian®)	2.61	a	3.04	ab	3.42	ab
Bailey	2.54	a	2.57	bcd	3.56	ab
Julior	2.34	a	2.25	de	3.29	ab
P30-135 (Controller 9)	2.65	a	2.73	a-d	1.99	de
Jaspi	--[x]		2.26	de	--[x]	
Pumiselect®	--[x]		--[x]		2.34	cde
Hiawatha	2.52	a	2.58	bcd	3.03	abc
K146-43 (Controller 5)	1.70	a	1.83	e	3.08	abc
K146-44	2.58	a	2.36	cde	1.83	e
VVA-1 (Krymsk®1)	2.90	a	2.10	de	2.78	bcd
Lovell	2.17	a	2.88	abc	3.58	ab
Cadaman®	2.49	a	--[x]		--[x]	
Redhaven						
	MO		NJ		ONT		UT	
BH-4	3.80	a	3.13	a	3.04	abc	3.78	a
SLAP (Cornerstone)	--[y]		3.00	ab	2.50	bcd	3.58	ab
SC-17 (Guardian®)	3.63	a	3.05	a	3.01	abc	3.45	abc
Bailey	2.97	cd	2.92	abc	2.90	abc	3.20	bcd
Julior	2.99	bcd	2.53	cd	2.47	cd	3.07	cd
P30-135 (Controller 9)	3.06	bc	2.63	bcd	2.10	d	2.55	e
Jaspi	2.44	e	2.43	d	2.35	cd	2.62	e
Pumiselect®	2.71	cde	2.58	cd	2.22	d	2.31	ef
Hiawatha	3.02	bcd	2.79	a-d	2.67	bcd	3.61	ab
K146-43 (Controller 5)	2.61	cde	2.59	bcd	2.40	cd	2.80	de
K146-44	2.57	de	2.63	bcd	2.18	d	2.59	e
VVA-1 (Krymsk®1)	2.18	e	2.39	d	--[x]		1.84	f
Lovell	3.54	ab	3.03	a	3.14	ab	3.60	ab
Cadaman®	3.59	ab	3.06	a	3.24	a	3.71	a

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] No trees of this rootstock survived at this site

[x] Indicates the rootstock was not planted at this site

Table 5. Canopy spread (m) by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	GA		MD		SC			
BH-4	4.83	ab	--[y]		5.50	abc		
SLAP (Cornerstone)	4.49	abc	3.68	cd	5.76	ab		
SC-17 (Guardian®)	--[y]		4.76	a	5.90	a		
Bailey	4.68	ab	4.47	abc	5.53	abc		
Julior	3.31	ef	3.35	d	3.86	def		
P30-135 (Controller 9)	4.70	ab	3.73	cd	5.35	abc		
Jaspi	3.65	de	3.68	cd	3.25	f		
Pumiselect®	3.71	cde	4.11	a-d	--[y]			
Hiawatha	4.23	bcd	3.90	bcd	4.78	cde		
K146-43 (Controller 5)	3.82	b-e	3.99	a-d	4.77	cde		
K146-44	4.16	bcd	3.93	bcd	4.79	cd		
VVA-1 (Krymsk®1)	2.68	f	3.24	d	3.67	ef		
Lovell	5.07	a	4.45	abc	5.46	abc		
Cadaman®	--[x]		4.64	ab	4.89	bcd		
Cresthaven								
	CO		TX		WA			
BH-4	3.19	a	4.37	a	3.27	ab		
SLAP (Cornerstone)	2.97	a	4.16	ab	3.49	a		
SC-17 (Guardian®)	3.31	a	3.85	abc	3.28	ab		
Bailey	3.29	a	3.19	bcd	3.40	ab		
Julior	3.03	a	2.69	cd	2.84	bc		
P30-135 (Controller 9)	3.17	a	3.35	a-d	2.05	de		
Jaspi	--[x]		2.67	d	--[x]			
Pumiselect®	--[x]		--[x]		2.79	bc		
Hiawatha	3.15	a	3.01	cd	3.13	ab		
K146-43 (Controller 5)	2.50	a	2.51	d	2.65	bc		
K146-44	3.14	a	2.87	cd	1.73	e		
VVA-1 (Krymsk®1)	3.32	a	2.20	d	2.29	cde		
Lovell	2.41	a	3.46	a-d	3.38	ab		
Cadaman®	3.25	a	--[x]		--[x]			
Redhaven								
	MO		NJ		ONT		UT	
BH-4	4.48	ab	5.01	a	3.21	ab	4.29	ab
SLAP (Cornerstone)	--[y]		4.71	abc	2.60	abc	4.20	abc
SC-17 (Guardian®)	4.32	ab	4.55	a-d	3.41	ab	4.02	bc
Bailey	3.85	a-e	4.13	b-e	3.22	ab	3.59	cd
Julior	3.60	c-g	3.85	de	2.57	bc	3.60	cd
P30-135 (Controller 9)	3.75	b-f	3.89	de	2.21	c	2.98	ef
Jaspi	3.11	g	3.44	e	2.36	bc	2.74	fg
Pumiselect®	3.26	efg	4.10	cde	2.15	c	2.47	fg
Hiawatha	3.92	a-d	4.19	b-e	2.94	abc	4.21	abc
K146-43 (Controller 5)	3.08	g	3.85	de	2.56	bc	3.13	def
K146-44	3.21	fg	3.94	de	2.13	c	2.82	fg
VVA-1 (Krymsk®1)	3.18	fg	3.28	e	--[x]		2.08	g
Lovell	4.24	abc	4.83	ab	3.47	ab	4.06	bc
Cadaman®	4.57	a	4.96	a	3.91	a	4.76	a

