

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, 2017 to Sept 30, 2018

Annual Meeting Dates: November 14-15, 2015, Mills River, NC

Publications

Refereed Journal Articles

- Abdelghafar A., Reighard G. and Gasic K. 2018. Antioxidant capacity and bioactive compounds accumulation in modern peach breeding germplasm. *J. American Pomological Society* 72(1):40-69.
- Adams, S., J. Lordan, G. Fazio, B. Bugbee, P. Francescato, T.L. Robinson and B. Black. 2018. Effect of scion and graft type on transpiration, hydraulic resistance and xylem hormone profile of apples grafted on Geneva®41 and M.9-NIC™29 rootstocks. *Scientia Horticulturae* 227:213-222.
- Autio, W., T. Robinson, B. Black, S. Blatt, D. Cochran, W. Cowgill, C. Hampson, E. Hoover, G. Lang, D. Miller, I. Minas, R. Parra Quezada, and M. Stasiak. 2017. Budagovsky, Geneva, Pillnitz, and Malling apple rootstocks affect ‘Honeycrisp’ performance over the first five years of the 2010 NC-140 ‘Honeycrisp’ Apple Rootstock Trial. *J. American Pomological Society* 71(3):149-166.
- Belisle, C., U. Phan, K. Adhikari, and D.J. Chavez. 2018. A survey of peach cultivars quality grown in the southeastern U.S. *HortTechnology* 28(2):1-13.
- Beckman, T.G., A. Rollins, J. Pitts, D. Chavez, and J.X. Chaparro. 2018. Disease resistance of ‘MP-29’, a clonal interspecific hybrid rootstock of peach, in post-release trials. *HortScience*. (in press)
- Bittencourt, F.M.S., R. Pio, J.P.R.A.D. Barbosa, G.L. Reighard, M.H. Tadeu and P.N. Curi. 2017. Adaptability and stability of reproductive and vegetative phases of peach trees in subtropical climate. *Acta Scientiarum* 39(4): 427-435.
- Bittencourt Machado de Souza, F., R. Pio, M. H. Tadeu, C. R. Zambon and G. L. Reighard. 2017. Boric acid in germination of pollen grains and fruit set of peach cultivars in subtropical region. *Revista Ciencia Agronomica* 48(3):496-500.
- Crassweller, R. M., R. P. Marini, T. A. Baugher, D. E. Smith. Five year nutritional study of apples in commercial high density orchards. Submitted to *Acta Horticulturae*
- Crassweller, R. M., L. F. Kime, R. P. Marini & D. E. Smith 2018. Orchard architecture effects on yield & economics of two apple cultivars. Submitted to *Acta Horticulturae*

