

Multistate Research Activity Accomplishments Report

Project Number: NC-140

Project Title: Rootstock and Interstem Effects on Pome- and Stone-fruit Trees

Period Covered: October 1, 2003- September 30, 2004

Date of This Report: January 28, 2005

Annual Meeting Dates: November 10-11, 2004

Participants: Please see annual meeting minutes, available on the NC-140 web-site: <http://www.nc140.org>. The address of the listserve for participants is nc140@virtualorchard.net.

Summary of Minutes: Please see annual meeting minutes, available on the NC-140 web-site: <http://www.nc140.org/>

Accomplishments and Impacts:

Objective 1: Evaluate the performance of pome-and stone-fruit rootstocks in various environments under different management regimes.

To evaluate the performance of rootstock material in different climatic and edaphic environments, replicated, uniform trials were planned, conducted, and coordinated by NC-140 (see <http://www.nc140.org/> for more details on planting design, rootstocks and locations). Several widely planted trials have been concluded in the last few years, and data from these plantings have either been published or are being prepared for publication. Currently there are 11 multi-state coordinated plantings from which data are being collected. These comprise six apple, three peach and two cherry plantings.

1992-1993 Liberty/CG Rootstock (coordinated by Terence Robinson, NY). Data collection from the plantings established in 1992 and 1993 is now complete. Analysis of data and preparation of publications is currently underway.

1994 Gala Dwarf Apple (coordinated by R. Marini, VA). 2003 marked the final year of data collection from this planting. A draft has been prepared and will be submitted for publication following review by the cooperators.

1994 Semi-dwarf Apple (coordinated by R. Marini, VA). 2003 marked the final year of data collection from this planting. A draft has been prepared and will be submitted for publication following review by the cooperators.

1998 Sweet Cherry Rootstock (coordinated by F. Kappel, BC). All trees with Mahaleb in their parentage are more vigorous than Mazzard. The most vigorous trees after 6 growing seasons are Mahaleb, Mazzard, Gi.6, W.10 and W.13, while trees on Gi.209/1 (=Gi.3) were consistently the smallest. The poorest survival was with Gi.195-20 and W.53 rootstocks.

1998 Tart Cherry Rootstock (coordinated by F. Kappel, BC). Similar to the sister sweet cherry planting, the most vigorous trees were on Mahaleb and W.10 rootstocks, and Gi.3 produced the smallest trees.

1998 Gala/Jonagold Apple G.16 Rootstock (coordinated by T. Robinson, NY).

Considerable variation among sites in the rankings of rootstocks for vigor was evident. At several sites there was no difference in tree size after 6 growing seasons. Generally, most rootstocks had higher yield efficiencies than the standard, M.26.

1999 Dwarf and Semidwarf Fuji/McIntosh Apple (coordinated by W. Autio, MA). In the dwarfing planting, trees growing on CG.5202 tended to be the largest trees with the lowest yield efficiencies. Conversely, trees on Sup. 1, Sup. 2 and Sup. 3 were smallest with high yield efficiencies. So far, survival of trees on all rootstocks has been better than those on M.9. In the semi-dwarfing planting, CG.4814 was the smallest and should probably be classified as a dwarf rather than a semi-dwarf rootstock although there was considerable overlap in the tree size of trees on dwarf and semi-dwarf rootstocks. Apart from CG.4814, the semi dwarf rootstocks in this planting were generally between M.26 EMLA and M.7 EMLA in size.

2001 Redtop/Redhaven Peach Rootstock (coordinated by G. Reighard, SC). Most rootstocks produced trees smaller than those on Lovell, but those higher vigor rootstocks included Cadaman, BH-4, SLAP, and SC-17. The most dwarfing rootstocks were VVA-1, Jaspri, and K146-43. In terms of yield efficiency, the best performers were Bailey, Lovell, and K146-43. These general trends held true across sites with Redtop and Redhaven as the cultivar. Survival of trees on Pumiselect has been low due to graft breakage in high winds.

2002 Cresthaven/Redhaven Peach Rootstock (coordinated by G. Reighard, SC).

The largest trees are consistently on Cadaman and Lovell rootstocks, and these trees also had the highest yield efficiency. Trees growing on VVA-1 and VSV-1 were typically the smallest and tended to have the lowest yield efficiencies.

