

SAES-422 Multistate Research Activity Accomplishments Report

Project No. NC 140 and Title: Improving Economic and Environmental Sustainability in Tree-Fruit Production Through Changes in Rootstock Use

Period Covered: Oct 1, 2012 to Sept 30, 2013

Annual Meeting Dates: November 6-9, 2013

Brief Summary of Minutes of Annual Meeting

The 2013 meeting was coordinated, hosted and chaired by Dr. Essie Fallahi, University of Idaho, Meridian (Boise), ID November 6-9, 2013. The meeting included a conference day long tour of commercial orchards and research plots at the Parma, ID research station. A report on each cooperative trial was given by planting coordinators. Current status of eight existing or recently terminated plantings and four future plantings were shared with the group. Sites for future meetings were confirmed. Next year's meeting will be coordinated by Greg Reighard and will be located in Clemson, SC. The following year's meeting will be in Northern California, organized by Rachel Elkins and in 2016 by Greg Peck, Virginia. Accomplishments report and minutes prepared by Essie Fallahi, ID and Rachel Elkins, CA.

Accomplishments

Objective 1. To evaluate the influence of rootstocks on temperate-zone fruit tree characteristics grown under varying environments using sustainable management systems.

Projects which are in various stages of data collection and evaluation include the following in association with years of plot establishment:

- 2003 Dwarf Apple Rootstock trial completed with publications forthcoming.
- 2004 Pear rootstock trial compares 3 rootstocks at 3 locations in North America.
- 2005 Pear rootstock trial at 6 locations in North America.
- 2005 Cherry high tunnel systems in MI.
- 2006 Cherry physiology trial compares the yield and fruit size of a dwarfing cherry rootstock at 4 locations in North America.
- 2009 Peach rootstock and physiology trials at 13 sites.
- 2009 Peach physiology study led by Johnson transferred to Marini following Johnson retirement.
- 2010 Apple rootstock trial.
- 2010 Cherry rootstock and training systems.
- 2014 Apple rootstock trial coordinated by Cline
- 2014 Apple organic rootstock trial coordinated by Robinson
- 2015 Sweet Cherry rootstock trial coordinated by Lang

The following projects are in their final stage of conclusion and wrap-up. The 2003 Apple Physiology study was completed with one paper published, one in press and two potential papers to be prepared. The 2003 Apple rootstock trial data collection is in its final year. Data will be summarized for writing and submitting a paper.

Apple Sub-Committee (Chair, Robinson, NY)

The 2014 Apple planting will be coordinated by John Cline who has also agreed to analyze the data. This trial has two semi dwarfing rootstocks that may be too large for a 3-foot spacing. The group voted in favor of extending this to 4 feet in the row and 12 feet between rows with the cultivar Honeycrisp, but keeping the tall spindle system. For Fuji, it was agreed to extend the spacing to 5 feet in the row, 13 feet between rows and a vertical axe training system. Each site will select a pollinizer variety since some sites are very limited in adapted varieties. Another trial is being organized by Robinson for expected planting of 2019. Potential rootstocks are from the East Malling series and New Zealand selections.

Cherry Sub-Committee (Chair, Lang, MI)

The 2010 Sweet Cherry Rootstock x Canopy Training System Coordinated Trial began with 13 sites; these have dwindled to 5-6 due to diseases, cooperator retirements or transitions, deer damage, etc. Work has begun on the first trial paper (Training Systems Establishment, Years 1-3) with adequate data expected from CA, MI, NY-Geneva, NY-New Paltz, NS, and BC. Of this group, CA likely will drop out for the next phase (Initial-Maturation Yields – Years 4-6) due to excessive mortality from Armillaria. Greg Lang will send out a call for missing data sets, as well as a draft of 2014 training and data protocols for subcommittee input, during January. Results from the project thus far have been presented at several international scientific conferences (ISHS-Canopy Physiology, Rootstocks, and Training Systems 2012; ISHS-Cherry 2013) and regional/international grower meetings (MI, MO, PA, WA, IFTA, Chile, New Zealand). The initial fruiting results from 2013 are limited, but interesting in that certain canopy architectures appear to have a potential influence on fruit quality traits such as soluble solids and firmness.

Two 2010 Tart Cherry Rootstock x Canopy Training System Independent Trials were established in UT (Brent Black) and MI-Traverse City (Greg Lang/Nikki Rothwell/Ron Perry). The focus is on examining rootstock x canopy training interactions to develop hedgerow-type trees for over-the-row mechanical harvest. Both sites remain on track; an initial paper on establishment has yet to be discussed.

Three new rootstock genotype evaluation trials are being discussed (Matt Stasiak and Greg Lang, organizers), probably for 2017 planting. Rootstocks up for testing are from MSU, several from Krymsk, several from Gisela, and perhaps one or more MxM stocks. Greg Lang initiated discussion of a new potential (2015) trial focused on trellised sweet cherry systems, i.e., single and dual (“V”) fruiting wall canopy architectures, if there is interest from other subcommittee members.

Pear Sub-Committee (Chair, Einhorn, OR)

The 2002 trial was published in JAPS. The 2004 trial is completed and Terence Robinson and Suzanne Blatt will collaborate on writing this up and presenting at the ISHS Pear Symposium in Belgium in July 2014. The 2005 trial will finish after the 2014 season; data to date will be presented in Belgium, but the final harvest data will not be available until Fall 2014. Rachel will prepare the JAPS article. The 2013 training/rootstock/spacing trial just completed its first season. Cooperators are OR (2 sites; Bartlett and Anjou), NY (Bosc), and CA (Bartlett). Trees were grown by Willow Drive Nursery in WA.

Einhorn had suggested a new trial of quince selections from the ones he had tested for freezing tolerance. In addition to OR, there was interest from: CA (not for cold hardiness; Bartlett, Bosc), CO (Bartlett), NY (Bartlett, Bosc), Nova Scotia (Bartlett, Bosc), and WA (Bartlett, Anjou). The group suggested: a Beurre Hardy interstem done in the nursery to ensure compatibility for Bartlett; Terence described an apple example: Golden Delicious is budded onto the rootstock, then when the trees were knipped (i.e. the 1-year-old stem headed after the first growing season), the desired scion bud was inserted. Suggested spacing was 1-1.5 m x 3.5 - 4 m. Standards would be all commercially available Quince (A, C, BA29, another) and OHF87. Projected planting is for 2016 or 2017, presuming material is available (tissue culture plants of the quince selections are being grown by North American Plant in Oregon).

Peach Sub-Committee (Chair, Reighard, SC)

A five year paper will be prepared for ISHS presentation. Johnson (CA) has retired and coordination will be assumed by Marini (PA). There will be a change in focus to fruit size measurements across climates with early/mid/late season; high to low crop load in 2014. Cooperators will collect temperature data during the growing season up to harvest date using an onsite data logger.

Objective 2. To develop improved rootstocks for temperate-zone fruit trees using state-of-the-art genomic tools in breeding programs.

Rootstocks from the California peach breeding program have been patented and released with an additional rootstocks to be released at a future date. Quince selections in OR are being screened as potential size-controlling pear rootstocks. Pyrus germplasm was established in a collection in WA to evaluate for size control, disease resistance and abiotic stress tolerances of pear trees. Germplasm will also be used for future pear breeding. Efforts to transform Gisela cherry rootstocks with genetic resistance to Prunus necrotic ringspot virus were successful. Field testing of elite cherry genotypes continued in WA and MI. Tissue culture propagation has enhanced rooting of Geneva apple rootstocks and increased the number of stock plants. Efficient methods for existing pear, cherry and apple rootstock micropropagation have been developed in WA for rapid multiplication of new rootstocks. A series of micropropagation experiments were conducted to test different methods to promote shoot proliferation of G.30, B.9 and G.41 apple rootstocks in ME. Peach rootstocks are being developed to reduce impact of Peach Tree Short Life decline for the South Eastern U.S. (GA).

