

## **SAES-422 Multistate Research Activity Accomplishments Report**

Project No. and Title: **NC140** IMPROVING ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY IN TREE-FRUIT PRODUCTION THROUGH CHANGES IN ROOTSTOCK USE  
Period Covered: 10-2009 to 09-2010  
Date of Report: 21-Dec-2010  
Annual Meeting Dates: 03-Nov-2010 to 05-Nov-2010

### **Participants**

Brent Black and Thor Lindstrom, Utah State Univ.; Jon Clements and Wes Autio, Univ. of Mass; John Cline, Univ. of Guelph; Rob Crassweller and Rich Marini, Penn. State Univ.; Paul Domoto, Iowa State Univ.; Charlie Embree, Atlantic Food & Hort. Research Center, Kentville, Nova Scotia; Todd Einhorn, Oregon State Univ.; Rachel Elkins and Scott Johnson, Univ. of California; Essie Fallahi, Idaho State Univ.; Gennaro Fazio, USDA ARS / Cornell Univ.; Valdemar Gonzalez, Fundacion Coahila, Mexico; Cheryl Hampson, AgCanada, BC Diane Miller, Jozsef Racsko,, and Bill Randle, Ohio State Univ.; Peter Hirst, Purdue Univ.; Emily Hoover, Univ. of Minn.; Greg Lang, Michigan State Univ.; Renae Moran, Univ. of Maine; Michael Parker, North Carolina State Univ.; Rafael Parra, INIFAP, Sierra de Chihuahua, Mexico; Ramesh Pokharel, Colorado State Univ.; Kris Pruski, Nova Scotia Agricultural College; Greg Reighard, Clemson Univ.; Terence Robinson, Cornell Univ.; Matt Stasiak, Univ. of Wisconsin; Michelle Warmund, Univ. of Missouri; Shengrui Yao, New Mexico State Univ.; KaiChun Zhang and Xioming Zhang, Institute of Forestry and Pomology, Beijing Academy of Agriculture and Forestry Sciences, Beijing China.

### **Brief Summary of Minutes of Annual Meeting**

Existing plantings 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 sub-committees for 4 fruit commodities (apple, cherry, peach, and pear) met to discuss management protocols of existing plantings and to discuss potential future plantings.

Apple Sub-Committee (T. Robinson, Chair): Some discussion was carried out as to how to address tree loss and lack of growth in the 2010 apple plantings. There are no definite plans for new apple plantings scheduled, but five possible projects were discussed: (1) a multi-location study with new rootstocks including six from New Zealand and 6-10 new Geneva selections (2015 at the earliest). (2) Using existing plantings to relate leaf nutrient content to rootstocks. This could potentially be funded by a SCRI grant. (3) Relating leaf and fruit mineral content to storage disorders in the 2010 Honeycrisp planting. (4) A study on the impact of replant treatment on yield and yield efficiency. (5) A rootstock trial under organic management (2013).

Cherry Sub-Committee (G. Lang, Chair). Plans were discussed for the 2010 systems trial. Since tree growth was insufficient at a number of sites, management timeline was postponed one year. Status of manuscripts from the 1998 planting was later discussed. In a follow up telephone conversation, these are nearing completion under the direction of G. Lang.

Peach Sub-Committee (G. Reighard, Chair) Plans were discussed to carry out comparative tissue analysis and bud hardiness studies study with the 2009 trial to look at site and rootstock interactions. IPNI was discussed as a possible funding source for the tissue analysis work. The cold hardiness study, would need partial funding of Michelle's study, and the trees are two years away from having enough wood.

Pear Sub-Committee (T. Einhorn, Chair) There are 3 new rootstocks in tissue culture that were damaged by cold temperatures. 2013 is the anticipated date for the next planting with 3 rootstocks -

Pyro 2-33, OHxF87 and OHxF69 and 3 Amelanchier clones. Kris Pruski might work on propagation issues.

### Accomplishments

Objective 1. To evaluate the influence of rootstocks on temperate-zone fruit trees characteristics grown under different management systems and environmental conditions. Status of concluded projects: " 1999 Dwarf and Semi-dwarf Fuji/McIntosh apple rootstock trial which compares 21 apple rootstocks at 17 locations in North America. Final reports have been accepted for publication in the J. Amer. Pom. Soc. " 2001 Peach trial of 14 Prunus rootstocks. The final report has been submitted for publication in the J. Amer. Pom. Soc. 2002 Peach trial of three peach varieties on eight rootstocks. A report was submitted to the J. Amer. Pom. Soc.