2002 Cresthaven Peach Physiology (coordinated by S. Johnson, CA). Uniform plantings have been established and are ready for treatments to be applied.

2002 Buckeye Gala Apple (coordinated by W. Autio, MA). Tree survival has generally been good. Fireblight infections were evident at some sites, but no rootstock differences in the severity of the disease were seen. The smallest trees were on JM.1, CG.3041, B.9 Treco and B.9 Europe rootstocks. Largest trees were produced by P.14, PiAU51-4, PiAU36-2, PiAU56-83 and CG.3007 rootstocks. Differences in productivity and yield efficiency should become more apparent as trees settle into a more mature cropping phase.

2003 Golden Delicious Physiology (coordinated by R. Marini, VA). Orchards have been established and are growing well. Few rootstock differences have been observed to date, and trees are nearing the point where treatments can be imposed.

2003 Dwarf Apple Rootstock (coordinated by R. Marini, VA). Consistently the following rootstocks produced the largest trees: PiAU56-83, PiAU51-84, with those on JM.2 and JM.7 being quite vigorous at some sites. The rootstocks B.9 and JTEG produced the smallest trees. Some mortality of trees on JM.7 and G.16 was evident at some sites.

Objective 2: To assess and improve asexual propagation techniques of pome and stone fruit rootstocks.

Two states are working on techniques for the improved propagation of apple (NY) and pear (OR) rootstocks.

Objective 3: To improve the ability to identify pome and stone fruit rootstocks through morphological, biochemical and genetic differences.

Efforts are continuing to confirm the identity of Cornell-Geneva series rootstocks around the world through molecular methods (NY).

Objective 4: To develop new and better pome and stone fruit rootstocks through breeding and genetic engineering.

Programs are underway in AR, CA, NY, OH and Ontario.

-An ongoing breeding program in Arkansas is testing twelve new apple and 44 new peach rootstock selections.

-At Cornell, four new CG apple rootstocks are being released over the next two years, with the collection of new rootstocks from programs worldwide. In 1999, 16 rootstocks from three European breeding programs were established for testing.

-The Vineland series of apple rootstocks together with several standard rootstocks are under evaluation for fire blight resistance in Ontario, Canada. The results indicate that wide differences in rootstock susceptibility exist.

Objective 4: To determine biotic and abiotic stress tolerance of pome and stone fruit trees in relation to new and existing rootstocks.

Programs are underway in New Brunswick, NY, Ontario and UT.

-In New Brunswick, Canada, morbidity and mortality of more than 70 rootstocks are being evaluated. These include rootstocks from within North America (New York, Michigan, Nova Scotia, Ontario) as well as rootstocks from England, Russia, Czech Republic, Germany, and Poland.

-In New York, the CG rootstocks, as well and many other rootstocks collected worldwide, are being screened for tolerance to biotic and abiotic factors as replant disease, late winter cold temperatures, Phytophthora root rots and fire blight.

-In Utah, field studies were conducted to evaluate fireblight sensitivity and bud union breakage under high winds of Gala apples on different rootstocks.

USEFULNESS OF FINDING AND IMPACT OF COOPERATIVE RESEARCH PROJECTS

From uniform trials planted across sites in North America that differ greatly in terms of environmental conditions and biotic and abiotic stresses, unbiased data is gathered to quickly assess new rootstocks in a timely fashion. These rootstocks are compared with industry standards, and from these comparisons, recommendations to growers can be made that are independent and backed by solid data. In developing such recommendations, consideration is given to not only productivity, but also to survival, cold tolerance, disease resistance, graft union integrity, and ease of management. The NC-140 project is recognized internationally as a leading source of comprehensive, unbiased data on field performance of tree fruit rootstocks.

WORK PLANNED FOR NEXT YEAR

Existing planting will be maintained and data collection will continue according to protocols developed by the respective technical committees. Planting coordinators will analyze and summarize data from the various sites for each coordinated planting, and will lead in writing 5 year progress reports and 10 year final reports for publication.

Technical committees will develop schedules of new promising rootstocks that merit broad testing, then prepare for trees to be propagated for future plantings.