Objective 3. To accelerate adoption of new rootstocks (a) by improving propagation techniques and (b) by acquiring new rootstocks from worldwide sources.

In WA, genomics and transcriptomics approaches are being tested to understand rootstock/scion interactions to ensure the compatibility of new rootstocks. The propagation of several Geneva rootstocks has been improved significantly by the use of tissue culture plants as mother plants for stoolbeds, especially with G.41 in NY. This has resulted in a mini-boom of planting of Geneva 41 stoolbeds. NY found that this research accelerated production in stool beds and resulted in a production of 800,000 liners of G.11 in 2012 and 600,000 liners of G.41. This process boosted availability of rootstock liners to 1.2million liners of G.41, 800,000 liners of G.11 and 300,000 liners of G.935, which will be harvested fall 2013. Mussachi (WA) offered that he was introducing 13 out of 32 dwarfing pear genotypes from the breeding program at the University of Bologna, IT. They are being processed in vitro through the National Clean Plant Network at Prosser. They would be released after 2 years (2016).

Objective 4. To better understand the impacts of biotic and abiotic stresses on scion/rootstock combinations in temperate-zone fruit trees.

Biotic stresses. Apple rootstock tolerance to replant disease continues in NY to categorize 36 genotypes as resistant, intermediate or susceptible. The 2006 apple replant trial continued in some sites. A 2006 apple fumigation trial in NJ and MA continued. A 2009 peach replant study continued in NC. Russian and Geneva apple rootstocks were evaluated for fireblight tolerance in NY. In VA, 10 rootstocks showed differing susceptibility when inoculated with fireblight bacteria. Studies to determine the performance of Fire blight resistance in Asian pears AL. Colonization with root lesion nematodes (*Pratylenchus penetrans*) was much higher for G13 than for Gi5 and Gi6 cherry rootstocks with no effects of training system on root health and no bacterial canker in BC. CA will begin studies in cherry rootstock resistance to *Armillaria mellea*. Studies are being conducted to determine incidence and interaction of Bacterial canker and metal wire trellising and rootstocks and varieties in MI. Research is being conducted on regional and rootstock differences in apple cultivar volatiles and their impact on apple maggot and apple sawfly host selection at NS, CAN. Studies are beginning in WV to plant a test of rootstock susceptibility to Tomato Ring Spot Virus. Peach Tree Short Life decline can be attenuated using rootstocks which can prolong tree and orchard life in GA.

Abiotic stresses. Evaluation of peach rootstock tolerance to soil alkalinity continued in Utah. Apple rootstock tolerance to soil pH is also being evaluated in NY. Cold Hardiness Testing of Apple Rootstock Cultivars and Selections (Collaboration with USDA ARS Geneva and the Univ. of Guelph) is continuing in ME. Cold hardiness of quince selections for pear continued in OR. In IA and MO, a study to determine the relationship of blackheart and tree performance continued. Rootstock treatments had little effect on

bud survival in the 2009 peach rootstock trial in SC, MO and UT despite warm winter temperatures. Nutritional studies are finding differences among cherry rootstocks in BC. Mineral nutrient absorption is being studied in ID among apple rootstocks. Studies being conducted on UT on iron deficiency in peaches utilizing the 2009 NC 140 peach rootstock trial to see if rootstocks influence iron levels in plant tissue of Redhaven scion.

Objective 5. To enhance the sustainability of temperate fruit farming through development and distribution of research-based information utilizing eXtension. Members of our research group have been working on making research-based information available to any one who would like to use it through eXtension (MN, PA, MA, NY, NC, MO, OH, WV, IN, VA). In 2013, we completed our databases for apple rootstocks and cultivars and can be viewed at <http://www.extension.org/apples>. This project was funded through the USDA-SCRI program and will be completed in August 2014. We have linked to the primary website for the research group, www.nc140.org. This site continues to be our primary outreach component serving as an important collaboration tool for cooperators. Members of the research group communicate through a list serve, and upload/download project files to password-protected directories (NJ, MA). We have used the site to allow for easier collaboration and comparison of replicated rootstock trials.

Impacts

Official Statement SAES-422: Over the last 30 years, fruit growers in North America have steadily transitioned from large canopied orchards to newer higher density orchards that use less land surface, increased production efficiency, and accommodate automation utilizing new technology in management. New rootstocks have largely been the impetus behind this transition as identified by NC-140 research in identifying superior performing rootstocks, their propagation and commercialization. The outcome of this work has given consumers supplies of sustainably grown quality fresh and processed fruit.

The NC-140 plantings are regularly used as demonstration plots of new rootstocks for growers, nurserymen, visiting scientists, and graduate students. Rootstock trials have also been conducted on grower's farms, which has yielded invaluable information on adaptability that was not known from experiment station trials. Over the last 16 years, there has been a large change in rootstock use in the United States and Canada.

Results from NC-140 research continue to accelerate the process of identifying superior performing tree rootstocks and of their propagation and commercialization. Growers in various regions of the North America have benefited by having these rootstocks made available earlier by nursery companies. The NC-140 cooperative plantings have identified the benefits of the disease resistant CG rootstocks for North American sites.

Documents have been uploaded in eXtension associated with rootstocks and apple varieties have become a very popular resource for information for growers throughout the eastern United States (MN, NC) found at www.extension.org/apples.

Apple and peach rootstocks with tolerance to replant disease are being identified to improve survival and productivity without the use of fumigants in CA, SC, NC, ID, WA, MI, PA, IN, WI, MN, IA, OR, CO, NY, NJ, NC and MA.

Given the increasing labor costs and emphasis on labor safety, some Californian peach growers are very interested in shifting to pedestrian orchard systems. The peach rootstock research associated with this cooperative research project are providing growers with options for reducing peach tree vigor that are required to meet their objectives.

Dwarfing apple rootstocks are critical to growers transitioning to training systems which accommodate the use of labor saving automation, such as mobile platforms and overhead water and chemical delivery regarding pruning, training, harvesting and pest control.

Apple and pear (quince) rootstocks with superior cold temperature tolerance are being identified to improve survival and productivity.

High density apple, pear and sweet cherry orchards that employ several dwarfing rootstocks have stimulated growers to expand commercial acreage. New peach rootstocks are motivating growers to transition to rootstocks tolerant of high pH calcareous soils which avoids use of chelating compounds to correct iron deficiency.

Yields, fruit quality, and labor efficiencies realized with the intensive high density cherry canopy architectures on dwarfing rootstocks are already stimulating grower experimentation with these new training and production concepts.

Changes in rootstock use were documented in Indiana. Previously, approximately 80% of apple orchards in the state were planted on more vigorous rootstocks. In plantings made in the last 15 years, use of the superior performing rootstocks in NC-140 trials in this state has increased 660%. The use of recommended rootstocks can increase crop value by more than \$12,000 per acre. On a state-wide basis, this is an increase of \$8.8 m per year.

The NC-140 web site, www.nc140.org continues to be an important outreach component satisfying the needs of growers. In 2012 we began using Google Analytics to track our web traffic. We had 2,064 visits with 5,551 page views. The NC-140 web site also serves as an important collaboration tool for cooperators who can communicate via an e-mail list, and upload/download project files to password-protected directories.

Grants

NC140 members have written research proposals and attracted extramural funding associated or directly related to the five objectives of this project from local, regional, national and international funding sources. For fiscal year 2012/2013, funding reported by members amounted to **\$1,182, 250 from primarily commodity groups and state sources. Additionally, funding from competitive grants associated with this project amounted to \$3.2 million.**

Publications

Collaborative research directed by members of this group led to 28 peer-reviewed publications, 41 non peer-reviewed publications, and numerous Extension articles and presentations that reached fruit growers throughout North America. Two articles in trade journals highlighted the impact of rootstock research on tree fruit production.