Ongoing projects: 2002 Gala apple rootstock trial compares 20 apple rootstocks at 10 locations in North America. 2002 Cameo apple rootstock trial compares 3 rootstocks at 2 locations in the eastern USA. 2002 Pear rootstock trial compares 7 rootstocks at 4 locations in the North America. 2003 Golden Delicious apple rootstock and physiology trials compares 23 rootstocks at 14 locations. 2004 Pear rootstock trial compares 3 rootstocks at 3 locations in North America. 2005 Pear rootstock trial compares 3 to 8 rootstocks with Bartlett and 7 rootstocks with Bosc at 6 locations in North America. 2006 Gala apple replant trial compares 12 rootstocks at 10 locations in fumigated and unfumigated soil at each site. 2006 Cherry physiology trial compares the yield and fruit size of a dwarfing cherry rootstock at 4 locations in North America. 2009 Peach rootstock trial compares 18 rootstocks at 14 locations in 12 states was planted. A companion study on crop load physiology was also planted in 2009.

Objective 2. To develop and improve rootstocks for temperate-zone fruit trees with breeding and genetic engineering, to improve propagation techniques for rootstocks, and to acquire new rootstocks from worldwide sources. Development of new rootstocks: New York State, in cooperation with the USDA continues to develop and test new rootstocks. Two tests with Honeycrisp and Fuji are helping to identify new elite clones. " Propagation of apple rootstocks: New York State, in cooperation with the USDA continues to work on techniques to improve propagation of apple rootstocks primarily difficult-to-root Geneva rootstocks such as G41. These include planting density, plant orientation, tissue culture, early-season shading, and growth regulators.

Objective 3. To study the genetics and developmental physiology of rootstock/scion interactions in temperate-zone fruit trees. In NY, a joint trial is being done on the mapping of root architecture traits on the genome. A population of unscreened seedling is being evaluated for root morphological characters which will allow mapping of root architecture characteristics. An ongoing breeding program in Arkansas is testing twelve new apple and 44 new peach rootstock selections. A breeding program in Michigan has developed a new series of tart cherry rootstocks which will be evaluated in the next NC-140 cherry rootstock trial. Breeding programs in California and Georgia are developing new peach rootstocks.

Objective 4. To better understand the response to and impacts of biotic and abiotic stresses on scion/rootstock combinations in temperate-zone fruit trees. Apple rootstock tolerance to soil pH is being evaluated in NY. A field trial of peach rootstocks in Utah is showing that Cadaman, and several peach x almond hybrids have the highest tolerance to alkaline soils, as measured by leaf chlorophyll. Apple rootstock tolerance to replant disease is being evaluated in NY. A field trial of Gala on 12 rootstocks is being conducted for tolerance to replant disease. This trial began in 2006. Trees on G.6210, M.9T337 and G.935 grew better on unfumigated soil than on fumigated soil. Cold Hardiness Testing of New Apple Rootstocks continues in ME. Rootstocks did not differ significantly in trunk hardiness in the 2009-10 evaluation.

### Impacts

1. Results from NC-140 research continue to direct the commercialization of tree fruit rootstocks.
2. The group website ([www.nc140.org](http://www.nc140.org)) is becoming an important source for information on new rootstocks, with 44,600 site visits during the reporting year.
3. Collaborative research under this group led to 4 refereed research publications, 22 non-refereed publications, 7 published abstracts, 3 Extension fact sheets and numerous Extension presentations that reached fruit growers throughout North America.

## Publications

### Refereed Publications

#### *Published*

Black, B.L., D. Drost, T. Lindstrom, J. Reeve, J. Gunnell, and G.L. Reighard. 2010. A comparison of root distribution patterns among *Prunus* rootstocks. *Journal of the American Pomological Society* 64(1): 52-62.

Czynczyk, A., P. Bielicki and T.L. Robinson. 2010. Seven-Year Evaluation Of Cornell-Geneva And Polish Rootstocks with 'Reinders Golden Delicious' in Poland. *Journal of the American Pomological Society* 64:42-51.