PUBLICATIONS

Website

<http://www.NC140.org>

E-mail distribution list

nc140@virtualorchard.net

Journal articles

Al-Hinai, Y.K. and T.R. Roper. 2004. Rootstock effects on growth and quality of 'Gala' apple fruit. *HortSci*. 39:1231-1233.

Al-Hinai, Y.K. and T.R. Roper. 2004. Rootstock effects on growth, cell number, and cell size of 'Gala' apples. *J. Amer. Soc. Hort. Sci.* 129(1):37-41.

Autio W., T. Robinson., L. Andersen, B. Barritt, J. Cline, R. Crassweller, C. Embree, D. Ferree, E. Garcia, G. Greene, E. Hoover, S. Johnson, K. Kosola, J. Masabni, M. Parker, R. Perry, G. Reighard, 2005. Early performance of 'Fuji' and 'McIntosh' apple trees on several dwarf rootstocks in the 1999 NC-140 rootstock trial. *Acta Hort.* (in press)

Autio W., T. Robinson. L. Andersen, B. Barritt, J. Cline, R. Crassweller, C. Embree, D. Ferree, E. Garcia, G. Greene, E. Hoover, S. Johnson, K. Kosola, J. Masabni, M. Parker, R. Perry, G. Reighard, 2005. Early performance of 'Fuji' and 'McIntosh' apple trees on several semidwarf rootstocks in the 1999 NC-140 rootstock trial. *Acta Hort.* (in press)

Ayala, M. and G. Lang. 2004. Examining the influence of different leaf populations on sweet cherry fruit quality. *Acta Hort.* 636:481-488.

Beckman, T.G. and G.A. Lang. 2003. Rootstock breeding for stone fruits. *Acta Hort.* 622:531-551.

Crassweller, R.M., Autio, W.R. and Privé, J.-P. 2004. Evaluation of 'Ginger Gold' apple on several rootstocks at three different sites. (in review).

Elfving, D.C., M.D. Whiting, G.A. Lang, and D.B. Visser. 2004. Growth and flowering response of sweet cherry cultivars to prohexadione-calcium and ethephon. *Acta Hort.* 636:75-82.

Ferree D.C., J.G. Streeter, and Y. Yuncong. 2003. Response of container grown apple trees to soil compaction. *HortScience* 39(1): 40-48.

Greene, D., Azarenko, A., Barritt, B., Belding, B., Berkett, L., Cline, J., Cowgill, W., Ferree, D., Garcia, E., Greene, G., Hampson, C., McNew, R., Merwin, I., Miller, D., Miller, S., Moran, R., Parker, M., Rosenburger, D., Rom, C., Roper, T., Schupp, J. and Stover, E. 2004. Multidisciplinary evaluation of new apple cultivars: the NE-183 regional project. *J. Amer. Pomol. Soc.* 58(2): 61-64.

Hampson, C.R., McNew, R., Azarenko, A., Berkett, L., Barritt, B., Belding, B., Brown, S., Clements, J., Cline, J., Cowgill, W., Crassweller, R., Garcia, E., Greene, D., Greene, G., Merwin, I., Miller, D., Miller, S., Moran, R., Obermiller, J.D., Rom, C., Roper, T., Schupp, J. and Stover, E. 2004. Performance of 'Braeburn', 'Golden Delicious' and 'Yataka Fuji' apple on Mark and M.9 rootstocks at multiple locations across North America. *J. Amer. Pomol. Soc.* 58(2): 78-89.

Hampson, C., Quamme, H.A., Kappel, F. and Brownlee, R.T. 2004. Varying density with constant rectangularity. I. Effects on apple tree growth and light interception in three training systems over ten years. *HortScience* 39(3): 501-506.

Hampson, C., Quamme, H.A., Kappel, F. and Brownlee, R.T. 2004. Varying density with constant rectangularity. II. Effects on apple tree yield, fruit size and fruit color development in three training systems over ten years. *HortScience* 39(3): 507-511.

Hoover, E., N. De Silva, S. McArtney and P. Hirst. 2004. Bud development and floral morphogenesis in four apple cultivars. *J. Hortic. Sci and Biotech.* 79: 981-984.