Peer Reviewed

Autio, W., J. Krupa, J. Clements, W. Cowgill, R. Magron, and S. Sollner-Figler. 2013. Third-leaf results from the 2010 NC-140 Apple Rootstock Trial in Massachusetts and New Jersey. *Fruit Notes* 78(3):7-8.

Autio, W., T. Robinson, D. Archbold, W. Cowgill, C. Hampson, R. Parra-Quezada and D. Wolfe. 2013. 'Gala' apple trees on Supporter 4, P.14, and different strains of B.9, M.9, and M.26 rootstocks: A final 10-year report on the 2002 NC-140 Apple Rootstock Trial. *Journal of the American Pomological Society* 67:62-71.

Beckman, T.G., J.X. Chaparro and W.B. Sherman. 2012. MP-29, a clonal interspecific hybrid rootstock for peach. *HortScience* 47(1):128-131.

- Clements, Jon M., W.P. Cowgill, R. Magron, and W.R. Autio. 2013. Ten-year Performance of Cameo® Apple Trees on Three Dwarf Rootstocks in Massachusetts and New Jersey as Part of the NC-140 Regional Rootstock Research Project. (Abstract.) HortScience, 48(9) (Supplement): S4.http://ashs.org/downloads/supplement/2013NE-ASHS_AnnualMtg.pdf
- DeJong, T. M. , S. Tombesi, B. Basile and D. Da Silva. 2013. Beakbane and Thompson (1939, East Malling) Had It Right: Scion Vigour is Physiologically Linked to the Xylem Anatomy of the Rootstock. Aspects of Applied Biology 119: 51-58.
- Einhorn, T., Castagnoli, S., Smith, T., Turner, J., and Mielke, E. 2013. Summary of the 2002 Pacific Northwest Pear Rootstock Trials: Performance of 'd'Anjou' and 'Golden Russet Bosc' pear on eight Pyrus rootstocks. Journal of the American Pomological Society 67 (2): 80-88.
- Fallahi, E. 2012. Influence of Rootstock and Irrigation Methods on Water Use, Mineral Nutrition, Growth, Fruit Yield and Quality in 'Gala' Apple. HortTechnology. 22 (6): 731-737.
- Fallahi, E. and T. Eichert. 2013. Principles and Practices of Foliar Nutrients with Emphasis on Nitrogen and Calcium Sprays in Apple. HortTechnology. 23(5): 542-547.
- Fallahi, E., B. Fallahi, and B. Shafii. 2013. Irrigation and Rootstock Influence on Water Use, Tree Growth, Yield, and Fruit Quality at Harvest at Different Ages of Trees in 'Pacific Gala' Apple. HortScience. 48:588-593.
- Fallahi, E., B. Fallahi, and B. Shafii. 2013. Water Use, Mineral Nutrition, Tree Growth, Yield, and Fruit Quality of 'Fuji' and 'Gala' Apples under Various Irrigation Systems and Rootstocks. Acta Horticulturae. 984:57-68.
- Fallahi, E., D. Bakhshi, and B. Fallahi. 2013. Postharvest Fruit Quality and Growth of 'Pacific Gala' Apple Trees at Different Ages as Influenced by Irrigation and Rootstock. International Journal of Fruit Science. 13 (4): 478-491.
- Fallahi, E., K. Arzani, and B. Fallahi. 2013. Long-term leaf mineral nutrition in 'Pacific Gala' apple (*Malus domestica* Borkh.) as affected by rootstock type and irrigation system during six stages of tree development. Journal of Horticultural Science & Biotechnology 88 (6) 685–692.
- Greene, D.W., A.N. Lakso, T.L. Robinson and P. Schwallier. 2013. Development of a fruitlet growth model to predict thinner response on apples. HortScience 48:584–587.
- Harshman, JM and CS Walsh. 2013. Effects of the phenotype and seed parent on the size, productivity and fruit quality in second-generation seedling apple trees. J. Amer. Pomological Soc. 67(3):168-174.
- Hoover, E., R. Marini, E. Tepe, W. Autio, W., A. Biggs, J. Clements, R. Crassweller, D. Foster, M. Foster, P. Hirst, D. Miller, M. Parker, G. Peck, J. Racsko, T. Robinson, and M. Warmund. 2012. eApples: A case study using eXtension to increase access to research-based information HortTechnology 22:576-579.
- Lang, G., E. Hanson, J. Biernbaum, D. Brainard, M. Grieshop, R. Isaacs, A. Montri, V. Morrone, and A. Schilder, D. Conner, and J. Koan. 2013. Holistic integration of organic strategies and high tunnels for Midwest/Great Lakes fruit production. Acta Hort. 1001:47-55.

Lang, G.A. 2013. Tree fruit production in high tunnels: current status and case study of sweet cherries. *Acta Hort.* 987:73-81.

Marini, R., W. Autio, B. Black, J. Cline, W. Cowgill, Jr., R. Crassweller, P. Domoto, C. Hampson, R. Moran, R. Parra-Quezada, T. Robinson, M. Stasiak, D. Ward and D. Wolfe, 2012. The Relationship Between 'Golden Delicious' Fruit Weight and Crop Density at 12 Locations as Influenced by Three Dwarfing Rootstocks. *Journal of the American Pomological Society*, Vol 66:4

Marini, R., W. Autio, B. Black, J. Cline, R. Crassweller, P. Domoto, C. Hampson, R. Moran, R. Quezada, T. Robinson, M. Stasiak, and D. Wolfe. 2012. The influence of crop density on annual trunk growth of 'Golden Delicious' apple trees on three rootstocks at 11 locations. *J. Amer. Pomol. Soc.* 66:183-195.

Marini, R., W. Autio, B. Black, J. Cline, W. Cowgill, R. Crassweller, P. Domoto, C. Hampson, R. Moran, R.A Parra-Quezada, T. Robinson, M. Stasiak, D. Ward, and D. Wolfe. 2012. Summary of the NC140 Apple Physiology Trial: the Relationship Between 'Golden Delicious' Fruit Weight and Crop Density at 12 Locations as Influenced by Three Dwarfing Rootstocks. *J. Amer. Pomological Society* 66:78-90.

Marini, R., W. Autio, W., B. Black, J. Cline, W. Cowgill, R. Crassweller, P. Domoto, C. Hampson, R. Moran, R. Quezada, T. Robinson, D. Ward, and D. Wolfe. 2013. Return bloom on 'Golden Delicious' apple trees as affected by previous season's crop density on three rootstocks at 11 locations. *J. Amer. Pomol. Soc.* 67:73-79.

Marini, R.P., W.R. Autio, B. Black, J. Cline, R.M. Crassweller, P.A. Domoto, C. Hampson, R. Moran, R.A. Quezada, T. Robinson, and D. Wolfe. 2013. Return bloom on 'Golden Delicious' apple trees as affected by previous season's crop density on three rootstocks at 10 locations. *Journal of the American Pomological Society* 67:73-79.

Marini, R.P., W.R. Autio, B. Black, J. Cline, R.M. Crassweller, P.A. Domoto, C. Hampson, R. Moran, R.A. Quezada, T. Robinson, D. Wolfe. 2013. Return bloom on 'Golden Delicious' apple trees as affected by previous season's crop density on three rootstocks at 11 locations. *Journal of the American Pomological Society* 67(2):72-79.

Marini, R.P., W.R. Autio, B. Black, J. Cline, W.R. Cowgill, Jr., R.M. Crassweller, P.A. Domoto, C. Hampson, R. Moran, R.A. Quezada, T. Robinson, D.L. Ward, and D. Wolfe. 2013. Return Bloom on 'Golden Delicious' Apple Trees as affected by Previous Season's Crop Density on Three Rootstocks at 11 Locations. *J Am Pom Soc. (APS)* 67:72-79, http://www.pubhort.org/aps/67/v67_n2_a2.htm

Marini, R.P., W.R. Autio, B. Black, J. Cline, W.R. Cowgill, R.M. Crassweller, P.A. Domoto, C. Hampson, R. Moran, R.A. Quezada, T. Robinson, D. Ward, and D. Wolfe. 2013. Return bloom on 'Golden Delicious' apple trees as affected by previous season's crop density on three rootstocks at 11 locations. *J. Amer. Pomological Society.* 67:72-79.

