

Basic Information

- **Project No. and Title:** [NC140 : Improving Economic and Environmental Sustainability in Tree-Fruit Production Through Changes in Rootstock Use](#)
- **Period Covered:** 10/01/2018 to 09/30/2019
- **Date of Report:** 01/06/2020
- **Annual Meeting Dates:** 11/13/2019 to 11/14/2019

Participants

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Brief Summary of Minutes of Annual Meeting

Accomplishments

Short-term Outcomes:

- B.9, a commonly planted dwarfing rootstock in many states, has inadequate vigor for Honeycrisp to fill the space in a tall spindle production system. More vigorous dwarf rootstocks such as G.41, G.935 or G.969 provide substantially greater yields over the first 8 years and substantially greater economic returns.
- Fire blight resistant apple rootstocks provide substantial economic benefits to apple growers nationwide and ensure against catastrophic tree losses due to fire blight epidemics.

- Prunus hybrid rootstocks were most productive on high pH soils and could have a significant impact on peach production in western states.
- The new peach rootstock Rootpac40 survived poorly at most NC-140 locations.
- The UFO and the TSA cherry training systems had the highest cumulative yield between 2012 and 2019 compared to the KGB and SSA training systems.
- Pear orchards planted on semi-dwarfing rootstocks at high density can provide double the yields over the first 10 years of a pear orchard's life.

Outputs:

- NC-140 members published 31 refereed papers in 2019 on results related to the project
- Members of the NC-140 project published 3 book chapters on advances in tree fruit rootstocks
- Members of the NC-140 project presented 13 posters at scientific meetings in 2019 summarizing results from this project
- Members of the NC-140 project published 6 abstracts, 7 technical reports, and 3 popular articles on advances in tree fruit rootstocks
- NC-140 members published 50 extension articles on advances in tree fruit rootstocks
- NC-140 members gave 91 presentations to growers on advances in tree fruit rootstocks
- NC-140 members leveraged more than \$5 million in funding for rootstock research

Activities:

Objective 1: Evaluate the influence of rootstocks on temperate-zone fruit tree characteristics grown under varying environments and training systems using sustainable management practices. One 10-year multi-location rootstock trial was completed in 2019 (2010 cherry systems × rootstock) and seven other long-term multi-location trials were continued to evaluate new rootstocks of apple, peach, cherry and pear and to evaluate new orchard systems for pear and sweet cherry. One new multi-location apple rootstock trial was planted in 2019. Future multi-location rootstock trials are being planned and nurseries are propagating trees for one apricot trial (2021) one sweet cherry trial (2021), one pear trial (2021) one cider apple trial (2022) and one peach trial (2023). Several cooperators are conducting companion rootstock evaluation trials in CO, ID, ME, NY, PA, and WA.

Objective 2. Develop improved rootstocks for temperate-zone fruit trees, including breeding, using phenomic and genomic tools and acquisition of new rootstocks from global sources. No new apple rootstocks were released in 2019 but 4 new rootstocks are proposed to be released in 2020 from the national USDA/Cornell rootstock breeding program at Geneva, NY.

Several new pear rootstocks from WA and OR are beginning commercial evaluation in a future NC-140 trial. Five new cherry rootstocks from MI are under early evaluation by NC-140. Four new apple rootstocks from New Zealand were acquired and were planted for evaluation in the new 2019 apple rootstock trial. Committee members are also in the process of acquiring one new apricot rootstock, several new peach rootstocks, and several new pear rootstocks.

Objective 3: To investigate physiological processes, biotic and abiotic stresses and scion/rootstock interactions on tree growth and productivity. Cooperators in NY and WA are leading an evaluation of bitter pit development of Honeycrisp and Fuji with the various rootstocks in the 2010 and 2014 NC-140 apple rootstock trials. Several NC-140 cooperators submitted fruit peel samples from 18 NC-140 trial locations in the fall of 2018 and 10 locations in 2019 which were analyzed for mineral nutrient concentrations. The incidence of bitter pit was evaluated on storage samples by individual cooperators and will be correlated to various nutrients concentrations and nutrient ratios for rootstock and each location. In addition several environmental variables at each location will be evaluated for their effect on bitter pit development. Other NC-140 cooperators are evaluated cold hardiness of peach (CO) and apple (NY and ME) rootstocks in 2019.

Objective 4: To integrate and disseminate research-based information that facilitates successful stakeholder adoption of rootstock technologies The NC-140 website was updated with the progress report from 2018 and the individual state reports allowing updated information to growers and other stakeholders. In addition a group of cooperators from the NC-140 group presented a half day mini-symposium on rootstock research and advances at the national conference of apple growers in Rochester NY in Feb. 2019. This has led to an effort to develop and online rootstock selection tool that will consider soil vigor, climate vigor, scion vigor and then recommend 1-3 possible rootstocks. Also individual cooperators presented rootstock information in their own states at numerous field days and fruit grower meetings (91 presentations).