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] No trees of this rootstock survived at this site

[x] Indicates the rootstock was not planted at this site

Table 6. Mean number of annual root suckers (2001-06) by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	CA		GA		MD		SC	
BH-4	0.0	b	0.6	bc	--[y]		0.0	c
SLAP (Cornerstone)	0.1	b	0.1	c	0.0	c	0.0	c
SC-17 (Guardian®)	1.0	b	--[y]		0.9	bc	0.1	c
Bailey	0.1	b	0.8	bc	0.6	c	0.0	c
Julior	7.3	a	9.8	a	15.1	a	17.2	b
P30-135 (Controller 9)	0.0	b	0.5	bc	0.1	c	0.0	c
Jaspi	7.1	a	3.6	b	6.8	b	32.3	a
Pumiselect®	1.0	b	0.5	bc	2.8	bc	--[y]	
Hiawatha	0.3	b	1.6	bc	5.1	bc	4.5	c
K146-43 (Controller 5)	0.1	b	0.2	bc	0.4	c	0.0	c
K146-44	0.0	b	0.1	c	0.2	c	0.1	c
VVA-1 (Krymsk®1)	0.3	b	2.3	bc	4.1	bc	10.5	bc
Lovell	0.7	b	0.0	c	1.1	bc	0.0	c
Cadaman®	0.2	b	--[x]		1.5	bc	0.4	c
Cresthaven								
	CO		TX		WA			
BH-4	0.3	b	0.1	bc	0.1	b		
SLAP (Cornerstone)	0.0	b	0.0	c	0.0	b		
SC-17 (Guardian®)	4.5	b	0.1	bc	0.2	b		
Bailey	0.0	b	0.0	c	0.0	b		
Julior	29.1	a	6.8	a	2.1	a		
P30-135 (Controller 9)	0.0	b	0.1	c	0.0	b		
Jaspi	--[x]		3.1	abc	--[x]			
Pumiselect®	--[x]		--[x]		0.8	b		
Hiawatha	0.2	b	0.9	abc	0.0	b		
K146-43 (Controller 5)	0.0	b	0.0	c	0.0	b		
K146-44	0.1	b	0.0	c	0.0	b		
VVA-1 (Krymsk®1)	1.5	b	5.3	ab	0.0	b		
Lovell	0.1	b	0.9	bc	0.0	b		
Cadaman®	0.3	b	--[x]		--[x]			
Redhaven								
	MO		NJ		ONT		UT	
BH-4	0.0	c	0.0	b	0.1	b	0.2	c
SLAP (Cornerstone)	--[y]		0.0	b	0.0	b	0.1	c
SC-17 (Guardian®)	0.0	c	0.3	b	0.2	b	2.3	c
Bailey	0.0	c	0.0	b	0.0	b	1.7	c
Julior	2.3	ab	2.8	a	1.2	a	16.1	b
P30-135 (Controller 9)	0.0	c	0.0	b	0.1	b	0.1	c
Jaspi	3.2	a	2.7	a	0.5	ab	25.9	ab
Pumiselect®	0.0	c	0.0	b	0.3	b	8.8	bc
Hiawatha	0.0	c	0.1	b	0.1	b	8.8	bc
K146-43 (Controller 5)	0.0	c	0.0	b	0.1	b	0.0	c
K146-44	0.0	c	0.0	b	0.2	b	0.0	c
VVA-1 (Krymsk®1)	0.3	bc	0.1	b	--[x]		28.2	a
Lovell	0.0	c	0.1	b	0.2	b	0.7	c
Cadaman®	0.0	c	0.0	b	0.0	b	0.4	c

