SCIENTIFIC WORKS OF THE LITHUANIAN INSTITUTE OF HORTICULTURE AND LITHUANIAN UNIVERSITY OF AGRICULTURE. SODININKYSTĖ IR DARŽININKYSTĖ. 2006. 25(3). 327–333.

PERFORMANCE OF *PRUNUS* ROOTSTOCKS IN THE 2001 NC-140 PEACH TRIAL

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[2]Co-authors are NC-140 cooperators from Colorado, Georgia, Maryland, Missouri, New Jersey, New York, South Carolina, Texas, Utah, Washington and Ontario, Canada and are listed in Table 1.

Fourteen *Prunus* rootstock cultivars and selections budded with either 'Redtop', 'Redhaven' or 'Cresthaven' peach were planted at 10 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 a NC-140 Cooperative Regional Rootstock Project (www.nc140.org). There were 14 rootstocks total, which included three peach seedling rootstocks: Lovell, Bailey, and Guardian® BY520-9 [selection SC-17]. Clonal rootstocks included peach x almond hybrids BH-4 and SLAP (Cornerstone); peach x 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* selection Pumiselect®. The largest trees were from 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 circumferences 30-40% smaller than Lovell. No rootstock had a significantly higher survival rate than Lovell at all locations. Julior, Jaspi, and VVA-1 had significantly more root suckers. Cumulative fruit yields were highest on the peach seedling, peach x almond, and Cadaman® rootstocks. Lowest cumulative yields were from trees on Jaspi, VVA-1, and K146-44 rootstocks. Fruit weight was significantly larger on BH-4, SLAP and Bailey rootstocks. Bailey and Jaspi had the highest and lowest cumulative yield efficiency, respectively.

Keywords: peach x almond hybrids, peach x plum hybrids, *Prunus persica* L.

Introduction. Peach production in North America has relied on peach seedling rootstocks since the mid-1800s. Entering the 21st century, peach growers must confront replant problems, the loss of 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 (Layne, 1987; Reighard, 2002). 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 (Perry et al., 2000; Reighard, 2000; Reighard et al., 2004) from this group have provided information on the performance of mostly peach seedling rootstocks in multiple environments throughout the United States and Canada.

In the past 5–10 years, clonal-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, a NC-140 trial was initiated. The objectives of this NC-140 trial were to evaluate these clonal peach rootstocks for survival, 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 that included peach x almond hybrids BH-4 and SLAP (Cornerstone); peach x 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* selection Pumiselect®. There were also 3 peach seedling rootstocks tested: Lovell and Bailey as controls and Guardian® BY520-9 [selection SC-17]. Liners or seed of each virus-indexed rootstock were collected in 1999 and sent to Burchell Nursery (Oakdale, California) 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 10 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 recommended practices 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 Georgia, Maryland and South Carolina. Data collected annually on each tree from each location included survival, trunk circumference, root suckering, bloom date (90% flowers open), fruit maturity date (10% fruit mature), fruit size (random 20-fruit sample), tree yield, and yield efficiency. Not all rootstocks were available for all sites. Cooperators and the test locations are listed in Table 1.

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

1 lentelė. **2001 m. NC-140 persikų poskiepių tyrimo bendradarbiai, institucijos ir vietovės**

State/Province Valstija/provincija	Location Vietovė	Cooperator Bendradarbis	Affiliation Institucija
Colorado	Grand Junction	Ron Godin	Colorado State University
Georgia	Byron	Kathryn Taylor	University of Georgia
		Thomas Beckman	USDA-ARS
Maryland	Wye Mills	Christopher Walsh	University of Maryland
Missouri	Mountain Grove	Martin L. Kaps	SW Missouri State University
New Jersey	Bridgeton	Robert D. Belding	Rutgers University
		Winfred Cowgill, Jr.	Rutgers University
New York	(no planting)	Terence Robinson	Cornell 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
Utah	Kaysville	Brent Black	Utah State University
		Thor Lindstrom	Utah State University
Washington	Prosser	Matthew Whiting	Washington State University

Due to unequal rootstock numbers among locations, data from 11 rootstocks that were common to the 10 sites were analyzed by PROC MIXED (SAS, Cary, NC) to detect rootstock differences for cultivar survival, trunk circumference, root suckers, bloom date, maturity date, fruit weight, cumulative yield, and yield efficiency. In addition, data for each location were analyzed by PROC MIXED to determine differences among the rootstocks present at that site. The SAS macro, PDMIX612, was used to convert pair-wise differences between least squares means to letter groupings using Fisher's LSD. All data presented in Table 2 are least squares means adjusted for missing cells.