Milestones:

- One 10-year multi-location rootstock trial was completed in 2019 (2010 cherry systems X rootstock)
- Final results of one cherry trial were published in 2019
- Final results of two apple and one peach trials were summarized in 2019 and submitted to peer-reviewed journals for publication in early 2020.
- One new multi-location apple rootstock trial was planted in 2019.
- The NC-140 comparative plantings have hastened the testing and commercialization of the disease resistant Geneva apple rootstocks.
- The NC-140 comparative plantings have hastened the commercialization of the peach rootstock Krymsk®86.

Fund Leveraging, specifically, collaborative grants between stations and members.

Autio, W, R Marini, J Cline, G Reighard, G Lang, and T Einhorn. 2019. NC-140 Rootstock Research Trial Coordinators. International Fruit Tree Association. \$12,000.

Bradshaw, T. 2019. New England Cider Apple Program: Optimizing Production for High-Value Markets. Northeast SARE Research and Demonstration Grants Program. PD: T. Bradshaw; Co-PIs: J. Clements, C. Cooley, R. Moran, J. Pinero. September 2019 – August 2022. \$229,867.

Bradshaw, T. 2019. Rootstock and tree training systems for unique apple production systems. Vermont Agriculture Experiment Station Hatch Grants Program, Oct 2017-Sep 2020. \$64,084. PI: T. Bradshaw

Chavez, D.J. 2019. Irrigation and fertilization management in Georgia. GA Commodity Commission for Peaches. Funding: \$11,137.00

Chavez, D.J., T.G. Beckman, and J.X. Chaparro. 2019. Development of peach and nectarine cultivars for Georgia. Cultivar Development Research Program – UGARF – University of Georgia. Funding: \$12,000.00

Coneva, E. Enhancing the Competitiveness of Apple Production in Alabama Through Improved Disease Resistant Varieties and Innovative Production Systems. USDA-NIFA-ADAI SCBG. Awarded \$25,000.

Coneva, E. Assessing Size Controlling Rootstocks for Enhanced Efficiency of Peach Production Systems. Alabama Agricultural Experiment Station Production Agriculture Research Program Grants, Awarded 50,000.

Coneva, E. Size Controlling Peach Rootstocks for Alabama. The Alabama Nut, Fruit and Vegetable Industries. Awarded \$5,000.

Crassweller, R.M. & J. R. Schupp. Apple rootstock & cultivar evaluations 2019. from State Horticultural Association of Pennsylvania (SHAP) Research Committee \$20,810.

Crassweller, R. M. & D. E. Smith. Third generation apple system trials from SHAP Research Committee. \$9,600

Crassweller, R. M, D. Choi, D. E. Smith. Effects of maintenance of training systems to a hedgerow. SHAP Research Committee \$9,100.

Crassweller, R. M. & H. J. Sommer. Buy-and-fly orchard management using unmanned aircraft (UA). SHAP Research Committee \$16,000.

Evans, K. (2015-2018): Developing the foundation for U.S. pear rootstock breeding. PNW Pear Bureau. Role: PI Kate Evans. Co-PI: Amit Dhingra. Budget: \$273,253.

Fallahi, E. Received \$ 9000 worth of chemicals from Wilbur Ellis Company for pest and disease control of rootstock projects.

Fallahi, E. Received approximately \$ 7,500 in labor and equipment (in-kind) from Idaho fruit industry for operation of various apple rootstock projects.

Fallahi, E. Our program has been a member of a team of NC-140 scientists who secured considerable funding from SCRI. Our share has been about \$160,000 over five years.

Fallahi, E. Received a contribution of \$7200 worth of 'Honeycrisp' apple fruit from Henggeler Packing Co., Inc, Fruitland, Idaho for this project.

Hao Xu. 2019. Apple rootstock evaluation in British Columbia conditions. Costs of supporting the 2010 NC-140 apple rootstock trial were covered by Agriculture and Agri-Food Canada's A-base Project Emergence of Rapid Apple Decline.

Hao Xu. 2019. Cherry rootstock and training system evaluation in British Columbia conditions. Costs of supporting the 2010 NC-140 cherry trial were covered by Agriculture and Agri-Food Canada's Agri-Science Project ASP-005 BCFGGA Activity 7, jointly funded by AAFC and the BC Fruit Growers' Association.