Parker, M. revised chapter by R.L. Perry and J.N. Cummins. 2013. Burrknot. In: Sutton, T.B., H.S. Aldwinckle, A.M. Agnello and J.F. Wallenbach (eds.) *Compendium of Apple and Pear Diseases and Pests*, Second Edition. APS Press. pp. 125-126.

Reighard, G.L. 2013. Peach, Plum and Apricot Rootstocks for the 21st Century. *Aspects of Applied Biology* 119:59-66.

Reighard, G.L., W. Bridges, B. Rauh and N.A. Mayer. 2013. Prunus rootstocks influence peach leaf and fruit nutrient content. *Acta Hort* 984:117-124.

Song, G.-Q., K.C. Sink, A.E. Walworth, M.A. Cook, R.F. Allison, and G.A. Lang. 2013. Engineering cherry rootstocks with resistance to Prunus necrotic ring spot virus through RNAi-mediated silencing. *Plant Biotechnology Journal* doi: 10.1111 / pbi.12060.

Other Publications (Abstracts, Fact Sheets, Newsletters, Reports)

Autio, W., T. Robinson, D. Archbold, W. Cowgill, C. Hampson, R. Parra Quezada and D. Wolfe. 2013. 2002 NC-140 Apple Rootstock Trial: Gala apple trees on Supporter 4, P.14 and different strains of B.9, M.9 and M.26 rootstock: Final Progress Report. *Compact Fruit Tree* 46(1):23-28.

Autio, W., T. Robinson, D. Archbold, W. Cowgill, C. Hampson, R. Quezada, and D. Wolfe. 2013. 2002 NC-140 Apple Rootstock Trial: Gala apple trees on Supporter 4, P.14, and different strains of B.9, M.9, and M.26 rootstocks, final progress report. *Compact Fruit Tree* 46 (1):23-28.

Coneva, E., Edgar Vinson, and Jim Pitts. 2013. Peach Rootstock Cultivar Evaluation, 2012. Spring 2012 Commercial Fruit and Vegetable Variety Trials Regional Bulletin 26.

Cowgill, W and J. Clement.2013. The NC-140 web site, www.nc140.org.

Davis, A.L. 2013. Low Temperature survival of 'Redhaven' peach floral buds on selected rootstocks. University of Missouri, Columbia. M.S. thesis.

Day, K, S. Johnson and T. M. DeJong. 2013. Evaluating Potential Peach Rootstocks in the NC-140 Trial, California Cling Peach Research Report 2013. 2 pages.

DeJong, T., S. Johnson, K. Day, R. Phene, and S. Castro. 2012. Improved rootstocks for peach and nectarine. California Cling Peach Research Report 2012. 3 pages.

Domoto, P. and Schroeder, L. 2013. Performance of 'Gibson Golden Delicious' on Dwarfing Rootstocks. *Ann. Prog. Rept. – 2012 for Hort. Res. Sta., ISRF12-36:45-46*
<http://www.ag.iastate.edu/farms/2012%20Farm%20Reports/Hort/GibsonGoldenDelicious.pdf>

Domoto, P. and Schroeder, L. 2013. Third year performance of Honeycrisp on dwarfing rootstocks. *Ann. Prog. Rept. – 2012 for Hort. Res. Sta., ISRF12-36:47-48*
<http://www.ag.iastate.edu/farms/2012%20Farm%20Reports/Hort/ThirdYearPerformanceHoneycrisp.pdf>

Elkins, R. 2012 California Pear Research Report, California Pear Advisory Board, Sacramento, California, p. 57-58.

Elkins, R. 2013. Evaluation of potential new size controlling rootstocks for European pear. 2012 California Pear Research Report, California Pear Advisory Board, Sacramento, California, p. 57-58.

Fazio, G., H. Aldwinckle and T. Robinson. 2013. Unique characteristics of Geneva® apple rootstocks. *NY Fruit Quarterly* 21(3):25-28.

Geng, F., R. Moran and D. Zhang. 2013. Light quality affects microshoot growth of apple rootstocks: B.9 & G.30. *HortScience* 48(9):S246 (Abstr.).

Gregory Reighard, W. Bridges, Jr., D. Archbold, A. Atucha, W. Autio, T. Beckman, B. Black, E. Coneva, K. Day, M. Kushad, R. Pokharel, R.S. Johnson, T. Lindstrom, M. Parker T. Robinson, J. Schupp, M. Warmund, and D. Wolfe. 2013. NC-140 Peach Rootstock Testing in 13 U.S. States. *Acta Horticulturae Book of Abstracts*.

Johnson, R.S., G.L. Reighard, T.G. Beckman, E.D. Coneva, K.R. Day, J. Fachinello, E. Fallahi, M.J. Newell, D. Ouellette, T.L. Robinson and D. Wolfe. 2013. Environmental effects on fruit ripening and average fruit weight for three peach cultivars. VIII Int. Peach Symposium: Program and Abstracts p. 125.

Johnson, R.S., T.G. Beckman, E.D. Coneva, K.R. Day, E. Fallahi, M.J. Newell, G.L. Reighard, T.L. Robinson and D. Wolfe. 2013. Environmental Effects on Fruit Ripening and Average Fruit Weight for Three Peach Cultivars. *Acta Horticulturae Book of Abstracts*.

Johnson, S., K. Day and T. M. DeJong, 2012. Evaluating Potential Peach Rootstocks in the NC-140 Trial, California Cling Peach Research Report 2012. 2 pages.

Lang, G.A., S. Blatt, J. Grant, C. Ingels, S. Hoying, D. Neilsen, G. Neilsen and T. Robinson. 2013. The NC140 Regional Research trial: Evaluation of four innovative orchard systems x three Gisela rootstocks x multiple sites across North America. VII Int. Cherry Symposium: Program and Abstracts p. 62.

Miranda Sazo, M. and T.L. Robinson. 2013. The split application strategy for pre-harvest fruit drop control in a super spindle apple orchard in Western NY. *NY Fruit Quarterly* 21(2):21-24.

Miranda-Sazo, M. and T. Robinson. 2013. Recent advances of mechanization for the Tall Spindle orchard system in New York State – Part 1. *NY Fruit Quarterly* 21(1):15-20.

Moran, R.E., F. Geng, G. Fazio and J. Cline. 2013. Genotypic variation in apple rootstock cold temperature tolerance. *HortScience* 48(9):S187 (Abstr.).

Reighard, G., W. Bridges, Jr., D. Archbold, A. Atucha, W. Autio, T. Beckman, B. Black, E. Coneva, K. Day, M. Kushad, R. Pokharel, R.S. Johnson, T. Lindstrom, M. Parker, T. Robinson, J. Schupp, M. Warmund, and D. Wolfe. 2013. NC-140 peach rootstock testing in 13 U.S. states. VIII Int. Peach Symposium: Program and Abstracts p. 18.

Reighard, G.L. and and NC-140 Cooperators. 2013. NC-140 Peach Rootstock Testing in 13 U.S. States. VIII th International Peach Symposium, Matera, Italy. June 17-20, 2013.

Robinson, T. (Ed). 2013. Precision Orchard Management. Cornell University . 146pp.

Robinson, T. 2013. High-density pear plantings for high early yields. *Compact Fruit Tree* 46(2):11-16.

Robinson, T. and M. Miranda Sazo. 2013. Advances in Mechanization of the Tall Spindle apple orchard system: Part 2 Harvest Mechanization Prospects. *NY Fruit Quarterly* 21(3):3-7.

Robinson, T., A. Lakso, and L. Dominguez. 2013. Precision irrigation management. *NY Fruit Quarterly* 21(2):17-19.