- Fallahi, E., M.J. Kiester, B. Fallahi, and S. Mahdavi. 2018. Cambium Disconnection, Rootstock, and Canopy Training Impacts on Growth and Leaf Mineral Nutrients in 'Aztec Fuji' Apple. *International Journal of Fruit Science*. In Press.
- Fallahi, E., M.J. Kiester, B. Fallahi, and S. Mahdavi. 2018. Rootstock, Canopy Architecture, Girdling and Scoring Influence on Growth, Productivity and Fruit Quality at Harvest in 'Aztec Fuji' Apple. *HortScience* 53(11):1–5.
<https://doi.org/10.21273/HORTSCI13348-18>
- Hansen, S. and B. Black. 2019. The response of 'Montmorency' tart cherry to renewal pruning strategies in a high-density system. *J. American Pomological Society*. 73(1): In press.
- He, L., and J. Schupp. 2018. Sensing and automation in pruning of apple trees: a review. *Agron.* 2018, 8, 211. <http://www.mdpi.com/2073-4395/8/10/211/pdf>. 18 pp.
- Kon, T.M., J.R. Schupp, K.S. Yoder, L.D. Combs, M.A. Schupp. 2018. Comparison of chemical blossom thinners using 'Golden Delicious' and 'Gala' pollen tube growth models as timing aids. *HortScience* 53:1143-1151.
- Kon, T.M. and J.R. Schupp. 2018. Apple crop load management with special focus on early thinning strategies: a USA perspective. *Hort. Rev.* 46:255-298 (In press).
- Lordan, J., P. Francescato, L.I. Dominguez and T.L. Robinson. 2018. Long-term effects of tree density and tree shape on apple orchard performance, a 20 year study - Part 1, Agronomic analysis. *Scientia Horticulturae*. 238:303-317.
- Lordan, J., P. Francescato, L.I. Dominguez and T.L. Robinson. 2018. Long-term effects of training systems and rootstocks on 'McIntosh' and 'Honeycrisp' performance, a 15-year study in a northern cold climate: Part 1 Agronomic Analysis. *HortScience* 53:968-977.
- Lordan, J., A. Wallis, P. Francescato, and T.L. Robinson. 2018. Long-term effects of training systems and rootstocks on 'McIntosh' and 'Honeycrisp' performance, a 20-year study in a northern cold climate- Part 2: Economic analysis. *HortScience* 53:978-992.
- Lordan, J., M. Gomez, P. Francescato and T.L. Robinson. 2019. Long-term effects of tree density and tree shape on apple orchard performance, a 20-year study - Part 2: Economic analysis. *Scientia Horticulturae* 244:435-444.
- Marini, R.P., R.M. Crassweller, W. Autio, R. Moran, T.L. Robinson, J. Cline, D. Wolfe, and R. Parra-Quezada. 2017. The interactive effects of early season temperatures, crop density, and rootstock average fruit weight of 'Golden Delicious' apples. *Acta Horticulturae* 1177:189-194. DOI 10.17660/ActaHortic.2017.1177.26
- Miller S.T., K.L. Otto, D. Sterle, I.S. Minas, and J.E. Stewart. 2018. Preventive Fungicidal Control of *Cytospora leucostoma* in Peach Orchards in Colorado. *Plant Disease*, <https://doi.org/10.1094/PDIS-01-18-0175-RE>
<https://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-05-18-0801-RE>
- Marini, R.P., E. Fallahi, P. Francescato, J. Lordan, M.J. Newell, D. Ouellette, G. Reighard, T.L. Robinson and D. Wolfe. 2018. The NC-140 multi-location peach physiology trial: Relationship between peach fruit weight, crop density and early season temperature. *J. American Pomological Society* 72:231-241.