Ingram, D.L (PI) and T.A. Woods (Co-PI). Kentucky Horticulture Infrastructure Development. Kentucky Horticulture Council Grant from Kentucky Agricultural Development Fund funding. (Collaborating faculty: W. Dunwell, Shawn Wright and J. Strang). About \$4,000 from this grant were used to cover cost of labor for maintenance and harvest of NC-140 rootstock trials.

Jayanty, S. S., Minas, I., Bartolo, M. E., Grant, "Postharvest handling strategies for Colorado specialty crops to increase marketability and improve consumer quality", Agricultural Experiment Station, Colorado State University, \$26,065.00, Active. (sub: May 12, 2016, start: September 29, 2016, end: June 30, 2018).

Kon, T.M. 2019. In-kind contribution: materials for a new research orchard. North Carolina Apple Growers Association. Amount Awarded: \$10,000.00

Miller, D. \$5,000. Ohio Fruit Growers Marketing Association. In support of rootstock and variety evaluation work in Ohio.

Miller, D. and Melanie Ivey. \$5,000. Midwest Apple Improvement Association. In support of rootstock and disease evaluations of MAIA varieties in B.9, G.11 rootstock trial.

Miller, D. \$7,500. Midwest Apple Improvement Association. In support of MAIA selections evaluation on B.9 rootstock.

Minas, I., Grant, "Establishment of a Tree Fruit Physiology and Quality Program at Western Colorado", Western Colorado Horticultural Society, \$10,000.00, Active. (start: October 1, 2016).

Minas, I., Grant, "WCRC Pomology", Colorado Apple Administrators Commission, Other, \$7,414.50, Active. (start: September 5, 2016).

Minas, I. (PI), Grant, 'Management strategies to maximize Colorado peach orchards productivity and fruit quality potential' Specialty Block Grants, Colorado Department of Agriculture (CDA) (2019): \$53,548 (PI). awarded: May, 2019, start: Jan 1, 2020, end: November 1, 2021).

Muehlbauer, M. 2019-ongoing (Grant Amount: \$3,446) New Jersey Horticulture Society Research Grant. Evaluation of the Impact of Apple Rootstocks on Orchard Productivity and Post-Harvest Disorders.

Muehlbauer, M. Rutgers University, New Jersey Agricultural Experiment Station

Muehlbauer, M. New Jersey Agricultural Experiment Station, Snyder Research and Extension Farm

Muehlbauer, M. Hunterdon County New Jersey Board of Chosen Freeholders

Musacchi, S. (2013): WA 38 rootstock and systems trial. Washington Tree Fruit Research Commission (WTFRC) Role: PI Stefano Musacchi, Kate Evans and Karen Lewis Budget: \$58,594.

Musacchi, S. (2014-2017): WA 38 Rootstock and Systems Trial. Washington Tree Fruit Research Commission (WTFRC) Role: PI Stefano Musacchi. Co-PI: Karen Lewis, Karina Gallardo, Tom Auvil. Total Budget: \$242,519 personal budget: \$133,495.

Musacchi, S. (2015-2018): Cosmic Crisp™: Training system and orchard management to optimize vigor control and quality. PI: Stefano Musacchi CO-PI: Lee Kalcsits, Desmond Layne, Sara Serra and Karina Gallardo. Total budget \$249,191. Personal budget: \$104,865. Specialty Crop Block Grant Program.

Musacchi, S. (2018-2021): NWPB (Northwest Pear Bureau) Project - Field Evaluation of Pear Cultivars on Cold Hardy Quince Rootstocks. PI Todd Einhorn, Co-PIs Stefano Musacchi. Total budget: \$220,007. Musacchi budget: \$132,035.

Peck, G. USDA-NIFA-Multistate Funding. Accelerating the Planting of Cider Apple Orchards Through A Coordinated Multi-State Rootstock Project. Peck, G.M. \$96,381.

Parker, M.L. NC Legislature/Special Bill funding for apple research - \$6,000.

Reighard, G. 2019. Guardian® rootstock seed sales. South Carolina Foundation Seed. \$265,000.

Reighard, G. 2019. "Screening peach rootstocks for adaptability, productivity, and tolerance to Armillaria and bacterial canker". South Carolina Peach Council research grant. \$3,000.

Reighard, G., K. Gasic, C. Sasaki, et al. "Short and long-term solutions for Armillaria Root Rot in Prunus." USDA Multi-State Specialty Crops Block Grant of \$927,000 with the Pennsylvania Dept. of Ag. March 31, 2017-April 1, 2021.

Robinson T.L. Strategies to improve root development, tree growth and management of apple nursery trees. - Sponsored by International Fruit Tree Association (\$10,000).

Robinson T.L. Evaluation of the Cornell-Geneva Apple Rootstocks and Other Promising Apple Rootstocks. - Sponsored by International Fruit Tree Association (\$10,000).