- Robinson, T., A. Lakso, D. Greene and S. Hoying. 2013. Precision crop load management. *NY Fruit Quarterly* 21(2):3-9.
- Robinson, T., and L. Dominguez. 2013. Production of sweet cherries under high tunnels in either the modified Spanish Bush or the Tall Spindle Systems. *NY Fruit Quarterly* 21(2):25-28.
- Robinson, T., S. Hoying, M. Miranda Sazo, A. DeMaree and L. Dominguez. 2013. A vision for apple orchards systems of the future. *NY Fruit Quarterly* 21(3):11-16.
- Robinson, T.L, S.K. Brown, G. Fazio and H.S. Aldwinckle. 2013. Introduction. In: Sutton, T.B., H.S. Aldwinckle, A.M. Agnello and J.F. Wallenbach (eds.) *Compendium of Apple and Pear Diseases and Pests*, Second Edition. APS Press. p1-10.
- Robinson, T.L. S.A. Hoying and L.I. Dominguez. 2013. Interaction of training system and rootstock on yield, fruit size, fruit quality and crop value of three sweet cherry cultivars. VII *Int. Cherry Symposium: Program and Abstracts* p. 98.
- Robinson, T.L. 2012. High-density planting systems and rootstocks for sweet cherries in the Northeast – 2012 Progress Report. *Compact Fruit Tree* 46(1):17-22.
- Robinson, T.L. 2013. Preparing fresh apple, peach and pear orchards for mechanical harvesting. *HortScience* 48(9)Supplement:S79 (Abstr.)
- Robinson, T.L. 2013. The effect of summer hedging of Tall Spindle apple trees on growth, fruit quality and flowering. *HortScience* 48(9)Supplement:S185 (Abstr.)
- Robinson, T.L. and L.I. Dominguez. 2013. Effect of timing of caustic bloom thinning sprays during bloom on yield, fruit size and fruit quality of peach. VIII *Int. Peach Symposium: Program and Abstracts* p. 123.
- Robinson, T.L., M. Miranda Sazo and C. Kahlke. 2013. Control of internal flesh pigmentation of apples with Retain. *Int. PGR Symposium: Program and Abstracts* p. 24.
- Robinson, T.L., M. Miranda Sazo, W. Cowgill and L. Huffman. 2013. Effect of Promalin, Benzyl Adenine and Cyclanilide on lateral branching of apple trees in the nursery and the orchard. *Int. PGR Symposium: Program and Abstracts* p. 20.
- Ward, D., W.P. Cowgill Jr., J.L. Frecon, G.C. Hamilton, J.R. Heckman, L.S. Katz, N. Lalancette, B.A. Majek, D. Polk. 2012. "New Jersey Commercial Tree Fruit Production Guide." *Cooperative Extension Bulletin E002* total pages (229).
- Wolfe, D. D. Archbold, J. Johnston, and G. Travis. 2012. Rootstock Effects on Apple and Peach Tree Growth and Yield. 2012 Fruit and Vegetable Crops Research Report. University of Kentucky College of Agriculture, Agricultural Experiment Station publication. PR-656:13-15.
<http://www2.ca.uky.edu/agc/pubs/pr/pr656/pr656.pdf>
- Yoder K. and G. Peck. 2012. 2011 Progress Report to Virginia Apple Research Program; Rootstock effects on growth and yield of Gala, Fuji, and York apples. (Apr. 2012) *Virginia Fruit Vol. 1, No. 76*:13-14.

Articles in Trade Publications

Lang, G. 2013. Pruning for large cherries. *Good Fruit Grower* 64(12):14-15.

Lang, G. 2013. Consistent production with covered systems. *American/Western Fruit Grower* (Sept/Oct):26-27.

Presentations:

Autio, W.R. February 2013. NC-140 Regional Rootstock Research Project: Past, Present, Future. International Fruit Tree Association 56th Annual Conference. Boston, MA. Grower, professional, research, Extension, industry audience. Attendance 450.

Autio, W.R., J. Clements, and J. Krupa. February 2013. NC-140 Peach and Apple Rootstock Plantings at the University of Massachusetts Cold Spring Orchard. International Fruit Tree Association 56th Annual Conference Post-Conference Tour. Belchertown, MA. Grower, professional, research, Extension, industry audience. Attendance 100.

Beckman, T.G. and Schnabel, G. January, 2012. Update on efforts to develop an oak root rot management program. Southeastern Fruit and Vegetable Conference. Grower and research community audience. Attendance ca. 75.

Blatt, SE. 2013. Post-harvest disorders and insect damage influenced by rootstock for Honeycrisp. Nova Scotia Fruit Growers Annual Convention. Greenwich, Nova Scotia. Grower and industry audience. Attendance: 240.

Blatt, SE. 2013. Rootstock performance in Honeycrisp. Nova Scotia Institute of Agrologists Field Tour. October. Attendance: 36.

Clements, Jon M., W.P. Cowgill, R. Magron, and W.R. Autio. January 2013. Ten-year Performance of Cameo® Apple Trees on Three Dwarf Rootstocks in Massachusetts and New Jersey as Part of the NC-140 Regional Rootstock Research Project. (Poster.) Annual Meeting of the American Society for Horticultural Science Northeast Region, New Brunswick, NJ. Professional audience. Attendance 65.

Coneva E. Field Performance of "Redhaven" Peach on 14 Newly Introduced Rootstocks. Chilton Area Peach Production Annual Meeting, Clanton, AL, February 2013. Attendance 87.

Cowgill, W.P., Jr. 2013. North Jersey Fruit Meeting, March 2012; Broadway, NJ, 62 attendees, growers

Cowgill, W.P., Jr. 2013. North Jersey Twilight Fruit Meeting, April, 11; Rutgers Snyder Farm, Pittstown, NJ 44 attendees, growers

Cowgill, W.P., Jr. 2013. North Jersey Twilight Fruit Meeting, May 3; Phillips Farm, Milford, NJ 66 attendees, growers

Cowgill, W.P., Jr. 2013. North Jersey Twilight Horticultural Research Meeting, Rutgers Snyder Farm, September, 2012; sponsored by RCE and NJ NOFA – 48 growers participating

Cowgill, W.P., Jr. 2013. Performance of NC-140 apple rootstocks and recommendations for planting. IFTA, NY.

Einhorn, T. August 8, 2013. An update on pear horticultural research at MCAREC. 2013 MCAREC Annual Field day, Hood River, OR. Members of the Oregon tree fruit industry. Estimated attendance 70.

Einhorn, T. February 6, 2013. New and continuing research on improving pear production efficiency. 2013 Hood River Winter Horticulture Meeting, Hood River, OR. Members of the regional fruit industry. Estimated attendance 85.

Einhorn, T. January 23, 2013. The search for cold hardy, dwarfing, precocious, productive, pear decline resistant, fire blight tolerant, large fruit promoting, easily rooting pear rootstocks: An update. 2013 North Central Washington Pear Day, Wenatchee, WA. Members of the North Central Washington and greater regional fruit industry. Estimated attendance 200.

Einhorn, T. July 11, 2013. The Mid-Columbia pear horticulture research program. 2013 SOREC annual field day, Medford, OR. Members of the Rogue Valley tree fruit industry. Estimated attendance 25.

Einhorn, T. March 20, 2013. Improving production practices of pear and sweet cherry. Yakima Pom Club, Yakima, WA. Members of the Washington State tree fruit industry. Estimated attendance 40.

Elkins, R. Evaluation of potential new size controlling rootstocks for European pear (two presentations). 2013 Sacramento River District Pear Research Meeting, February 6, 2013; Walnut Grove, California and 2013 North Coast Pear Research Meeting, February 13, 2013, Ukiah, California. Total of attendees.