Results. Table 2 shows data for 11 rootstocks that were common to all locations. There were significant differences among rootstocks for the combined cultivars and locations. In addition, there were significant rootstock and location interactions. Tree survival (Table 2) differed significantly among rootstocks for different reasons. No rootstock survived better than Lovell. Hiawatha had the poorest survival, and it appeared that delayed incompatibility was occurring. Other rootstocks not planted at all sites (data not shown = DNS) included Pumiselect®, which had very low survival at 3 locations partly due to weak rooting or poor anchorage and VVA-1, which had died from bacterial canker and/or incompatibility at 5 locations.

After 5 years, trunk circumference (i.e., radial growth) across all sites was largest for trees on SC-17, Lovell, BH-4 and SLAP, whereas Jaspi, Julior, K146-43 and K146-44 produced the smallest trees (Table 2). The largest trees were from Georgia, Maryland, and South Carolina, states that had longer growing seasons and 'Redtop' as the scion cultivar. Fruit weight and yields were correlated tree size. The largest mean fruit weights were found on the peach/almond hybrid rootstocks, which were also some of the largest trees. The smallest average fruit weights were from

cultivars on three of the four most dwarfing rootstocks; Jaspi, K146-43 and K146-44. Cumulative yields were low for these dwarfing rootstocks, yet cumulative yield efficiencies were not significantly different from the most vigorous rootstocks. The highest yields were from the peach/almond hybrids and peach seedling rootstocks. However, only Bailey had significantly higher yield efficiency than the dwarfing rootstocks. In this trial, Bailey was the most yield efficient rootstock and Jaspi the least efficient with all other rootstocks falling in between these two rootstocks.

T a b l e 2. **Five-year combined performance of Redhaven, Cresthaven, and Redtop on 11 rootstocks at 10 locations.**

2 l e n t e l ė. **'Redhaven', 'Cresthaven' ir 'Redtop' veislių persikų vaismedžių su 11 poskiepių vertinimas dešimtyje vietovių penkerius tyrimo metus**

Rootstock Poskiepis	Survival Vaismedžių išlikimas[z], % Fall 2005 2005 m. ruduo	Trunk circumference Kamieno skersmuo, cm Fall 2005 2005 m. ruduo	Mean fruit weight Vidutinė vaisiaus masė, g 2003–2005	Cumulative fruit yield Suminis derlius, kg 2003–2005	Cumulative yield efficiency Suminis produktyvumas, kg/cm^2 2003–2005
BH-4	70.8 bc	36.9 ab	176 ab	64.9 ab	0.62 b
SLAP	71.2 bc	36.6 ab	180 a	66.6 ab	0.65 b
SC-17	72.5 bc	38.2 a	168 bcd	71.5 a	0.63 b
Bailey	89.7 abc	33.5 bc	173 abc	69.5 a	0.80 a
Julior	76.9 abc	28.8 def	168 bcd	40.6 cd	0.59 b
P30-135	94.4 a	30.3 cde	168 bcd	40.8 cd	0.56 bc
Jaspi	75.0 abc	25.4 f	155 f	26.7 d	0.46 c
Hiawatha	70.0 c	31.1 cd	165 cde	49.7 bc	0.62 b
K146-43	81.6 abc	26.9 ef	157 ef	34.9 cd	0.66 b
K146-44	91.2 ab	27.0 ef	160 def	30.3 d	0.56 bc
Lovell	87.0 abc	37.5 a	169 bcd	72.9 a	0.66 b
Locations in analysis Tyrimo vietovių skaičius	10	10	9	10	10
Rootstock x location interaction Poskiepio ir vietovės sąveika	***	***	***	***	***

[z] Mean separation within columns using Fisher's LSD, $P< 0.05$

[z] Vidutiniai skirtumai skiltyse pagal Fišerio kriterijų, $P< 0,05$

*, **, *** Significant at $P< 0.05$, 0.01, and 0.001, respectively.