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] No trees of this rootstock survived at this site

[x] Indicates the rootstock was not planted at this site

Table 7. Calendar days to full bloom (2001-06) by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	MD		SC					
BH-4	--[y]		77.6	bc				
SLAP (Cornerstone)	126.2	abc	78.2	abc				
SC-17 (Guardian®)	127.6	a	78.3	abc				
Bailey	127.6	a	77.9	abc				
Julior	125.3	bc	77.3	c				
P30-135 (Controller 9)	125.3	c	78.8	a				
Jaspi	126.8	ab	77.4	bc				
Pumiselect®	129.0	a	--[y]					
Hiawatha	127.8	a	78.4	abc				
K146-43 (Controller 5)	127.2	a	78.7	ab				
K146-44	126.6	abc	78.3	abc				
VVA-1 (Krymsk®1)	126.5	abc	78.2	abc				
Lovell	127.3	a	78.5	abc				
Cadaman®	127.7	a	78.6	abc				
Redhaven								
	MO		NJ		ONT		UT	
BH-4	93.4	c	108.1	a	131.8	a	101.4	b
SLAP (Cornerstone)	--[y]		107.9	a	132.6	a	101.4	b
SC-17 (Guardian®)	93.9	bc	108.9	a	131.9	a	101.5	b
Bailey	94.5	abc	110.3	a	132.3	a	101.6	b
Julior	93.7	bc	107.2	a	132.6	a	101.3	b
P30-135 (Controller 9)	93.4	c	110.4	a	131.9	a	102.5	a
Jaspi	94.4	bc	108.0	a	132.5	a	101.4	b
Pumiselect®	95.8	a	108.4	a	131.3	a	101.9	ab
Hiawatha	95.1	ab	109.5	a	132.8	a	101.3	b
K146-43 (Controller 5)	94.3	bc	110.6	a	132.6	a	101.7	b
K146-44	93.3	c	108.8	a	132.3	a	101.5	b
VVA-1 (Krymsk®1)	94.0	bc	110.3	a	--[x]		101.4	b
Lovell	93.9	bc	109.4	a	132.7	a	101.4	b
Cadaman®	94.0	bc	108.8	a	132.2	a	101.4	b

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)
[y] No trees of this rootstock survived at this site
[x] Indicates the rootstock was not planted at this site

ent (by design or unintentional) horticultural practices (e.g., scion cultivar, irrigation, weed control, nitrogen applications, time of thinning, etc.) as to the site's different edaphic and climatic characteristics.

Trends in yield efficiency did not exactly match those for tree size or per-tree yield. With 'Redhaven', the large trees on Bailey were among the most yield-efficient at all 4 locations (Table 11). 'Redhaven' trees on Pumiselect® were both unproductive and relatively inefficient in ONT, UT and NJ (Table 11). 'Cresthaven' on Bailey, SLAP, K146-43 and VVA-1 were all efficient combinations, but the last two had low per-tree yields yet not always the smallest canopies (Tables 5, 10 and 11). With 'Redtop', rootstock performance varied so greatly among locations that few general statements can be made. Although not always a top performer, 'Redtop'/Bailey was among the better combinations for achieving high production and high efficiency.