Elkins, R., Einhorn, T and Musacchi, S. October 22, 2013. The NC-140 2013 pear rootstock trials: a new approach for evaluation of rootstock performance. UCANR- Pear Orchard Systems Field Meeting, Hopland, CA. Members of the North Coast California tree fruit industry. Estimated attendance 30.

Elkins, R., T. Einhorn, S. Musacchi, B. Lampinen and T. DeJong. Pear Orchard Systems Field Meeting. October 22, 2013, Hopland, Mendocino County. 35 attendees.

Fallahi, E. and B. Shafii. March 8, 2013. Training and Growing Habit of Fuji Apple on Different Rootstocks. Idaho and Washington Fruit Grower audience. Attendance: 79.

Fallahi, E. November 2012. NC-140 Fuji/Rootstock Progress Report. Annual Conference of NC-140, Portland, Maine, Attendance 42.

Fallahi, E., B. Fallahi, and B. Shafii. July 18, 2013. Research Update on Apple Rootstock. Idaho State Horticultural Society Summer Tour, Parma, ID. Grower audience. Attendance 107.

Fallahi, E., B. Fallahi, B. Shafii. September 6, 2013. Performance of Apple Rootstocks under Intermountain West Conditions. University of Idaho Pomology Program Fruit Field Day, Growers and public audience. Attendance 980.

Grant, J. G. Lang, and C. Ingels. Chilean agricultural scientist delegation. July 15, 2013, 9 attendees.

Hoying. S.A. and T.L. Robinson. 2013. Hand Thinning for Precision Crop Load Management. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Hoying. S.A. and T.L. Robinson. 2013. Pruning for Precision Crop Load Management. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Ingels, C. and B. Kirkpatrick. Visit by UC Davis Fruit Pathology Class to discuss training systems, rootstocks, and oak root fungus. April 18, 2013, 16 attendees.

Ingels, C. and R. Elkins. UC European Pear Workgroup and pear & cherry tour, including cherry trial site. June 27, 13 attendees.

Ingels, C. US EPA and Calif. Dept. of Pesticide Regulation farm tour stop at cherry trial and pear orchard. July 11, 2013, 46 attendees.

ISU Fruit & Vegetable Field Day, Hort Res. Sta., Ames, IA NC-140 dwarf apple rootstock trial, 90 attendees.

Johnson, R.S., G.L. Reighard and NC-140 Cooperators. 2013. Environmental Effects on Fruit Ripening and Average Fruit Weight for Three Peach Cultivars. VIIIth International Peach Symposium, Matera, Italy. June 17-20, 2013.

Johnson, R.S., G.L. Reighard, T.G. Beckman, E.D. Coneva, K.R. Day, J. Fachinello, E. Fallahi, M.J. Newell, D. Ouellette, T.L. Robinson and D. Wolfe. 2013. Environmental Effects on Fruit Ripening and Average Fruit Weight for Three Peach Cultivars. VIII International Peach Symposium. Matera (Italy). June 17- 20, 2013.

Kahlke, C. and T.L. Robinson. 2013. Internal Bleeding of Idared Apples. Orleans County Fruit School. Feb. 4, 2013. 150 people.

Kahlke, C. and T.L. Robinson. 2013. Internal Bleeding of Idared Apples. Wayne County Fruit School. Feb. 5, 2013. 200 people.

Lang, G.A. 10 Jan 2013. Fundamentals of Sweet Cherry Production. Great Plains Growers Conference. St. Joseph, MO. Grower audience. Attendance 38.

Lang, G.A. 10 Jan 2013. Growing Fruit Trees in High Tunnels. Great Plains Growers Conference. St. Joseph, MO. Grower audience. Attendance 53.

Lang, G.A. 11 Dec 2013. Innovative and Labor Efficient Cherry Training Systems: Results So Far Across North America. Great Lakes Fruit, Vegetable, & Farm Market Expo. Grand Rapids, MI. Grower audience. Attendance 148.

Lang, G.A. 11 Jan 2013. Fundamentals of Tart Cherry Production. Great Plains Growers Conference. St. Joseph, MO. Grower audience. Attendance 48.

Lang, G.A. 11 Nov 2013. Recent Developments Sweet Cherry Training Systems, Rootstocks, and Orchard Management. SummerGreen Seminar/Workshop. Roxburgh, New Zealand. Grower audience. Attendance 31.

Lang, G.A. 12 Nov 2013. Recent Developments Sweet Cherry Training Systems, Rootstocks, and Orchard Management. SummerGreen Seminar/Workshop. Cromwell, New Zealand. Grower audience. Attendance 43.

Lang, G.A. 14 Nov 2013. Recent Developments Sweet Cherry Training Systems, Rootstocks, and Orchard Management. SummerGreen Seminar/Workshop. Blenheim, New Zealand. Grower audience. Attendance 37.

Lang, G.A. 15 Nov 2013. Recent Developments Sweet Cherry Training Systems, Rootstocks, and Orchard Management. SummerGreen Seminar/Workshop. Hawkes Bay, New Zealand. Grower audience. Attendance 52.

Lang, G.A. 17 Apr 2013. Optimizing Cherry Production: Physiology-Based Management. Haygrove Growers Conference. Canterbury, United Kingdom. Grower audience. Attendance 89.

Lang, G.A. 22 Oct 2013. Comparing the TSA, KGB, UFO, and SSA Sweet Cherry Training Systems. 2nd International Seminario on Updates and Advances in the Development of New Training Systems and Pedestrian Orchards in Chile. Curico, Chile. Grower audience. Attendance 130.

Lang, G.A. 24 Jun 2013. The NC140 Regional Research Trial: Evaluation of Four Innovative Orchards Systems x Three Gisela Rootstocks x Multiple Sites Across North America. 7th International Cherry Symposium (International Society for Horticultural Science). Plascencia, Spain. Scientific audience. Attendance 225.

Lang, G.A. 24 Jun 2013. Trends and Characteristics of Current, New, and Future Cherry Cultivars Around the World (Keynote Address). 7th International Cherry Symposium (International Society for Horticultural Science). Plascencia, Spain. Scientific audience. Attendance 225.

Lang, G.A. 29 Jan 2013. Current Status and Future Outlook for Growing Tart Cherries. Oregon Horticultural Society. Grower audience. Portland, OR. Attendance 39.

Lang, G.A. 29 Jan 2013. Research Results from the North American Sweet Cherry Training Systems Trial. Oregon Horticultural Society. Portland, OR. Grower audience. Attendance 33.

Lang, G.A. 3 Dec 2013. The NC140 Cherry Training System Story: A Continent-wide Trial Comparing UFO, KGB, SSA, and Tall Spindle Axe (TSA). Washington State Horticultural Association. Wenatchee, WA. Grower audience. Attendance 265.

Lang, G.A. 31 Jan 2013. Tree Fruit Crops in High Tunnels. Mid-Atlantic Fruit & Vegetable Convention. Hershey, PA. Grower audience. Attendance 177.

Lang, G.A. 6 Feb 2013. Innovations in Cherry Production Around the World. Southwest Hort Days. Benton Harbor, MI. Grower audience. Attendance 31.

Lang, G.A. and C. Kaiser. 3 Dec 2013. Managing Soil Moisture to Minimize Rain Cracking. Washington State Horticultural Association. Wenatchee, WA. Grower audience. Attendance 265.

Lang, G.A., L.E. Long, and J. Schupp. 24 Feb 2013. Cherry & Peach Pruning Demonstration. International Fruit Tree Association. Boston, MA. Grower audience. Attendance 91.

Mayer, N.A., B. Ueno and G. L. Reighard . 2013. Selection of Prunus mume as rootstocks for peaches on PTSL site. VIIIth International Peach Symposium, Matera, Italy. June 17-20, 2013.

Mayer, N.A., G. L. Reighard and W. Bridges.. 2013. Peach rootstock propagation under intermittent mist system. VIIIth International Peach Symposium, Matera, Italy. June 17-20, 2013.

Meeting. Kelowna, BC grower audience.