Lang, G.A., J.W. Olmstead, and M.D. Whiting. 2004. Sweet cherry fruit distribution and leaf populations: modeling canopy dynamics and management strategies. *Acta Hort.* 636:591-599.

Maguylo, K., G.A. Lang, and R.L. Perry. 2004. Rootstock genotype affects flower distribution and density of 'Hedelfinger' sweet cherry and 'Montmorency' sour cherry. *Acta Hort.* 636:259-266.

Miller, S., McNew, R., Belding, B., Berkett, L., Brown, S., Clements, J., Cline, J., Cowgill, W., Crassweller, R., Garcia, E., Greene, D., Greene, G., Hampson, C., Merwin, I., Moran, R., Roper, T., Schupp, J. and Stover, E. 2004. Performance of apple cultivars in the 1995 NE-183 regional project planting: II. Fruit quality characteristics. *J. Amer. Pomol. Soc.* 58(2): 65-77.

Olmstead, M.A., N.S. Lang, G.A. Lang, F. Ewers, and S. Owens. 2004. Characterization of xylem vessels in sweet cherries (*Prunus avium* L.) on dwarfing rootstocks. *Acta Hort.* 636:129-135.

Privé, J.-P. 2004. Summer and winter pruning apple trees can reduce cold hardiness. *Acta Hort* (in press).

Quamme, H.A. and Hampson, C.R. 2004. Winter hardiness measurements on 15 new apple cultivars. *J. Amer. Pomol. Soc.* 58(2): 98-107.

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

Robinson, T.L. and S.A. Hoying. 2004. Which high-density orchard planting system for replant sites in NY is the most productive and profitable. *Acta Hort.* 636:701-709.

Robinson, T.L. and A.N. Lakso. 2004. Variation between years and within years on chemical fruit thinning efficacy of apple during cool springs. *Acta Hort.* 636:283-294.

Robinson, T.L. and S.A. Hoying. 2004. Performance of elite Cornell Geneva apple rootstocks in long-term orchard trials on growers farms. *Acta Hort.* 658:221-229.

Robinson, T.L., R.L. Andersen, and S.A. Hoying. 2004. Performance of Gisela cherry rootstocks in the Northeastern United States. *Acta Hort.* 658:231-240.

Robinson, T., L. Anderson, A. Azarenko, B. Barritt, G. Brown, J. Cline, R. Crassweller, P. Domoto, C. Embree, A. Fennell, D. Ferree, E. Garcia, A. Gaus, G. Greene, C. Hampson, P. Hirst, E. Hoover, S. Johnson, M. Kushad, R. Marini, R. Moran, C. Mullins, M. Parker, G. Reighard, R. Perry, J.P. Privé, C. Rom, T. Roper, J. Schupp, M. Warmund, W. Autio, W. Cowgil, K. Taylor, D. Wolfe. 2004. Performance Of Cornell-Geneva Rootstocks in Multi Location NC-140 Rootstock Trials Across North America. *Acta Hort.* 658:241-245.

Robinson, T.L. 2005. Developments in high density sweet cherry pruning and training systems around the world. *Acta Hort.* (in press)

Robinson, T. 2005. Recent advances and future directions in orchard planting systems. *Acta Hort.* (in press)

Robinson, T. 2005. Effect of tree density and tree shape on light interception, tree growth, yield and economic performance of apples. *Acta Hort.* (in press)

Robinson, T.L., R.L. Andersen and S.A. Hoying. 2005. Performance of six high density cherry training systems in the northeastern United States. *Acta Hort.* (in press)

Robinson, T., L. Anderson, W. Autio, B. Barritt, J. Cline, R. Crassweller, W. Cowgill, C. Embree, D. Ferree, E. Garcia, G. Greene, C. Hampson, K. Kosola, M. Parker, R. Perry, T. Roper and M. Warmund 2005. A multi-location comparison of Geneva 16, Geneva 41 and M.9 apple rootstocks across North America. *Acta Hort.* (in press)

Robinson, T.L., A.M. DeMarree and S.A. Hoying. 2005. An economic comparison of five high density apple planting systems. *Acta Hort.* (in press)

Shupert, D., A.P. Smith, J. Janick, P.B. Goldsbrough and P.M. Hirst. 2004. Segregation of scab resistance in three apple populations: molecular marker and phenotypic analysis. *HortScience* 39(6): 1183-1184.