- Marini, R.P. and g. Fazio. 2018. Apple rootstocks: history, physiology, management, and breeding. *Hort. Rev.* 45:197-312.
- Moran, R., Peterson, G. Fazio, and J. Cline. 2018. Genotypic variation in apple rootstock low temperature tolerance during spring and fall. *J. Amer. Soc. Hort. Sci.* 143:319-332.
- Karagiannis E., M. Michailidis , K. Karamanoli, A. Lazaridou , I.S. Minas, and A. Molassiotis. 2018. Postharvest cold responses of sweet cherry fruit and stem tissues revealed by metabolomics profiling. *Plant Physiology and Biochemistry* 127, 478-484. <https://www.sciencedirect.com/science/article/abs/pii/S0981942818301876>
- Minas I.S., G. Tanou, and A. Molassiotis. 2018. Environmental and orchard bases of peach fruit quality. Invited Review article for the Special Issue: Quality and Safety of Fresh Fruits and Vegetables. *Scientia Horticulturae*, 325, 307-322. <https://www.sciencedirect.com/science/article/pii/S0304423818300323>
- Redpath, L.E., D.J. Chavez, A. Malladi, and E.D. Smith. 2018. Southern highbush blueberry floral bud cold hardiness through dormancy in sub-tropical climate. *J. American Pomological Soc.* 72:166-172
- Reig, G., J. Lordan, G. Fazio, M.A. Grusak, S. Hoying, L. Cheng, P. Francescato, and T. Robinson. 2018. Horticultural performance and elemental nutrient concentrations on ‘Fuji’ grafted on apple rootstocks under New York State climatic conditions. *Scientia Horticulturae* 227:22-37.
- Reig, G., J. Lordan, M. Miranda Sazo, S.A. Hoying, M. Fargione, G. Reginato, D. Donahue, P. Francescato, Gennaro Fazio, and T.L. Robinson. 2019. Long term performance of ‘Gala’, Fuji’ and ‘Honeycrisp’ apple trees grafted on Geneva® rootstocks and trained to four production systems under New York State climatic conditions. *Scientia Horticulturae*. 244:277-293.
- Reig, G., J. Lordan, M. Miranda Sazo, S.A. Hoying, M. Fargione, G. Reginato, D. Donahue, P. Francescato, G. Fazio, and T.L. Robinson. 2019. Effect of tree type and rootstock on the long-term performance of ‘Gala’, Fuji’ and ‘Honeycrisp’ apple trees in a Tall Spindle production system under New York State climatic conditions: I. Long-term horticultural and fruit quality performance. *Scientia Horticulturae* (in press).
- Reighard, G., D. Archibold, Atucha, Autio, W., T. Beckman, B. Black, Chavez, D., I. Minas, R. Pokharel, T. Lindstrom, M. Parker, T. Robinson, J. Schupp, M. Warmund, and D. Wolfe. 2018. Rootstock performance in the 2009 NC-140 peach trial across 11 states. *Acta Hortic.* (Accepted 19 Apr 2018).
- Sherif,, S, K.S. Yoder and G.M. Peck. 2018 .Effects of dwarfing and semi-dwarfing apple rootstocks on the growth and yield of Gala, Fuji and York apples. *Acta Horticulturae* (In review).
- Vilorio, Z., G. Travis, W. Dunwell, and R. Villanueva. 2018. Seasonal emergence of invasive ambrosia beetles in Western Kentucky in 2017©. *Acta Hortic.* 1212: in Press.
- Wolfe, D., D. Archbold, J. Johnston, and G. Travis. 2018. Rootstock Effects on Apple and Peach Tree Growth and Yield. Fruit and Vegetable Crops 2017 Research Report. University of Kentucky College of Agriculture, Agricultural Experiment Station publication. PR-739:16-19. <http://www2.ca.uky.edu/agcomm/pubs/PR/PR739/PR739.pdf>
- Zhebentyayeva, T., G. Reighard, B. Krska, V. M. Gorina, and A.G. Abbott. 2018. Origin of resistance to Plum pox virus in apricot: microsatellite (Ssr) data analysis. February

Symposium Proceedings

- Muehlbauer, M. and S. Fong. Influence of rootstock and cropload on bitterpit incidence in ‘Honeycrisp’ apples grown in New Jersey. NEPPSC Proceedings. 2018(3):76
https://www.newss.org/wp-content/uploads/2018-NEPPSC-Proceedings_FINAL.pdf
- Muehlbauer, M., J.M. Clements, W. Cowgill and W.R. Autio. 2018. Assessment of the Effect of Vineland and Geneva Rootstocks on Apple Tree Vigor and Yield in Three Honeycrisp and Fuji NC-140 Rootstock Trials. NACAA AMPIC Proceedings. 2018(103):46
<https://www.nacaa.com/ampic/2018/2018%20Proceedings%20lr.pdf>