Though no rootstock yielded better than Lovell except Cadaman® in Utah (Table 10), the cumulative yield and yield efficiency data for the first 4 bearing years suggest that semi-

Table 8. Calendar days to fruit maturity (2003-06) by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	GA		MD		SC			
BH-4	177.6	ab	--[y]		180.2	abc		
SLAP (Cornerstone)	178.3	ab	172.0	a	180.5	ab		
SC-17 (Guardian®)	--[y]		174.3	a	181.1	a		
Bailey	177.8	ab	173.8	a	180.3	abc		
Julior	176.8	ab	170.8	a	178.4	c		
P30-135 (Controller 9)	177.7	ab	172.2	a	179.4	bc		
Jaspi	177.2	b	171.0	a	178.2	c		
Pumiselect®	178.6	ab	164.3	a	--[y]			
Hiawatha	177.1	b	171.7	a	179.7	abc		
K146-43 (Controller 5)	178.5	ab	173.1	a	180.5	ab		
K146-44	177.8	ab	172.6	a	179.3	bc		
VVA-1 (Krymsk®1)	176.8	b	173.0	a	178.5	bc		
Lovell	178.7	a	173.4	a	179.9	abc		
Cadaman®	--[x]		174.3	a	178.5	bc		
Cresthaven								
	WA							
BH-4	242.4	a						
SLAP (Cornerstone)	241.2	a						
SC-17 (Guardian®)	241.7	a						
Bailey	242.7	a						
Julior	241.7	a						
P30-135 (Controller 9)	234.6	c						
Jaspi	--[x]							
Pumiselect®	242.8	a						
Hiawatha	242.6	a						
K146-43 (Controller 5)	239.4	ab						
K146-44	237.3	bc						
VVA-1 (Krymsk®1)	240.1	ab						
Lovell	243.0	a						
Cadaman®	--[x]							
Redhaven								
	MO		NJ		ONT		UT	
BH-4	194.6	bc	203.8	a-d	229.3	a-d	212.9	bcd
SLAP (Cornerstone)	--[y]		204.2	abc	230.0	abc	212.1	cde
SC-17 (Guardian®)	194.9	abc	203.1	a-e	229.9	abc	211.2	de
Bailey	195.7	a	205.2	a	230.1	ab	215.4	a
Julior	194.8	abc	203.0	a-e	229.3	a-d	212.7	bcd
P30-135 (Controller 9)	194.3	bc	201.3	de	229.3	a-d	211.6	cde
Jaspi	194.2	c	202.1	cde	228.9	a-d	211.7	cde
Pumiselect®	195.1	abc	205.2	a	228.5	cd	214.9	ab
Hiawatha	194.4	bc	203.9	abc	229.4	a-d	211.4	cde
K146-43 (Controller 5)	194.4	bc	203.3	a-e	228.7	bcd	213.3	bc
K146-44	194.4	bc	202.5	b-e	227.8	d	210.5	e
VVA-1 (Krymsk®1)	194.3	bc	201.0	e	--[x]		210.5	e
Lovell	195.2	ab	204.5	ab	230.0	abc	213.2	bc
Cadaman®	194.8	abc	204.7	a	230.3	a	212.8	bcd

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] No trees of this rootstock survived at this site

[x] Indicates the rootstock was not planted at this site

Table 9. Mean fruit weight (g) for 2003-06 by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	CA		GA		MD		SC	
BH-4	191	a	138	ab	--[y]		206	a
SLAP (Cornerstone)	186	a	151	ab	153	a	208	a
SC-17 (Guardian®)	174	ab	--[y]		153	a	198	ab
Bailey	179	a	139	ab	158	a	205	a
Julior	181	a	136	ab	142	a	193	ab
P30-135 (Controller 9)	181	a	142	ab	156	a	194	ab
Jaspi	172	abc	163	a	146	a	165	b
Pumiselect®	148	d	122	b	146	a	--[y]	
Hiawatha	174	ab	140	ab	152	a	201	ab
K146-43 (Controller 5)	150	cd	127	ab	151	a	186	ab
K146-44	157	bcd	135	ab	155	a	204	a
VVA-1 (Krymsk®1)	175	ab	122	b	141	a	196	ab
Lovell	180	a	141	ab	152	a	199	ab
Cadaman®	185	a	--[x]		154	a	189	ab

Cresthaven				
	CO		WA	
BH-4	233	a	233	ab
SLAP (Cornerstone)	243	a	236	a
SC-17 (Guardian®)	212	a	223	abc
Bailey	227	a	226	ab
Julior	233	a	216	abc
P30-135 (Controller 9)	221	a	198	bc
Jaspi	--[x]		--[x]	
Pumiselect®	--[x]		201	abc
Hiawatha	216	a	206	abc
K146-43 (Controller 5)	197	a	203	abc
K146-44	192	a	187	c
VVA-1 (Krymsk®1)	263	a	236	a
Lovell	225	a	225	ab
Cadaman®	223	a	--[x]	