Robinson, T.L., D. Wolfe, J. Masabni, R. Andersen, A. Azarenko, J. Freer, G. Reighard, P. Hirst, R. Hayden, B. McCluskey. 2010. Performance of Plum Rootstocks with 'Stanley', 'Valor', 'Veeblue', and 'Santa Rosa' Scions in the 1991 NC-140 Multi-State Plum Trial. *Journal of the American Pomological Society* 64:173-182.

Rupasinghe, H.P.V., G.M. Huber, C. Embree, and P.L. Forsline. 2010. Red-fleshed apple as a source for functional beverages. *Canadian Journal of Plant Science* 90: 95-100.

#### *In press*

Autio, W.R., T.L. Robinson, B. Black, T. Bradshaw, J.A. Cline, R.M. Crassweller, C.G. Embree, E.E. Hoover, S.A. Hoying, K.A. Iungerman, R.S. Johnson, G. Lang, M.L. Parker, G.L. Reighard, J.R. Schupp, M. Stasiak, M. Warmund, and D. Wolfe. Performance of 'Fuji' and 'McIntosh' Apple Trees after 10 Years as Affected by Several Dwarf Rootstocks in the 1999 NC-140 Apple Rootstock Trial *Journal of the American Pomological Society*. (in press).

Autio, W.R., T.L. Robinson, B. Black, T. Bradshaw, J.A. Cline, R.M. Crassweller, C.G. Embree, E.E. Hoover, S.A. Hoying, K.A. Iungerman, R.S. Johnson, G. Lang, M.L. Parker, R.L. Perry, G.L. Reighard, M. Stasiak, M. Warmund, and D. Wolfe. Performance of 'Fuji' and 'McIntosh' Apple Trees after 10 Years as Affected by Several Semidwarf Rootstocks in the 1999 NC-140 Apple Rootstock Trial. *Journal of the American Pomological Society*. (in press).

Johnson, S., R. Anderson, W. Autio, T. Beckman, B. Black, P. Byers, J. Cline, C. Chavez-Gonzalez, W. Cowgill, R. Godin, G. Greene, M. Kaps, J. Kamas, H. Larsen, T. Lindstrom, D. Miller, M. Newell, D. Ophardt, D. Ouelette, R. Parra-Quezada, R. Pokharel, G. Reighard, T. Robinson, J. Schupp, L. Stein, K. Taylor, C. Walsh, D. Ward, M. Warmund, and M. Whiting. 2010. Performance of the 2002 NC1-40 Cooperative Peach Rootstock Planting. *J. Amer. Pomol. Soc.*

Reighard, G.L., T. Beckman, R. Belding, B. Black, P. Byers, J. Cline, W. Cowgill, R. Godin, S. Johnson, J. Kamas, M. Kaps, H. Larsen, T. Lindstrom, M. Newell, D. Ouellette, R. Phokharel, L. Stein, K. Taylor, C. Walsh, D. Ward and M. Whiting. Six-year performance of 14 *Prunus* rootstocks at 11 sites in the 2001 NC-140 peach trial. *Journal of the American Pomological Society*. *In press*.

### Non-refereed Publications

Agnello, A.M., A. Landers, D.A. Rosenberger, T.L. Robinson, J.E. Carroll, L. Cheng, P.D. Curtis, D.I. Breth, and S.A. Hoying. 2010. Pest management guidelines for commercial treefruit production 2010. Cornell University, Ithaca NY 252 pp.

Autio, W., J. Krupa, and J. Clements. 2009. An update on the 2003 NC-140 Apple Rootstock Physiology Trial, 2009 results. *Fruit Notes* 74:1-7.

Autio, W., J. Krupa, and J. Clements. 2009. An update of the 2002 NC-140 Apple Rootstock Trial, 2009 results. *Fruit Notes* 74:8-10.

Autio, W., J. Krupa, J. Clements, W. Cowgill, and R. Magron. 2010. New NC-140 apple rootstock trials in Massachusetts and New Jersey in the spring of 2010. *Fruit Notes* 75(3):1-3.

Autio, W., J. Clements, and J. Krupa. 2010. 2009 NC-140 peach rootstock trial in Massachusetts. *Fruit Notes* 75(3):12-14.