Poster Presentations

- Casamali, B., M. Van Iersel, and D.J. Chavez. 2018. Seasonal nitrogen dynamics in young peach tree. Where does the nitrogen go? Amer. Soc. Hort. Sci. Annual Meeting
- Crassweller, R. M. & D. Smith. Apple rootstock trials at Rock Springs. Presented at the Mid Atlantic Fruit and Vegetable Conference. January 30 – Feb 1, 2018.
- Crassweller, R. M., R. P. Marini, T. A. Baugher, and D. E. Smith. Five year nutritional study of apples in commercial high density orchards. Presented at. 30th International Horticultural Congress. August 15, 2018. Istanbul, Turkey.
- Kon, T.M. and C.D. Clavet. 2018. Effects of leader bagging, 6-benzyladenine (6-BA), and GA 4+7 plus 6-BA on lateral branching of 3rd leaf ‘Gala’ apple. The American Society for Horticultural Science Annual Conference, Washington, DC
- Muehlbauer, M., J.M. Clements, W. Cowgill, and W.R. Autio. 2018. Assessment of the Effect of Vineland and Geneva Rootstocks on Apple Tree Vigor and Yield in Three Honeycrisp and Fuji NC-140 Rootstock Trials.. Chattanooga TN, NACAA
- Schupp, J., H. E. Winzeler, and M. A. Schupp. 2018. NC 140 peach rootstock trial. Mid Atlantic Fruit and Vegetable Conference, Hershey, PA.
- Schupp, J., E. Winzeler, M. Schupp, and L. Kime. 2018. Pruning by the numbers. Mid Atlantic Fruit and Vegetable Conference, Hershey, PA.
- Schupp, J., E. Winzeler, and M. Schupp. 2018. Effects of rootstock and tree spacing in mineral nutrition and productivity of peach trees in Pennsylvania. Mid Atlantic Fruit and Vegetable Conference, Hershey, PA.
- Sutton, M., A. Malladi, and D. Chavez. 2018. Crop Load Reduction in Peach (*Prunus persica* L.): The Effects of Timing and Intensity. Amer. Soc. Hort. Sci. Annual Meeting
- Sutton, M., A. Malladi, and D. Chavez. 2018. Crop Load Reduction in Peach (*Prunus persica* L.): The Effects of Timing and Intensity. Plant Center Retreat, University of Georgia.
- Weipz, R., J. Schupp, M. Schupp, and E. Winzeler. 2018. The effects of five levels of artificial spur extension on “Gala” in Pennsylvania. Mid Atlantic Fruit and Vegetable Conference, Hershey, PA.

- Winzeler, H. E., and J. Schupp. 2018. Use of Ethephon and 1-MCP in the harvest and storage of Manchurian crabapples. Mid Atlantic Fruit and Vegetable Conference, Hershey, PA.

Published Abstracts

- Francescato, P., B. Carra, S.C. Uber, J. Lordan and T.L. Robinson. 2018. Strategies to improve defoliation of apple nursery trees in the Eastern US. ASHS Annual Conference. Washington D.C., USA. Abstracts.
- Francescato, P., J. Lordan and T.L. Robinson. 2018. Efficacy of metamitron as a postbloom thinner – the American Northeast experience. International Horticulture Congress Istanbul, Turkey. Abstracts.
- Francescato, P., Lordan, J. and Robinson, T.L. 2018. Precision crop load management in apples. International Horticulture Congress Istanbul, Turkey. Abstracts.
- Lordan, J., T.L. Robinson, P. Francescato, P. Herzeelle, and G. Fazio. 2018. Effects of apple rootstocks on nutrient concentration in 'Honeycrisp' scions. International Horticulture Congress Istanbul, Turkey. Abstracts.