Redhaven								
	MO		NJ		ONT		UT	
BH-4	145	a	148	bc	139	a	200	a
SLAP (Cornerstone)	--[y]		150	bc	146	a	205	a
SC-17 (Guardian®)	138	ab	153	abc	129	a	208	a
Bailey	140	ab	159	ab	139	a	202	a
Julior	141	ab	147	bc	137	a	193	ab
P30-135 (Controller 9)	146	a	157	abc	125	a	197	a
Jaspi	140	ab	156	abc	137	a	193	ab
Pumiselect®	117	b	140	c	122	a	178	ab
Hiawatha	131	ab	145	bc	133	a	183	ab
K146-43 (Controller 5)	128	ab	151	abc	129	a	171	b
K146-44	131	ab	153	abc	127	a	192	ab
VVA-1 (Krymsk®1)	149	a	174	a	--[x]		206	a
Lovell	141	ab	148	bc	126	a	194	a
Cadaman®	149	a	154	abc	131	a	209	a

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)
[y] No trees of this rootstock survived at this site
[x] Indicates the rootstock was not planted at this site

Table 10. Cumulative fruit yield (kg) for 2003-06 by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State							
Redtop								
	CA		GA		MD		SC	
BH-4	220.7	a	77.1	abc	--[y]		206.4	abc
SLAP (Cornerstone)	202.7	ab	90.4	abc	68.8	abc	243.4	ab
SC-17 (Guardian®)	194.4	ab	--[y]		138.6	a	270.1	a
Bailey	181.4	abc	106.9	ab	119.1	ab	272.5	a
Julior	95.2	def	22.4	c	46.1	c	109.2	d
P30-135 (Controller 9)	141.7	cd	73.5	abc	97.9	abc	179.9	bcd
Jaspi	97.3	def	47.7	c	59.3	bc	65.6	d
Pumiselect®	131.5	cde	56.1	bc	73.6	abc	--[y]	
Hiawatha	160.2	bc	56.2	bc	88.5	abc	170.8	bcd
K146-43 (Controller 5)	86.9	ef	33.9	c	77.0	abc	149.6	cd
K146-44	87.3	ef	51.7	c	89.0	abc	157.3	cd
VVA-1 (Krymsk®1)	69.7	f	23.5	c	56.6	bc	100.3	d
Lovell	198.1	ab	118.0	a	124.0	a	241.1	ab
Cadaman®	211.0	ab	--[x]		120.8	ab	180.7	a-d
Cresthaven								
	CO		WA					
BH-4	62.6	ab	160.8	ab				
SLAP (Cornerstone)	77.1	a	183.5	a				
SC-17 (Guardian®)	52.2	bc	116.9	bcd				
Bailey	64.8	ab	163.6	ab				
Julior	52.7	bc	129.8	bc				
P30-135 (Controller 9)	9.0	d	22.1	e				
Jaspi	--[x]		--[x]					
Pumiselect®	--[x]		68.7	cde				
Hiawatha	31.3	cd	123.4	bcd				
K146-43 (Controller 5)	35.0	bcd	56.7	cde				
K146-44	12.2	d	17.4	e				
VVA-1 (Krymsk®1)	29.6	cd	62.3	cde				
Lovell	63.3	ab	160.4	ab				
Cadaman®	66.5	ab	--[x]					
Redhaven								
	MO		NJ		ONT		UT	
BH-4	116.2	a-d	55.0	abc	63.5	abc	138.7	b
SLAP (Cornerstone)	--[y]		54.7	a-d	56.3	a-d	140.1	b
SC-17 (Guardian®)	143.4	ab	64.6	ab	72.4	ab	118.8	bc
Bailey	120.4	abc	63.0	ab	66.1	abc	105.8	cd
Julior	85.5	cde	43.7	bcd	50.6	a-d	81.1	de
P30-135 (Controller 9)	107.7	bcd	47.4	bcd	44.5	bcd	59.5	ef
Jaspi	40.6	fg	35.4	d	38.1	cd	46.6	fg
Pumiselect®	76.3	def	38.8	cd	30.2	d	31.8	gh
Hiawatha	81.6	de	39.9	cd	54.8	a-d	122.6	bc
K146-43 (Controller 5)	53.4	efg	46.5	bcd	37.1	cd	52.9	fg
K146-44	38.0	g	44.4	bcd	40.4	cd	51.1	fg
VVA-1 (Krymsk®1)	87.5	cde	33.5	d	--[x]		22.1	h
Lovell	145.7	a	66.6	a	63.8	abc	127.5	bc
Cadaman®	135.3	abc	67.0	a	75.1	a	173.7	a