Autio, W., J. Krupa, J. Clements, W. Cowgill, and R. Magron. 2010. New NC-140 apple rootstock trials in Massachusetts and New Jersey in the spring of 2010. *Horticultural News* 90(3):1-3.

Autio, W., J. Clements, and J. Krupa. 2010. 2009 NC-140 peach rootstock trial in Massachusetts. *Horticultural News* 90(3):12-14.

Caroll, J., T. Robinson, T. Burr, S. Hoying, K. Cox. 2010. Evaluation of pruning techniques and bactericides to manage bacterial canker of sweet cherry. *NY Fruit Quarterly* 18(1): 9-13.

Crassweller, R., J. R. Schupp and D. E. Smith. 2010 Cultivar and rootstock plantings at PSU. *PA Fruit News* 90(1):57-59.

Crassweller, R. and D. E. Smith. 2010. Summary of 2003. Golden Delicious rootstock trial through 2009. *PA Fruit News*. 90:65-69.

Crassweller, R. M. and D. E. Smith. 2010. Performance of Golden Delicious on 18 Rootstocks in Pennsylvania. *Proc. Cumberland Shenandoah Fruit Workers Conference* 85:77-81.

Domoto, P. and L. Schroeder. 2010. 2003 NC-140 Dwarf Apple Rootstock Trial Performance in 2009. *Ann. Prog. Rept. – 2009 Hort. Res. Sta., ISRF09-36:29-30*. <http://www.ag.iastate.edu/farms/09reports/Horticulture/DwarfAppleRootstock.pdf>

Miranda-Sazo, M., A. DeMarree, and T. Robinson. 2010. The platform factor – Labor positioning machines producing good results for NY apple industry. *NY Fruit Quarterly* 18(2): 5-9.

Robinson, T., S. Hoying, K. Iungerman and D. Kviklys. 2010. Retain Combined with NAA Controls Pre-harvest Drop of McIntosh Apples Better Than Either Chemical Alone. *NY Fruit Quarterly* 18(3): 9-13.

Robinson, T.L. 2010. Pros and cons of an on-farm nursery. *Proceedings of 2010 In-depth Fruit School on On-farm Nursery Management*. pp 3-7.

Robinson, T.L. 2010. Management of the on-farm nursery. *Proceedings of 2010 In-depth Fruit School on On-farm Nursery Management*. pp 51-62.

Robinson, T., and M. Miranda-Sazo. 2010. Current Recommendations for using ReTain. *Lake Ontario Fruit Newsletter* 2010(18):1-2.

Robinson, T., S. Brown, K. Maloney and M. Miranda-Sazo. 2010. Choosing the right rootstocks for the new Cornell apple varieties NY 1 and NY 2 *Lake Ontario Fruit Newsletter* 2010(16):3-4.

Schupp, J. and R. Crassweller. 2010. Peach Rootstock Research in Pennsylvania. *PA Fruit News* 90(8): 14-15.

Schupp, J., R. Crassweller, E. Winzeler and D. Smith. 2010. Dwarfing rootstocks for peach. *PSU Fruit Times* 29(8):7.

D. Ward, W.P. Cowgill Jr., J.L. Frecon, G.C. Hamilton, J.R. Heckman, L.S. Katz, N. Lalancette, B.A. Majek, D. Polk. 2010. "New Jersey Commercial Tree Fruit Production Guide." *Rutgers Cooperative Extension Bulletin E002 total pages (242)*

Wolfe, D., D. Archbold, J. Johnston, and G. Travis. 2009. Rootstock and Interstem Effects on Pome Fruit Trees. 2009 Fruit and Vegetable Crops Research Report. University of Kentucky College of Agriculture, Agricultural Experiment Station publication PR-603:13-15.

*In Press*

Autio, W., T. Robinson, J. Cline, R. Crassweller, C. Embree, E. Hoover, G. Lang, J. Masabni, M. Parker, G. Reighard and M. Warmund. 2009. Performance of Several Semidwarfing Rootstocks with 'Fuji' and 'McIntosh' as Scion Cultivars in the 1999 NC-140 Semidwarf Apple Rootstock Trials. Acta Hort. (in press).