Technical Reports/Commercial Industry Reports

- Clements, J., W.R. Autio, M. Muehlbauer, and W. Cowgill. 2018. Tree size and fruit yield in 2017 of Honeycrisp and Fuji apple trees in the 2014 NC-140 Rootstock Trials in Massachusetts and New Jersey. Fruit Notes 83(1):20-25. <http://www.umassfruitnotes.com/v83n1/a6.pdf>
- Clements, J., W.R. Autio, M. Muehlbauer, and W. Cowgill. 2018. Tree size and fruit yield in 2017 of Honeycrisp and Fuji apple trees in the 2014 NC-140 Rootstock Trials in Massachusetts and New Jersey. Horticultural News 98(1): 20-25. <http://www.horticulturalnews.org/98-1/a6.pdf>
- Cline, J. and A. Gunter. 2018. Rootstocks for Honeycrisp – an Update. Orchard Network Newsletter Feb 2018 5 p.
- Francescato, P., T. Robinson, J. Jordan and P. Herzeelle. 2018. The use of plant growth regulators for crop load management in apples. I. Fruit thinning and flower formation. New York Fruit Quarterly 26:(1):5-10.
- Fazio, G., J. Lordan, P. Francescato, and T.L. Robinson. 2018. Breeding apple rootstocks to match cultural and nutrient requirements of scion varieties. New York Fruit Quarterly 26:(2):25-30.
- Marini, R. 2018. Interstem Apple Trees Revisited. Pennsylvania Fruit Times. Feb. 2018. <https://extension.psu.edu/apple-rootstocks-interstem-apple-trees-revisited>
- Schupp, J., R. Marini and T. Baugher. 2018. Competitive Orchard Systems and Technologies. Pennsylvania Fruit News 98(1):21-23.
- Schupp, J., B. Wipz, E. Winzeler and M. Schupp. 2018. Evaluation of Artificial Spur Extinction or 6BA at bloom as Potential Crop Load Management Techniques. Pennsylvania Fruit News 98(1):24-25.
- Schupp, J., E. Winzeler and M. Schupp. 2018. Effects of Rootstock and Tree Spacing on Mineral Nutrition and Productivity of Peach Trees in Pennsylvania. Pennsylvania Fruit News 98(1):29-30.

- Sherif, S. and K. Yoder. 2018. 2017 Progress Report to Virginia Apple Research Program; New Rootstocks, Cultivars, and Training Systems for Virginia, Project Support for 2017. 7 pp. (May 2018).
- Warmund, M.R. Jan. 2018. Fruit tree research update. Great Plains Growers Conference, St Joseph, MO.
- Yoder, K. 2018. 2017. Progress Report to Virginia Apple Research Program. Apple rootstock susceptibility to Tomato Ring Spot Virus (TmRSV) and latent viruses. Project Support for 2017. Virginia Fruit. 3 pp. (May 2018).

Extension Fact Sheet Publications

- Hansen, S., T. Maughan and B. Black. 2018. Tart cherries in the Garden. USU Extension, Horticulture/Fruit/2018-03pr.
- Hansen, S., T. Maughan and B. Black. 2018. Training and pruning peach trees. USU Extension, Horticulture/Fruit/2018-01pr.
- Stewart, J.E., S.T. Miller, and I.S. Minas. 2018. Preventive Control for Cytospora Canker on Peach. Colorado State University Extension, Crop Series, Diseases, Fact Sheet No. 2.954.

Popular Articles

- Casamali, B. and D.J. Chavez. 2018. Improving irrigation and fertilization recommendations for young peach plants in the southeastern United States. Peach News Magazine. Spring Issue.

Other Creative Works

- Baugher, T. and J. Schupp. 2018. Peach Crop Load Management: Blossom Thinning to Increase Fruit Size and Reduce Labor Requirement. Fruit Times, 20 April 2018.
- Cochran, D.R. NC-140 ‘Honeycrisp’ rootstock trial update 2018. Iowa State University Fruit and Vegetable Growers Field Day, Horticulture Research Farm, IA, August 7, 2018.
- Moran, R. Website – Plum Production in Maine, <https://extension.umaine.edu/publications/2034e/>
- Crassweller, R. 2018. Climate & Orchards – Part 1. What changes have already occurred <https://extension.psu.edu/climate-change-and-orchards-part-1-what-changes-have-already-occurred>
- Crassweller, R. 2018. Climate Change and Orchards – Part 2 Seasonal Shifts. <https://extension.psu.edu/climate-change-and-orchards-part-2-seasonal-shifts>
- Crassweller, R. 2018. Climate Change and Orchards – Part 3. Changes in Weather and Pest Populations. <https://extension.psu.edu/climate-change-and-orchards-part-3-changes-in-weather-and-pest-populations>
- Crassweller, R. 2018. Climate Change and Orchards – Part 4. Managing Orchards in a Changing Climate. <https://extension.psu.edu/climate-change-and-orchards-part-4-managing-orchards-in-a-changing-climate>
- Crassweller, R., T. Baugher, and L. Kime 2018. Trellis Construction Workbook. <https://extension.psu.edu/trellis-construction-workbook>