Robinson T.L. Orchard management systems for improved yield and fruit quality – Sponsored by Apple Research and Development Program (\$50,000).

Schupp, J. R. Development of a high density, highly mechanized, pedestrian peach system. State Hort. Assoc. PA Research Program. \$10,148.

Schupp, J. R. Effects of Rootstock and Tree Spacing on Mineral Nutrition and Productivity of Peach Trees in Pennsylvania. Pennsylvania Peach & Nectarine Research Program. \$10,544

Sherif, S. 2018-2019. Support for 2019; New Rootstocks, Cultivars, and Training Systems for Virginia, Virginia Apple Research Program. \$11,408.

Stewart, J. E. (PI), Minas, I. (CoPI), Grant, “Cytospora management in peach orchards through cultural practices, cultivar selection, and stress mitigation”, Specialty Block Grants, Colorado Department of Agriculture (CDA) (2017): \$91,218 (awarded: May, 2017, start: Feb 1, 2018, end: November 1, 2019).

Villani, S.M., J.F. Walgenbach, T.M. Kon, C. Ranger, A.M. Agnello, and K.D. Cox. 2019- 2022. Development and implementation of integrated strategies for the management of ambrosia beetle associated rapid apple decline in the eastern United States. USDA-NIFA- AFRI CARE. Amount Awarded: \$299,629.00

Villani, S., T. Kon, and J. Walgenbach. 2019. Integrated management of rapid apple decline. North Carolina Specialty Crop Block Grant Program. Amount Awarded: \$125,000.00

Villanueva, Raul, Ricardo Bessin, John Obrychi, Winston Dunwell. 2017-2020. Studies on Ambrosia Beetles Affecting Nursery Crops and Fruit Trees in Kentucky. Kentucky Specialty Crop Block Grant Program. About \$500 from this grant is being used to cover the cost of Ambrosia beetle research on trees that were previously a part of the 2010 NC-140 apple rootstock trial.

Walsh, CS, B. Butler 2017. Developing the perfect slender spindle pedestrian orchard for direct market and pick-your-own apple growers in Maryland. Maryland Specialty Block Grant Program (SCBGP). \$30,494.

Warmund, M. and M. Kwasniewski. Optimizing Cultivars and Processing for Hard Cider and Apple Wines. MO Dept. Agric. Specialty Crop Block Grant Program \$33,398.

Warmund, M. Missouri State Horticulture Society/Apple Merchandising Committee. Tree Fruit research. \$2,850.

Impacts

1. In 2018 a significant outbreak of fire blight disease in WA killed ~5 million apple trees. This was especially problematic with several new varieties which are highly susceptible to fire blight when they were grafted on susceptible rootstocks such as M.9 or M.26. The 2010 apple rootstock trial demonstrated that several Geneva rootstocks are highly productive but less susceptible to fire blight than M.9 clones currently used. As a result, most new orchards in WA are being planted on Geneva rootstocks.
2. Results from NC-140 trials demonstrated the high productivity of new dwarfing rootstocks when planted in the new high-density tall spindle system. Many progressive growers in all apple producing states are adopting this combination of rootstock and system.
3. Information generated from NC-140 trials is useful in ascertaining the environment x genetic interactions of rootstocks on yield, precocity and tree performance in each location. This is leading to a database of information that will allow growers to essentially design their orchard with the most adapted rootstock for their climate, soil and scion variety.
4. NC-140 trials in UT and CO have identified peach rootstocks that are tolerant of high pH soils common in western states. Based on the results of the 2009 Peach Rootstock Trial, the prunus hybrid rootstock, Krymsk®86, is dominating the new planting selections due to high yields, tree vigor, cold hardiness and fruit quality that were communicated to the CO industry through various means of outreach activities
5. The value of the new peach rootstock 'MP-29', which is resistant to Armillaria root rot, is being evaluated by NC-140. In addition, propagation research is leading to greater availability of peach trees on this rootstock in areas previously abandoned due to Armillaria root rot for which the standard rootstock Guardian® is highly susceptible.
6. The adoption of new dwarfing apple rootstocks and high density planting systems with a narrow 2-dimensional profile have resulted in orchards which can adopt mechanical labor aids resulting in reduced pruning, thinning and harvest labor. These orchards also require less pesticide use and have higher profitability.
7. Researchers in several states have identified apple rootstocks that may reduce bitter pit incidence in Honeycrisp apples and enhance the cold hardiness of apple and peach trees.
8. NC-140 cherry rootstocks demonstrated the value of high-density sweet cherry systems such as the UFO and the TSA when combined with dwarfing or semi-dwarfing rootstocks. This has led to expansion of sweet cherry acreage in both western and eastern states.