*, **, *** Skirtumai esminiai, kai P atitinkamai <0,05, 0,01 ir 0,001.

Other data not given in Table 2 showed that Lovell, SC-17, SLAP, and BH-4 produced significantly larger (height and width) trees, and Jaspi and Julior had significantly more root suckers than the other 9 rootstocks. Trees on Julior consistently bloomed early and on K146-43 bloom was late. Fruit maturity was significantly advanced only on Jaspi.

The rootstocks Cadaman®, Pumiselect®, and VVA-1, which were not planted at all sites, had significant differences at the sites they were included (DNS). Cadaman® was one of the most vigorous rootstocks with high yields, while VVA-1 was one of the least vigorous with low cumulative yields. VVA-1 also produced many root suckers. Pumiselect® experienced significant windthrow at two locations due to below ground root breakage below the graft union. Trees on Pumiselect® also leaned (i.e., uneven anchorage) at some locations.

Discussion. Although no rootstock yielded better than Lovell, the cumulative yield and yield efficiency data for the first 3 bearing years suggest that semi-dwarfing and dwarfing rootstocks 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 (Reighard 2000; Loreti, Massai, 2002; Massai, Loreti, 2004). Still the positive traits that these particular interspecific *Prunus* rootstocks confer to peach cultivars such as growth control (Jacob, 1992; DeJong et al., 2004), tolerance to waterlogging and calcareous soils (Reighard, 2002), and resistance to soil fungi (Beckman, Pusey, 2001), nematodes (McFadden-Smith et al., 1998; Nyczepir et al., 1999) and bacteria (Okie et al., 1994; Pinochet et al., 2002) makes them a viable rootstock alternative to peach seedling rootstocks on selected problem sites.

Conclusions. Significant differences among 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. Higher tree densities might show an advantage for some dwarfing rootstocks, but this was not tested. Since most of the locations were not difficult replant sites and the plantings are only 5 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 unexpected 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 Dwarf Fruit Tree Association for financial support.

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References

1. Beckman T. G., Pusey P. L. 2001. Field testing peach rootstocks for resistance to Armillaria root rot. HortScience 36 (1): 101–103.

2. DeJong T., Johnson R. S., Doyle J. F., Weibel A., Solari L., Basile B., Marsal J., Ramming D., Bryla D. 2004. Growth, yield and physiological behaviour of size-controlling peach rootstocks developed in California. Acta Horticulturae Vol. 658: 449–455.

3. Jacob H. 1992. *Prunus pumila* L., eine geeignete schwachwachsende Pfirsichuntererlage. Erwerbsobstbau 34: 144–146.

4. Layne R. E. C. 1987. Peach rootstocks. In: Rom R.C., Carlson R.F. (eds.) Rootstocks for Fruit Crops. Wiley, New York. 185–216.

5. Loreti F., Massai R. 2002. MiPAF targeted project for evaluation of peach rootstocks in Italy: Results of six years of observations. Acta Horticulturae Vol. 592: 117–124.

6. Massai R., Loreti F. 2004. Preliminary observations on nine peach rootstocks grown in a replant soil. Acta Horticulturae Vol. 658: 185–192.

7. McFadden-Smith W., Miles N. W., Potter J. W. 1998. Greenhouse evaluation of *Prunus* rootstocks for resistance or tolerance to the root-lesion nematode (*Pratylenchus penetrans*). Acta Horticulturae Vol. 465: 723–730.

8. Nyczepir A. P., Beckman T. G., Reighard G. L. 1999. Reproduction and development of *Meloidogyne sp*. and *M. javanica* on Guardian peach rootstock. Journal of Nematology 31 (3): 334–340.

9. Okie W. R., Beckman T. G., Nyczepir A. P., Reighard G. L., Newall Jr. W. C., Zehr E. I. 1994. BY520-9, A peach rootstock for the southeastern United States that increases scion longevity. HortScience 29 (6): 705–706.