- Crassweller, R., 2018. Orchard Production Systems: Selection Considerations. <https://extension.psu.edu/orchard-production-systems-selection-considerations>
- Marini, R. P., J. R. Schupp, R. Crassweller, T. A. Baugher and C. Walsh. 2018. Fruit Disorders - Harvest Practices to Prevent Storage Disorders in Honeycrisp. Fruit Times, September 6, 2018. https://extension.psu.edu/fruit-disorders-harvest-practices-to-prevent-storage-disorders-in-honeycrisp?j=268406&sfmc_sub=33456380&l=159_HTML&u=5275049&mid=7234940&jb=3
- Marini, R. P. 2018. Apple Rootstocks: Interstem Apple Trees Revisited. <https://extension.psu.edu/apple-rootstocks-interstem-apple-trees-revisited>
- Marini, R.P. 2018. Fruit Tree Pruning: Summer Pruning Cautions. <https://extension.psu.edu/fruit-tree-pruning-summer-pruning-cautions>
- Schupp, J. 2018. Scarf Skin and Russet, Two Apple Skin Disorders: Description, Causes and Management. Penn State Fruit Times, https://extension.psu.edu/apple-skin-disorders-scarf-skin-and-russet?j=215664&sfmc_sub=22239605&l=159_HTML&u=4146476&mid=7234940&jb=1
- Schupp, J. 2018. After Top-Working: Managing the New Grafts. Penn State Fruit Times, https://extension.psu.edu/after-top-working-managing-the-newgrafts?j=228965&sfmc_sub=33456380&l=159_HTML&u=4462941&mid=7234940&jb=3
- Schupp, J., T. Baugher and P. Heinemann. 2018. Peach Crop Load Management: Blossom Thinning and Fruit Size. Penn State Fruit Times, https://extension.psu.edu/peach-crop-load-management-blossom-thinning-and-fruit-size?j=215664&sfmc_sub=22239605&l=159_HTML&u=4146493&mid=7234940&jb=1
- Schupp, J. 2018. Is it okay to concentrate chemical thinners? <https://extension.psu.edu/is-it-okay-to-concentrate-chemical-thinners>
- Schupp, J., R. Crassweller, R. Marini and T. Baugher. 2018. Thinning after hail. https://extension.psu.edu/chemical-thinning-after-an-early-season-hail-storm?j=222770&sfmc_sub=33456380&l=159_HTML&u=4290451&mid=7234940&jb=3
- Schupp, J., E. Winzeler, M. Schupp, T. Baugher, D. Weber, and D. Seifrit. 2018. Gala Apple Scarf Skin 2018 Grower Trials. Penn State Fruit Times. <https://extension.psu.edu/scarf-skin-reduction-trials-in-grower-orchards-show-promise>
- Weidner, K. 2018. History and Accomplishments of the Penn State Fruit Research and Extension Center, 1977 – 2018. L. Hull and J. Schupp, eds. 48 pp.

Plant Patents

- Cummins, JN.; H.S. Aldwinckle, T.L. Robinson and G. Fazio. 2017. Apple tree rootstock named 'G.814'. US. Plant Patent 27,643.
- Cummins, JN.; H.S. Aldwinckle, T.L. Robinson and G. Fazio. 2017. Apple tree rootstock named 'G.213'. US. Plant Patent 28,581.