Miranda Sazo, M. and T.L. Robinson. 2013. Frost Protection Methods. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Miranda Sazo, M. and T.L. Robinson. 2013. Working Efficiently in the Orchard of the Future. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Moran, R. 2013. Tree Fruit Research at Highmoor Farm, Maine State Pomological Society Summer Tour, Monmouth, ME, July 31, 2013. Attended by 35 growers.

Moran, R. 2013. Update on Research at the Experiment Station, Maine Agricultural Trades Show, Augusta, ME, January 9, 2013. Attended by 60 growers.

Neilsen, D. and Neilsen, G. 7th March, 2013. OKCFGA Report - NC140 trials and Crop Load Management.

Parker, M.L. February 2013. Mike's "Crystal Ball" for Apple Varieties and Rootstocks for Western NC. Western District Apple School, Hendersonville, NC. Commercial grower audience. Attendance 100.

Parker, M.L. February 2013. Apple Varieties and Rootstocks for NC. Brushy Mountain Fruit School, Wilkesboro, NC. Commercial grower audience. Attendance 40.

Parker, M.L. January 2013. Maximizing Orchard Productivity -- The Bearing Years. Southeastern Apple Growers Meeting, Asheville, NC. Commercial grower audience. Attendance 120.

Parker, M.L. January 2013. Maximizing Peach Production - Rootstock Selection. Peach Production Workshop. Sandhills Research Station, Jackson Springs, NC. Commercial grower audience. Attendance 40.

Peck, G. and K. Yoder. 16 May 2013. Breakfast Meeting for Commercial Growers. Winchester, VA. Grower audience. Attendance: 15.

Peck, G. and K. Yoder. 19 Jul 2013. Alson H. Smith, Jr. AREC Field Day for Commercial Growers. Winchester, VA. Grower audience. Attendance: 55.

Pokharel, R. R., and G. L. Reighard. 2013. Evaluation of biofumigation and soil solarization on peach replant disease. VIIIth International Peach Symposium, Matera, Italy. June 17-20, 2013.

Pokharel, R. R., and G. L. Reighard. 2013. Evaluation of Rootstock Effect on Tolerance to Iron Chlorosis and Cytospora Canker in Peaches. VIIIth International Peach Symposium, Matera, Italy. June 17-20, 2013.

Pokharel, R. R., G. L. Reighard and D. Reich. 2013. Deficit irrigation for iron chlorosis did not affect fruit production and quality in peach. VIIIth International Peach Symposium, Matera, Italy. June 17-20, 2013.

Reighard, G.L. 2013. Peach rootstock cultivars and genetics. Michigan Spring Peach Update Meeting. Benton Harbor, MI. March 5, 2013.

Reighard, G.L. 2013. Technology choices for a profitable 21st Century peach farm. IFTA 56th Annual Conference. Boston, MA. Feb. 23 to March 2, 2013.

Reighard, G.L. 2013. Emerging technologies in U.S. peach production. WCHS & VinCO Conference. Grand Junction, CO. Jan. 15-17, 2013.

Reighard, G.L. 2013. New apple rootstocks from Vineland and Geneva. Illinois Specialty Crops, Agritourism and Organic Conference. Springfield, IL. Jan. 9-11, 2013.

Reighard, G.L. 2013. New peach and apple rootstocks for the grower. WCHS & VinCO Conference. Grand Junction, CO. Jan. 15-17, 2013.

Reighard, G.L. 2013. Peach culture in the 21st century. Illinois Specialty Crops, Agritourism and Organic Conference. Springfield, IL. Jan. 9-11, 2013.

Reighard, G.L. 2013. Peach, Plum and Apricot Rootstocks for the 21st Century. East Malling Centenary Conference, Fruits and Roots: A Celebration and Forward Look. East Malling, UK. November 6-7, 2013.

Reighard, G.L. and NC-140 Cooperators. 2013. NC-140 Peach Rootstock Testing in 13 U.S. States. VIIIth International Peach Symposium, Matera, Italy. June 17-20, 2013.

Reighard, G.L., W. Bridges, Jr., D. Archbold, A. Atucha, W. Autio, T. Beckman, B. Black, E. Coneva, K. Day, M. Kushad, R. Pokharel, R.S. Johnson, T. Lindstrom, M. Parker, T. Robinson, J. Schupp, M. Warmund, and D. Wolfe. 2013. NC-140 Peach Rootstock Testing in 13 U.S. States. VIII International Peach Symposium. Matera (Italy). June 17- 20, 2013.

Robinson, T.L. S.A. Hoying and L.I. Dominguez. 2013. Interaction of training system and rootstock on yield, fruit size, fruit quality and crop value of three sweet cherry cultivars. VII Int. Cherry Symposium, Placencia, Spain, June, 25, 2013. 150 people.

Robinson, T.L. 2013. Outdoor Pruning Workshop in Orleans County NY. Feb. 19, 2013. 100 people.

Robinson, T.L. 2013. Crop Load Management of Apples. Xian, China, Extension Agents Training Meeting. Mar. 9, 2013. 400 people.

Robinson, T.L. 2013. Crop Load Management of Apples. Yantai, China, Extension Agents Training Meeting. Mar. 5, 2013. 400 people.

Robinson, T.L. 2013. High Density Delicious Orchards with Geneva Rootstocks. Field Workshop during IFTA Spring Tour-Hudson NY. Feb. 28, 2013. 100 people.

Robinson, T.L. 2013. High Density Pear Orchards. IFTA Annual Meeting-Boston, MA. Feb. 25, 2013. 300 people.

Robinson, T.L. 2013. Management of Modern High Density Apple Orchards. Xian, China, Extension Agents Training Meeting. Mar. 9, 2013. 400 people.

Robinson, T.L. 2013. Management of Modern High Density Apple Orchards. Yantai, China, Extension Agents Training Meeting. Mar. 5, 2013. 400 people.

Robinson, T.L. 2013. Management Strategies for 2013 after the Small Crop of 2012. Hudson Valley Fruit School. Feb. 12, 2013. 250 people.

Robinson, T.L. 2013. Management Strategies for 2013 after the Small Crop of 2012. Orleans County Fruit School. Feb. 4, 2013. 150 people.

Robinson, T.L. 2013. Management Strategies for 2013 after the Small Crop of 2012. Wayne County Fruit School. Feb. 5, 2013. 200 people.

Robinson, T.L. 2013. Maximizing Crop Value by Thinning. IFTA In-depth Workshop on Crop Load Management-Boston, MA. Feb. 23, 2013. 150 people.

Robinson, T.L. 2013. Mechanization of High Density Apple Orchards. Xian, China, Extension Agents Training Meeting. Nov. 23, 2013. 200 people.

Robinson, T.L. 2013. Mechanization of High Density Apple Orchards. Yantai, China, Extension Agents Training Meeting. Nov. 19, 2013. 200 people.

Robinson, T.L. 2013. Precision Crop Load Management. IFTA In-depth Workshop on Crop Load Management-Boston, MA. Feb. 23, 2013. 150 people.

Robinson, T.L. 2013. Pruning and Training Apple Trees. Orleans County Fruit School. Feb. 4, 2013. 50 people.

Robinson, T.L. 2013. Pruning and Training Apple Trees. Outdoor Pruning Workshop in Wayne County NY. Feb. 18, 2013. 100 people.

Robinson, T.L. 2013. Pruning and Training Apple Trees. Wayne County Fruit School. Feb. 5, 2013. 20 people.

Robinson, T.L. 2013. The Evolution Towards More Competitive Apple Orchard Systems in the USA. NC Fruit School. Feb. 6, 2013. 100 people.

Robinson, T.L. 2013. The Fruiting Wall with Tall Spindle Trees. IFTA Annual Meeting-Boston, MA. Feb. 27, 2013. 300 people.