10. Perry R., Reighard G., Ferree D., Barden J., Beckman T., Brown G., Cummins J., Durner E., Greene G., Johnson J., Layne R., Morrison F., Myers S., Okie W., Rom C., Rom R., Taylor B., Walker D., Warmund M., Yu K. 2000. Performance of the 1984 NC-140 Peach Rootstock Planting. J. Amer. Pom. Soc. Vol. 54: 6–10.

11. Pinochet J., Fernandez C., Cunill M., Torrents J., Felipe A., Lopez M. M., Lastra B., Penyalver R. 2002. Response of new interspecific hybrids for peach to root-knot and lesion nematodes, and crown gall. Acta Horticulturae Vol. 592 (2): 707–716.

12. Reighard G. L. 2000. Peach rootstocks for the United States: are foreign rootstocks the answer? HortTechnology Vol. 10: 714–718.

13. Reighard G. L. 2002. Current directions of peach rootstock programs worldwide. Acta Horticulturae Vol. 592: 421–428.

14. Reighard G., Andersen R., Anderson J., Autio W., Beckman T., Baker T., Belding R., Brown G., Byers P., Cowgill W., Deyton D., Durner E., Erb A., Ferree D., Gaus A., Godin R., Hayden R., Hirst P., Kadir S., Kaps M., Larsen H., Lindstrom T., Miles N., Morrison F., Myers S., Ouellette D., Rom C., Shane W., Taylor B., Taylor K., Walsh C., Warmund M. 2004. Growth and yield of Redhaven peach on 19 rootstocks at 20 North American locations. J. Amer. Pomol. Soc. Vol. 58(4): 174–202.

SODININKYSTĖ IR DARŽININKYSTĖ. MOKSLO DARBAI. 2006. 25(3). 327–333.

PRUNUS POSKIEPIŲ VERTINIMAS 2001 M. NC-140 PERSIKŲ BANDYME

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Santrauka

2001 m. ‘Redtop’, ‘Redhaven’ arba ‘Cresthaven’ veislių persikų vaismedžiai su keturiolika *Prunus* poskiepių ir selekcinių numerių buvo pasodinti dešimtyje Šiaurės Amerikos vietovių. Bandymas įrengtas 8 atsitiktine tvarka parinktų blokų pakartojimais, vaismedžių sodinimo schema – 5 x 6 m. Tyrimas buvo NC-140 kooperacinio regioninio poskiepių projekto dalis (www.nc140.org). Tirti sėkliniai persikų poskiepiai Lovell, Bailey, ir Guardian® BY520-9 (selekcinis Nr. SC-17), kloniniai poskiepiai BH-4 ir SLAP (Cornerstone) (persiko ir migdolo hibridai), K146-43 (Controller 5), K146-44 ir P30-135 (Controller 9) (persiko ir slyvos hibridai), Hiawatha, Jaspi ir Julior (tarprūšiniai slyvų hibridai), Cadaman® ir VVA-1 (Krymsk® 1) (tarprūšiniai *Prunus* hibridai) bei Pumiselect® (*Prunus pumila*). Augiausi vaismedžiai buvo Džordžijoje, Merilende ir Pietų Karolinoje, augiausi poskiepiai – BH-4, SLAP, SC-17, Lovell, ir Cadaman®. Mažiausiai augūs buvo Jaspi, K146-43, K146-44 ir VVA-1 poskiepiai. Vaismedžių su šiais poskiepiais kamienų skersmuo buvo 30–40% mažesnis negu su Lovell. Visose vietovėse daugiausia vaismedžių išgyveno su Lovell poskiepiu. Julior, Jaspi ir VVA-1 poskiepiai išaugino daugiausia šaknų atžalų. Didžiausią suminį derlių davė vaismedžiai su persikų sėjinukais, persiko ir migdolo hibridais ir Cadaman®, mažiausią – su Jaspi, VVA-1 ir K146-44. Didžiausius vaisius išaugino vaismedžiai su BH-4, SLAP ir Bailey poskiepiais. Produktyviausi buvo vaismedžiai su Bailey poskiepiu, mažiausiai produktyvūs – su Jaspi.

Reikšminiai žodžiai: persiko ir migdolo hibridai, persiko ir slyvos hibridai, *Prunus persica* L.