Scientific and Outreach Oral Presentations

- Autio, W.R. Tour and update of the 2009 and 2010 NC-140 trials in Massachusetts. Massachusetts Fruit Growers' Association Annual Summer Meeting, July 10, 2018. Attendance: 100.
- Barac, G., C. Saski, G.L. Reighard, and K. Gasic. 2018. Unveiling genetic background of peach tree short life syndrome. American Society of Hort. Sci. Annual Meeting. Washington, D.C. July 30 to August 3, 2018.
- Black, B. and B. Bugbee. 2018. Water Conservation Research for Orchards: Rootstock drought tolerance. Utah Water Users Conference. St. George, UT. (attendance: 40)
- Black, B. and B. Bugbee. 2018. Water Conservation Research for Orchards: Rootstock drought tolerance. Extension Agent In-Service and Utah Water Initiative planning meeting USU Extension Annual Conference, Lehi, UT. (attendance: 35).
- Black, B. Peach rootstocks and thinning. 2018. Northern Utah Fruit Growers Meeting. Brigham City, UT. (attendance: 47)
- Black, B. 2018. Rootstocks and pruning: Research update. Annual Conference of the Utah State Horticulture Association, Spanish Fork, UT. (attendance: 65)
- Bradshaw, T. 2018. Sustainability Practices Support Vermont Orchards and Vineyards. Atlantic Seed Association Annual Convention. Burlington, VT
- Bradshaw, T. 2018. Trunk Boring Insects in Apple Trees. UVM Apple Program & VT Tree Fruit Growers Assn 122nd Annual Meeting. Middlebury, VT.
- Bradshaw, T. 2018. Constraints & Opportunities for Selling Apples to the Cider Market. UVM Apple Program
- Cochran, D.R. NC-140 'Honeycrisp' rootstock trial update 2018. Iowa State University Fruit and Vegetable and Vegetable Growers Field Day, Horticulture Research Farm, IA.
- Crassweller, R., J. Schupp, and C. Walsh. 2018. Apple variety showcase. Mid Atlantic Fruit and Vegetable Conference, Hershey, PA.
- Crassweller, R. M., L. F. Kime, R. P. Marini & D. E. Smith 2018. Orchard architecture effects on yield & economics of two apple cultivars. Presented at 30th International Horticultural Congress. Istanbul, Turkey
- Evans, K. 2018. Pear rootstock breeding. International New varieties network presentation and discussion.
- Evans, K. 2018. Pear rootstock breeding. International Pome Fruit Alliance
- Fallahi, E. 2018. We had a daylong educational tour in Parma, Idaho and showed growers how to design the new tree architectures and training in several rootstocks to commercial apple growers of Idaho (38 growers participated).
- Fallahi, E. 2018. Results of 2010 and 2014 NC-140 apple rootstocks. Utah Horticulture Convention, Salt Lake City, UT.
- Fallahi, E. 2018. Results of rootstock performance in Fuji and Honeycrisp. Idaho State Horticultural Society Summer Tour. 57 participants
- Fallahi, E. 2018. Participated a ½ day educational tour at Parma Research Center where results of our rootstock performance trials. 530 participants
- Fallahi, E. 2018. Impacts of various rootstocks on yield and fruit size. Idaho apple growers, Parma, Idaho