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] No trees of this rootstock survived at this site

[x] Indicates the rootstock was not planted at this site

Table 11. Cumulative fruit yield efficiency (kg/cm² TCA) for 2003-06 by location of 'Redtop', 'Cresthaven' and 'Redhaven' on various rootstocks at the end of six growing seasons as part of the 2001 NC-140 peach rootstock trial. All values are least-squares means adjusted for missing subclasses.[z]

Scion and Rootstock	State			
Redtop				
	CA	GA	MD	SC
BH-4	0.58 fg	0.43 ab	--[y]	0.92 ab
SLAP (Cornerstone)	0.63 efg	0.39 ab	0.61 a	0.96 ab
SC-17 (Guardian®)	0.61 fg	--[y]	0.49 a	0.97 ab
Bailey	0.88 cde	0.50 ab	0.58 a	1.19 a
Julior	0.98 bc	0.27 b	0.52 a	0.90 ab
P30-135 (Controller 9)	0.52 g	0.30 ab	0.69 a	0.74 b
Jaspi	1.22 ab	0.57 a	0.64 a	0.91 ab
Pumiselect®	0.81 c-f	0.38 ab	0.33 a	--[y]
Hiawatha	0.94 cd	0.43 ab	0.58 a	1.14 a
K146-43 (Controller 5)	0.95 cd	0.30 ab	0.55 a	1.09 ab
K146-44	0.80 c-f	0.27 b	0.71 a	0.92 ab
VVA-1 (Krymsk®1)	1.28 a	0.32 ab	0.77 a	1.34 a
Lovell	0.71 d-g	0.46 ab	0.52 a	1.06 ab
Cadaman®	0.53 fg	--[x]	0.54 a	0.95 ab

Cresthaven		
	CO	WA
BH-4	0.88 ab	1.75 ab
SLAP (Cornerstone)	1.00 a	1.89 a
SC-17 (Guardian®)	0.69 ab	1.34 ab
Bailey	0.88 ab	1.90 a
Julior	0.71 ab	1.79 a
P30-135 (Controller 9)	0.47 b	1.05 b
Jaspi	--[x]	--[x]
Pumiselect®	--[x]	1.09 ab
Hiawatha	0.67 ab	1.73 ab
K146-43 (Controller 5)	1.01 a	1.84 a
K146-44	0.56 ab	1.27 ab
VVA-1 (Krymsk®1)	0.96 a	1.92 a
Lovell	0.80 ab	1.67 ab
Cadaman®	0.84 ab	--[x]

Redhaven				
	MO	NJ	ONT	UT
BH-4	0.81 bc	0.54 bcd	0.69 ab	1.39 abc
SLAP (Cornerstone)	--[y]	0.56 bcd	0.59 ab	1.51 ab
SC-17 (Guardian®)	0.90 bc	0.69 ab	0.70 ab	1.37 abc
Bailey	1.37 a	0.90 a	0.88 a	1.70 a
Julior	0.96 abc	0.68 abc	0.74 ab	1.02 cd
P30-135 (Controller 9)	0.90 bc	0.64 bc	0.76 ab	1.16 bcd
Jaspi	0.66 c	0.61 bcd	0.75 ab	1.20 bcd
Pumiselect®	0.86 bc	0.41 d	0.36 b	0.72 d
Hiawatha	0.79 bc	0.46 cd	0.70 ab	1.38 abc
K146-43 (Controller 5)	0.87 bc	0.75 ab	0.64 ab	1.19 bcd
K146-44	0.65 c	0.62 bc	0.65 ab	1.27 bcd
VVA-1 (Krymsk®1)	1.46 a	0.60 bcd	--[x]	1.07 bcd
Lovell	1.06 ab	0.63 bc	0.62 ab	1.44 ab
Cadaman®	0.81 bc	0.58 bcd	0.59 ab	1.44 ab

[z] Separation of least squares means within columns for each location by Tukey's HSD (P=0.05)