Whiting, M.D. and G.A. Lang. 2004. Effects of leaf area removal on sweet cherry vegetative growth and fruit quality. *Acta Hort.* 636:467-472.

Whiting, M.D. and G.A. Lang. 2004. 'Bing' sweet cherry on the dwarfing rootstock Gisela 5: I. Crop load effects on fruit quality, vegetative growth, and carbon assimilation. *J. Amer. Soc. Hort. Sci.* 129:407-415.

Whiting, M.D., G. Lang, and D. Ophardt. 2004. Rootstock and training system affect sweet cherry growth, yield and fruit quality. *HortScience* (in press).

Trade Publications

Lang, G.A., J.W. Olmstead, and M.D. Whiting. 2004. La distribuzione dei frutti e delle foglie nel ciliegio dolce: nuova modelli di gestione e controllo dell'albero. *Rivista di Frutticoltura* 66(1):40-45.

Proceedings

Robinson, T.L. and C.B. Watkins. 2004. Cropload affects fruit quality of Honeycrisp apple. *Proc. of the 2004 Empire State Fruit and Veg. Expo.* 2:16-19.

Abstracts

Autio, W.R., J.A. Cline, R.M. Crassweller, C.G. Embree, M.E. Garcia, E.E. Hoover, K. Kosola, R.L. Perry, and T.L. Robinson. 2004. Early performance of 'McIntosh' apple on several dwarf rootstocks in the 1999 NC-140 Rootstock Trial. *HortScience* 39:800.

Autio, W.R., J.A. Cline, R.M. Crassweller, C.G. Embree, M.E. Garcia, E.E. Hoover, K. Kosola, R.L. Perry, and T.L. Robinson. 2004. Early performance of 'McIntosh' apple on several semidwarf rootstocks in the 1999 NC-140 Rootstock Trial. *HortScience* 39:799.

Autio, W.R., J.L. Anderson, B.H. Barritt, R.M. Crassweller, D.C. Ferree, G.M. Greene, S. Johnson, J. Masabni, M.L. Parker, G.L. Reighard, and M. Warmund. 2004. Early

performance of 'Fuji' apple on several dwarf rootstocks in the 1999 NC-140 Rootstock Trial. *HortScience* 39:800.

Autio, W.R., J.L. Anderson, B.H. Barritt, R.M. Crassweller, D.C. Ferree, G.M. Greene, S. Johnson, J. Masabni, M.L. Parker, G.L. Reighard, and M. Warmund. 2004. Early performance of 'Fuji' apple on several semidwarf rootstocks in the 1999 NC-140 Rootstock Trial. *HortScience* 39:799-800.

Greene, D.W., A.N. Lakso, and T.L. Robinson. 2004. Development and testing of a model to rapidly predict apple thinner response. *HortScience* 39: 793.

Leinfelder, M.M., I.A. Merwin, G. Fazio, and T. Robinson. 2004. Resistant rootstocks, preplant compost amendments, soil fumigation and row repositioning for managing apple replant disease. *HortScience* 39: 841.

Robinson, T.L., and C.B. Watkins. 2004. Crop load affects fruit quality of Honeycrisp apple. *HortScience* 39: 841.