Autio, W., T. Robinson, J. Cline, R. Crassweller, C. Embree, E. Hoover, G. Lang, J. Masabni, M. Parker, G. Reighard, and M. Warmund. 2009. Performance of Several Dwarfing Rootstocks with 'Fuji' and 'McIntosh' as Scion Cultivars in the 1999 NC-140 Dwarf Apple Rootstock Trials. Acta Hort. 11 pp. (in press).

Autio, W., T. Robinson, W. Cowgill, C. Hampson, M. Kushad, G. Lang, J. Masabni, D. Miller, R. Parra Quezada, and C. Rom. 2009. Performance of 'Gala' Apple Trees on Supporter 4 and Different Strains of B.9, M.9, and M.26 Rootstocks as Part of the 2002 NC-140 Apple Rootstock Trial. Acta Hort. (in press).

Clements, J.M., W.P. Cowgill, and W.R. Autio. 2010. To-Date Performance of Three Dwarf Rootstocks in the 2002 NC-140 Apple/Cameo Rootstock Trial in Massachusetts and New Jersey. Fruit Notes, Vol. 75 Winter-Spring Issue. (In press.)

Cline, J. A., Norton, D., Embree, C. G., and Privé, J-P. 2009. Performance of 'Jonagold,' 'McIntosh' and 'Novaspy' on three new size-controlling apple rootstocks compared to M. 26 in Eastern Canada. Submitted to Canadian Journal of Plant Science.

Fazio, G., H.S. Aldwinckle, T.L. Robinson and Y. Wan. 2010. Implementation of molecular marker technologies in the apple rootstock breeding program in Geneva - challenges and successes. Acta Hort. (in press)

Johnson, S., M. Newell, G. Reighard, T. Robinson, K. Taylor and D. Ward. 2010. Weather conditions affect fruit weight, harvest date and soluble solids content of 'Cresthaven' peaches. Acta Hort. (in press)

Kviklys, D. and T. Robinson. 2010. Temperature before and after application of chemical thinners affects thinning response of 'Empire' apple trees. Acta Hort. (in press)

Lang, G. and T. Valentino, T. Robinson, J. Freer, H. Larsen and R. Pokharel. 2010. Differences in mineral nutrient contents of dormant cherry spurs as affected by rootstock, scion, and orchard site. Acta Hort. (in press)

Reginato, G.H., T.L. Robinson, and T.M. Yoon. 2010. Crop regulation and cytokinin sprays to improve 'Sweetheart' cherry fruit size. Acta Hort. (in press)

Robinson, T., A. Lakso and S. Hoying. 2010. Predicting chemical thinner response with a carbohydrate model. Acta Hort. (in press)

Robinson, T., S. Hoying and G. Fazio. 2010. Performance of Geneva rootstocks in on-farm trials in New York State. Acta Hort. (in press)

Robinson, T., S. Hoying and G. Reginato. 2010. The Tall Spindle System: Principles and Performance. Acta Hort. (in press)

Robinson, T., S. Hoying, G. Reginato and D. Kviklys. 2010. Fruit size of high density peaches is smaller than low density systems. Acta Hort. (in press)

Robinson, T., S. Hoying, K. Iungerman and D. Kviklys. 2010. AVG combined with NAA control pre-harvest drop of 'McIntosh' apples better than either chemical alone. *Acta Hort.* (in press)

Robinson, T., S. Lopez and K. Iungerman. 2010. Chemical thinning and summer PGR's for consistent return cropping of 'Honeycrisp' apples. *Acta Hort.* (in press)

Robinson, T., G. Bujdoso and G. Reginato. 2011. Influence of Pruning Severity on Fruit Size of 'Sweetheart', 'Lapins' and 'Hedelfingen' Sweet Cherry Grown on Gisela Rootstocks. *Acta Hort.* (in press)

Robinson, T. and S. Hoying. 2011. Training system and rootstock affect yield, fruit size, fruit quality and crop value of sweet cherry. *Acta Hort.* (in press)

Robinson, T., S. Lopez and K. Iungerman. 2011. Crop load affects 'Honeycrisp' fruit quality more than nitrogen, potassium, or irrigation. *Acta Hort.* (in press)