[y] No trees of this rootstock survived at this site

[x] Indicates the rootstock was not planted at this site

dwarfing rootstocks (e.g., Hiawatha) could be used in place of standard size rootstocks if tree spacing is adjusted for the smaller canopies. However, some of the size-controlling rootstocks tested exhibited incompatibility, horticultural, and/or disease problems with peach scion cultivars, which likely limits their use as peach rootstocks since these problems have been reported elsewhere (6, 7, 13, 16). Still the positive traits that these particular interspecific *Prunus* rootstocks confer to peach cultivars such as growth control (3, 4), tolerance to waterlogging and calcareous soils (13), and resistance to soil fungi (1), nematodes (8, 9, 12) and bacteria (10, 12) may make them a viable alternative to peach seedling rootstocks on selected problem sites (e.g., fine textured, imperfectly drained or high pH soils).

Summary. The trees on peach seedling rootstocks were vigorous and productive, with consistently acceptable to good performance across locations, with the possible exception of Bailey in Texas and Utah. The peach × almond rootstocks also tended to produce vigorous, high yielding trees and performed well, but they had poor survival at a few sites caused by waterlogging. The peach × plum rootstocks K146-44 and P30-135 had some dwarfing potential and survived well at all locations, but had the disadvantages of anchorage problems or reduced fruit size in some of the test sites. In addition, P130-135 was inconsistent in vigor control across locations, so its effect on tree size might be difficult to predict in an orchard setting. K146-43 had high yield efficiency and it advanced fruit maturity in two locations, but had smaller fruit than Lovell in California. The interspecific plum hybrids (Hiawatha, Jaspi and Julior) had several serious drawbacks, including poor survival, inadequate anchorage, inconsistent tree vigor control and excessive root suckering at some or all locations. These rootstocks may have promise at specific locations but are not sufficiently consistent for a general recommendation. VVA-1 and Pumiselect® had high mortality at some locations and exhibited poor survival or anchorage under conditions of soil waterlogging or high winds. The dwarfing effect of Pumiselect® was inconsistent across locations, it reduced fruit size in California, and it was both unproductive and inefficient in other locations. Trees on VVA-1 were consistently small, with low yield per tree but high efficiency and no reduction in fruit size. Scion incompatibility, root suckering and susceptibility to bacterial canker were problematic with VVA-1 at a few sites. Cadaman® performed well at most locations, with vigorous yet productive trees, but lower trunk necrosis was observed in SC and MO.

Despite statistical limitations due to uneven rootstock cultivars and tree numbers for some sites in this study, significant differences among the 14 rootstocks were found for all characters measured, but no clonal rootstock in this trial yielded more than the three peach seedling rootstocks on a per tree basis, with Bailey being the most yield-efficient standard size rootstock in this trial. Higher tree densities might show an advantage for some semi-dwarfing rootstocks, but this was not tested. Other than the semi-dwarfing Hiawatha, the more size-controlling rootstocks in this study were not that productive even on a yield efficiency basis. Since most of the locations were not difficult replant sites and the plantings are only 6 years old, trees may not have yet been challenged by environmental stresses such as winter cold, waterlogging, nematodes, soil fungi, or other factors. Therefore, it was not surprising that the peach seedling rootstocks performed equal or better than the other rootstocks at low tree densities.

Acknowledgements

The authors would like to thank Burchell Nursery, Varieties International, North American Plants, Hilltop Nursery, U.C. Davis and Clemson University for either providing plant material or producing the trees, and the International Fruit Tree Association for financial support. The authors also thank William Bridges, Jr. for statistical assistance and Cheryl Hampson for extensive editorial assistance.

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U.S. Postal Service Statement of Ownership Management and Circulation

Journal of the American Pomological Society is owned and published by the American Pomological Society, with publication and business offices located at: 102 Tyson Building, University Park, PA 16802. Frequency of issue: quarterly. Publication number: 211-320. Annual U.S. subscription price: $55.00. Editor: Cheryl R. Hampson, Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, P.O. Box 5000, Summerland, BC Canada V0H1Z0. Business manager: Robert M. Crassweller, 102 Tyson Building, University Park, PA 16802.

The average number of copies of each issue printed during the preceding 12 months was 550; total paid circulation, 301; free distribution, 0; total distribution, 301; office use and left over, 249. The actual number of a single issue published nearest to filing date was 550; total distribution 301; office use and left over, 249.

I certify that the statements made by me above are correct and complete. R.M. Crassweller, Business Manager. December 31, 2010.