Robinson, T.L. 2013. A Vision for Orchards of the Future. Great Lakes Fruit Workers Meeting, Bowmanville, Ontario, Canada,. Nov. 13, 2013. 50 people.

Robinson, T.L. 2013. A Vision for Orchards of the Future. Idaho Horticulture Society, Nampa ID,. Nov. 3, 2013. 100 people.

Robinson, T.L. 2013. A Vision for Orchards of the Future. Washington State Horticulture Association, Wenatchee WA,. Dec. 2, 2013. 400 people.

Robinson, T.L. 2013. Controlling Biennial Bearing of Apple. Idaho Horticulture Society, Nampa ID,. Nov. 3, 2013. 100 people.

Robinson, T.L. 2013. Crop Load Management Strategies for 2013. Champlain Valley Spring Field Workshop. May 28, 2013. 40 people.

Robinson, T.L. 2013. Crop Load Management Strategies for 2013. Hudson Valley Spring Field Workshop. May 21, 2013. 100 people.

Robinson, T.L. 2013. Crop Load Management Strategies for 2013. Niagara/Orleans County Spring Field Workshop. May 22, 2013. 100 people.

Robinson, T.L. 2013. Crop Load Management Strategies for 2013. Saratoga County Spring Field Workshop. May 24, 2013. 40 people.

Robinson, T.L. 2013. Crop Load Management Strategies for 2013. Wayne County Spring Field Workshop. May 23, 2013. 100 people.

Robinson, T.L. 2013. Geneva rootstocks for Organic Apple Production. Stuttgart, Germany Organic Apple Conference. April. 26, 2013. 100 people.

Robinson, T.L. 2013. Hand Thinning of Apples with Platforms. Champlain Valley Field Workshop. July 1, 2013. 30 people.

Robinson, T.L. 2013. Hand Thinning of Apples with Platforms. Wayne County Field Workshop. June 15, 2013. 80 people.

Robinson, T.L. 2013. High Density Apple Orchards of the Future. Chihuahua International Apple Symposium for Fruit Growers Conference. Nov. 15, 2013. 200 people.

Robinson, T.L. 2013. High Density Apple Orchards. Beijing, China, Extension Leaders Meeting. Nov. 25, 2013. 30 people.

Robinson, T.L. 2013. High Density Apple Orchards. Xian, China, University Seminar at Northwest A&F University. Nov. 22, 2013. 100 people.

Robinson, T.L. 2013. High Density Apples and Cherries and Rootstocks. Geneva Fruit Field Day. Aug. 1, 2013. 200 people.

Robinson, T.L. 2013. High Density Apples. Michigan Fruit Field Day. Aug. 8, 2013. 200 people.

Robinson, T.L. 2013. Management of High Density Apple Orchards. Chilean Valent Fruit Growers Conference. Sept. 10, 2013. 100 people.

Robinson, T.L. 2013. Management of High Density Apple Orchards. INIA Uruguay Fruit Growers Conference. Sept. 26, 2013. 200 people.

Robinson, T.L. 2013. Managing Honeycrisp Apples. Washington State University Honeycrisp In-depth School, Wenatchee WA,. Dec. 5, 2013. 300 people.

Robinson, T.L. 2013. Managing the Risk of Hail and Sunburn. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Robinson, T.L. 2013. Mechanization of Apple Orchards. ASOEX Chile Exporters Conference. Aug. 5, 2013. 400 people.

Robinson, T.L. 2013. Mechanization of Pear Orchards. International Pear Symposium (Interpera), General Roca, Argentina, June 6, 2013. 250 people.

Robinson, T.L. 2013. Precision Chemical Thinning. Geneva Fruit Field Day. Aug. 1, 2013. 200 people.

Robinson, T.L. 2013. Precision Crop load Management Workshop. Champlain Valley Spring Workshop. May 15, 2013. 30 people.

Robinson, T.L. 2013. Precision Crop load Management Workshop. Geneva Workshop. May 9, 2013. 50 people.

Robinson, T.L. 2013. Precision Crop Load Management. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Robinson, T.L. 2013. Precision Crop load Management. University of Chile Fruit Growers Conference. Sept. 11, 2013. 100 people.

Robinson, T.L. 2013. Precision Crop load Management. University of Chile Fruit Growers Conference. Sept. 13, 2013. 100 people.

Robinson, T.L. 2013. Precision Harvest Management. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 16, 2013. 220 people.

Robinson, T.L. 2013. Precision Nutrient Management. Orleans County Field Workshop. April 15, 2013. 100 people.

Robinson, T.L. 2013. Precision Orchard Management. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Robinson, T.L. 2013. Preparing fresh apple, peach and pear orchards for mechanical harvesting. Annual Meeting of the American Society for Horticultural Science, Palm Desert, CA July 23, 2013. 100 people.

Robinson, T.L. 2013. Pruning and Training Apple Trees. Champlain Valley Spring Field Workshop. April 9, 2013. 40 people.

Robinson, T.L. 2013. Summer Pruning with Machines. Champlain Valley Field Workshop. July 11, 2013. 30 people.

Robinson, T.L. 2013. Summer Pruning with Machines. Geneva Fruit Field Day. Aug. 1, 2013. 200 people.

Robinson, T.L. 2013. The effect of summer hedging of Tall Spindle apple trees on growth, fruit quality and flowering. Annual Meeting of the American Society for Horticultural Science, Palm Desert, CA July 24, 2013. 50 people.

Robinson, T.L. and A.N. Lakso. 2013. Precision Irrigation of Apple Orchards. Hudson Valley Fruit School. Feb. 12, 2013. 250 people.

Robinson, T.L. and A.N. Lakso. 2013. Precision Irrigation of Apple Orchards. NY State Horticultural Expo. Jan 24, 2013. 200 people.

Robinson, T.L. and M. Miranda Sazo. 2013. Our Version of the Fruiting Wall with Tall Spindle Trees. NY State Horticultural Expo. Jan 23, 2013. 200 people.

Robinson, T.L., A.N. Lakso, and L. Dominguez. 2013. Precision Irrigation Management. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Robinson, T.L., A.N. Lakso, D. Greene, and S. Hoying. 2013. Precision Chemical Thinning. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Robinson, T.L., M. Miranda Sazo and C. Kahlke. 2013. Control of internal flesh pigmentation of apples with Retain. Meeting of International Plant Growth Regulator Society, Orlando, FL. July 29, 2013. 100 people.

Robinson, T.L., M. Miranda Sazo and P. Wafler. 2013. Harvest Mechanization: Challenges and Outlook. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

Robinson, T.L., M. Miranda Sazo, W. Cowgill and L. Huffman. 2013. Effect of Promalin, Benzyl Adenine and Cyclanilide on lateral branching of apple trees in the nursery and the orchard Meeting of International Plant Growth Regulator Society, Orlando, FL. July 29, 2013. 100 people.

Robinson, T.L., S. Hoying, M. Miranda Sazo, A. DeMarree, and L. Dominguez. 2013. Apple Orchard Systems of the Future. Cornell Fruit In-depth School 2013, Geneva, NY. Mar. 15, 2013. 220 people.

S. Johnson, K. Day and DeJong, T. NC140 field meeting. UC Kearney Agricultural Center, Parlier, May 29, 2013, 65 attendees.

Stasiak, M. 21 March 13. Apple Rootstocks and the Orchard of the Future. UW Peninsular Research Station Fruit School. Sturgeon Bay, WI. Audience commercial fruit growers, attendance 50.

Stasiak, M. 23 July 13. NC140 Rootstock Trial Tour. WAGA Summer Apple Field Day. Sturgeon Bay, WI. Audience apple growers, attendance 90.

Strang, J. 5 January 2013. Apple Rootstocks. Kentucky Fruit & Vegetable Growers Conference, Lexington, KY. grower audience. attendance 50.

Wolfe, D. 27 June 2013. Apple and peach rootstock trials in Kentucky. UKREC Horticulture Field Day. homeowner / grower audience. attendance 20.