Presentations

Autio, W.R., J.L. Anderson, B.H. Barritt, J.A. Cline, R.M. Crassweller, C.G. Embree, D.C. Ferree, M.E. Garcia, G.M. Greene, E.E. Hoover, S. Johnson, K. Kosola, J. Masabni, M.L. Parker, R.L. Perry, G.L. Reighard, T.L. Robinson, and M. Warmund. 2004. Early performance of 'Fuji' and 'McIntosh' apple on several dwarf rootstocks in the 1999 NC-140 Rootstock Trial. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Autio, W.R., J.L. Anderson, B.H. Barritt, J.A. Cline, R.M. Crassweller, C.G. Embree, D.C. Ferree, M.E. Garcia, G.M. Greene, E.E. Hoover, S. Johnson, K. Kosola, J. Masabni, M.L. Parker, R.L. Perry, G.L. Reighard, T.L. Robinson, and M. Warmund. 2004. Early performance of 'Fuji' and 'McIntosh' apple on several semi-dwarf rootstocks in the 1999 NC-140 Rootstock Trial. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Hirst, P.M., W.R. Autio, J.A. Barden, and R.P. Marini. 2004. Precocity and productivity of apple as affected by cultivar, rootstock and growing location. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Privé, J.-P. 2004. Summer and winter pruning apple trees can reduce cold hardiness. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Robinson, T. 2004. Recent advances and future directions in orchard planting systems. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Robinson, T. 2004. Effect of tree density and tree shape on light interception, tree growth, yield and economic performance of apples. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Robinson, T.L., R.L. Andersen and S.A. Hoying. 2004. Performance of six high density cherry training systems in the northeastern United States. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Robinson, T., L. Anderson, W. Autio, B. Barritt, J. Cline, R. Crassweller, W. Cowgill, C. Embree, D. Ferree, E. Garcia, G. Greene, C. Hampson, K. Kosola, M. Parker, R. Perry, T. Roper and M. Warmund 2004. A multi-location comparison of Geneva 16, Geneva 41 and M.9 apple rootstocks across North America. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Robinson, T.L., A.M. DeMarree and S.A. Hoying. 2004. Economic comparison of five high density apple planting systems. VIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems, ISHS, Hungary.

Extension publications

Andersen, R. L. 2004. WhiteGold: a new white fleshed sweet cherry from Geneva. *NY Fruit Quarterly* 12(2):1

Autio, W.R., J. Krupa, and J. Clements. 2003. A comparison of six strains of M.9 over 10 years. *Fruit Notes of New England* 68 (2):22-25.

Autio, W.R., J. Krupa, and J. Clements. 2003. An early look at a few of the Geneva Series apple rootstocks in Massachusetts. *Fruit Notes of New England* 68(2):28-30.

Autio, W.R. 2003. How does B.9 stack up compared to M.9. *Fruit Notes of New England* 68(2):31

Carroll, J. and T. Robinson. 2004. The New York state apple IFP, our "most friendly practices". *NY Fruit Quarterly*. 12(2):5-8.

Cheng, L. and T. Robinson. 2004. Management of Nitrogen and carbohydrate reserves to improve growth and yield of apple trees. *NY Fruit Quarterly*. 12(3):19-22.

Masabni, J.G., G.R. Brown, and D.E. Wolfe. 2004. Rootstock and interstem effects on pome fruit trees. 2004. Fruit and Vegetable Crops Research Report. University of Kentucky publication PR-504:36-38.

Privé, J.-P. 2004. Apple rootstock research. Proc. from the NB Apple Grower meetings, Fredericton, N.B.

Robinson, T. and W. Stiles. 2004. Fertigation of apple trees in humid climates. *NY Fruit Quarterly*.12(1):32-38.

Robinson, T., G. Fazio, H. Aldwinckle and S. Hoying. 2004. Performance of the New Geneva® Apple Rootstocks in Trials in the US, NZ and Europe. *Compact Fruit Tree* 37(3):91-94.

Extension Presentations

Autio, W.R. "Current rootstock research – 1999 NC-140 Dwarf & Semidwarf Apple Rootstock Trials." July 14, 2004, Belchertown, MA. 110 in attendance.

Autio, W.R. "Current rootstock research – 1995 Massachusetts/Maine/Nova Scotia Cultivar-Rootstock Trial." July 14, 2004, Belchertown, MA. 110 in attendance.

Autio, W.R. "Current rootstock research – 2002 NC-140 Apple Rootstock Trial." July 14, 2004, Belchertown, MA. 110 in attendance.

Domoto, P. Iowa Fruit and Vegetable Growers Association Field Day, 12 July 2004, ISU Horticulture Farm, Ames, IA. Grower attendance 90.

Ferree, D. 2004. Performance of NC-140 rootstock trials in Ohio. Winter meetings Ohio Fruit Growers Society.

Hirst, P.M. 2003. Apple rootstocks: which is best and what is right for you? Indiana Horticultural Congress. Attendance: 70.

Myers, S. 2004. NC-140 Rootstock Trials in Ohio. Summer Tour, Ohio Fruit Growers Society, Wooster, OH.