Robinson, T., W. Autio, J. Clements, W. Cowgill, C. Embree, G. Fazio, V. Gonzalez, S. Hoying, M. Kushad, M. Parker, R. Parra, J. Schupp. 2011. Rootstock differ in tolerance to apple replant disease for improved sustainability of apple production. *Acta Hort.* (in press)

Robinson, T., A. Lakso and S. Hoying. 2011. Can we predict chemical thinning response? *Acta Hort.* (in press)

Yoon, T.M., T. Robinson, and G. Reginato. 2010. Effects of Temperature and Light Level on Efficiency of Chemical Thinner on 'Empire' Apple trees. *Acta Hort.* (in press)

Yoon, T.M., T. Robinson, and J. Osborne. 2010. Blossom thinning of 'Redhaven' and 'Babygold 5' peaches with different chemicals. *Acta Hort.* (in press)

Wolfe, D., D. Archbold, J. Johnston, and G. Travis. 2010. Rootstock and Interstem Effects on Pome Fruit Trees. 2010 Fruit and Vegetable Crops Research Report. University of Kentucky College of Agriculture, Agricultural Experiment Station publication. (in press).

## **Abstracts**

Lakso, A.N., T.L. Robinson, C.B. Watkins. 2010. Seasonal regulation of fruit development, abscission, and postharvest quality - a case study of apple. 28th International Hort Congress-Abstract Book 2:491. (Abstr.)

Lakso, A.N., T. Robinson, D. Greene, S. Gan and L. Cheng. 2010. Effects of low light on early apple fruit development and retention - Genetic, biochemical, physiological and modeling approaches. 28th International Hort Congress-Abstract Book 1:120. (Abstr.)

Robinson, T.L. 2010. Long-term effects of tree density and tree shape on apple orchard performance. *HortScience* 45(8):S134 (Abstr.).

Robinson, T.L. and A.N. Lakso. 2010. Predicting chemical thinner response in apple. 28<sup>th</sup> International Hort Congress-Abstract Book 1:121. (Abstr.)

Robinson, T. and S. Lopez. 2010. Crop load affects 'Honeycrisp' fruit quality more than nitrogen, potassium, or irrigation. 28th International Hort Congress-Abstract Book 2:513. (Abstr.)

Robinson, W. Cowgill, C. Embree, G. Fazio, V. Gonzalez, S. Hoying, M. Kushad, M. Parker, R. Parra, J. Schupp. 2010. Rootstock tolerance to apple replant disease for improved sustainability of apple production. 28th International Hort Congress-Abstract Book 2:512. (Abstr.)

Robinson, T.L. 2010. High density pear production with *Pyrus* rootstocks. XI International Pear Symposium Abstract Book. (Abstr/)

### **Extension Factsheets**

Autio, W., J. Krupa, and J. Clements. 2010. 2002 NC-140 Apple Rootstock Trial in Massachusetts. University of Massachusetts Extension Factsheet F-138.

Autio, W., J. Krupa, and J. Clements. 2010. 2010 NC-140 Apple Rootstock Trial in Massachusetts. University of Massachusetts Extension Factsheet F-137.

Autio, W., J. Krupa, and J. Clements. 2010. 2009 NC-140 Peach Rootstock Trial in Massachusetts. University of Massachusetts Extension Factsheet F-135R.

### **Extension/Outreach Activities**

Chilton County Regional Peach Production Meeting, February 2, 2010, Clanton, AL. "NC-140 2009 Peach Rootstock Trial." (Attendance 105).

North AL Peach Production Meeting, February 18, 2010, Madison, AL. "NC-140 2009 Peach Rootstock Trial." (Attendance 35).

29 Jul All-Horticulture Field Day, ISU Horticulture Research Station, Ames, IA. "NC-140 2003 apple rootstock trial" (Attendance 200).

North Jersey Fruit Meeting, March 2010; Broadway, NJ, 62 attendees, growers

North Jersey Twilight Fruit Meeting, April, 21; Wightman Farms, Morristown, NJ, 46 attendees, growers

North Jersey Twilight Horticultural Research Meeting, Rutgers Snyder Farm, September, 2010; sponsored by RCE and NJ NOFA – 44 growers participating

Utah Fruit and Vegetable Field Day, Kaysville Research Farm, August 17, 2010. (75 attendees