- Kon, T.M. and C.D. Clavet. 2018. Effects and interactions of bloom and post-bloom thinners on 'Gala' fruit set, fruit growth rate, and yield. Southeastern Professional Fruit Workers Conference, Manchester, TN
- Kon, T.M. 2018. Effects of 6-BA and NAA on fruit set, fruit growth, and yield of 'Gala' in North Carolina. Northeast Plant Growth Regulator Working Group, Wilkes Barre, PA
- Kon, T.M. 2018. Minimizing stem end splitting of 'Gala': Effects and interactions of AVG and GA4+7. Northeast Plant Growth Regulator Working Group, Wilkes Barre, PA
- Kon, T.M. 2018. Effect of AVG formulation and application number on preharvest drop control and fruit quality of 'Red Delicious' apples. Northeast Plant Growth Regulator Working Group, Wilkes Barre, PA
- Kon, T.M. 2018. Inducing lateral branching and shoot extension of 'Gala' apple with chemical and cultural practices. Northeast Plant Growth Regulator Working Group, Wilkes Barre, PA
- Kon, T.M. 2018. Developing a horticultural research and extension program for the southeastern apple industry. North Carolina State University Department of Horticultural Science Seminar Series, Raleigh, NC.
- Kon, T.M. 2018. Apple Thinning Update. Apple Production Twilight Meeting, Richmind Orchards, Flat Rock, NC
- Kon, T.M. 2018. Early Season & Preharvest Plant Growth Regulator Applications. Apple Growing Updates, Rockingham County Agricultural Center, Reidsville, NC
- Kon, T.M. 2018. Early Season Plant Growth Regulator Applications. Northwest Winter Tree Fruit Meeting, Wilkes County Agricultural Center, Wilkesboro, NC
- Kon, T.M. 2018. Harvest & Postharvest Handling of Apple. Upstate Fruit Meeting, Oconee Extension Office, Walhalla, SC
- Kon, T.M. 2018. Apple Tree Pruning Workshop. Alexander/Wilkes County Tree Fruit Pruning Workshop, Taylorsville, NC.
- Kon, T.M. 2018. Early Season & Preharvest Plant Growth Regulator Applications. 2018 North Georgia Apple Production Meeting, Gilmer County Library, Ellijay, GA
- Kon, T.M. 2018. Apple Tree Pruning Workshop. Transylvania County Master Gardeners Program, Mountain Horticultural Crops Research and Extension Center, Mills River, NC
- Kon, T.M. 2018. Apple Tree Pruning. Apple Field Day, Georgia Mountain Research and Education Center, Blairsville, GA.
- Kon, T.M. 2018. Early Season Plant Growth Regulator Applications. Western District Winter Apple School, Hendersonville, NC
- Kon, T.M. 2018. Plant Growth Regulator Applications in Apple Production. Master Pomologist Program, Henderson County Extension Office, Hendersonville, NC
- Kon, T.M. 2018. Managing fruit quality and preharvest drop. Southeastern Apple Growers Meeting, Asheville, NC
- Lavelly, E.K., R.M. Crassweller, D. Eissenstat, and R.P. Marini. 2018. The effect of fruit removal and rootstock on stored carbohydrates and response to chemical thinning in apple. Presented at the Annual Conference of Amer. Soc. Hort. Sci., Washington, D.C.
- Marini, R.P., E. Fallahi, P. Francescato, G.L. Reighard, J. Lordan, T.L. Robinson, D. Wolfe, and M.J. Newell. 2018. The relationship between peach fruit weight, crop density and early season temperature. Presented at the Annual Conference of Amer. Soc. Hort. Sci., Washington, D.C.

- Minas I.S., D. Sterle D., and F. Blanco-Cipollone. 2018. Near infrared spectroscopy can nondestructively assess the effect of rootstock, crop load and canopy position on peach fruit harvest maturity and internal quality. 30th International Horticultural Congress, ISHS, Istanbul, Turkey.
- Minas I.S., and D. Sterle D. 2018. Differential thermal analysis sheds light on the effect of environment, cultivar, rootstock, and crop load in peach floral buds early acclimation and maximum cold hardiness. 30th International Horticultural Congress, ISHS, Istanbul, Turkey.
- Minas, I.S. 2018. Understanding the environmental bases for cold hardiness and damage in peach. Invited Speaker, Idaho State Horticultural Society, Nampa, Idaho.
- Minas, I.S. 2018. Colorado Tree Fruit Research Challenges & Opportunities. Invited Speaker, Idaho State Horticultural Society, Nampa, Idaho.
- Moran, R. 2018. Highmoor Farm Tree Fruit Research Summary. Maine Ag. Trades Show, Augusta, ME. 60 participants.
- Muehlbauer, M. et al. 2018. A total of 6, 4 hour workshops with handouts were held with Master Gardeners to educate them about the NC-140 rootstock plantings at the Rutgers University Snyder Research and Extension Farm, Pittstown, NJ.
- Muehlbauer, M. et al. 2018. An additional 2 hour workshop with handouts was held with high school students to educate them about the NC-140 rootstock plantings at the Rutgers University Snyder Research and Extension Farm, Pittstown, NJ.
- Musacchi, S, K. Evans, and S. Serra. 2018. WA 38 Fall Field Visit Rootstock trial – Sunrise (Rock Island). 100 people attended the field day.
- Parker, M.L. January 2018. SE Apple Growers Meeting. Asheville, NC. Commercial grower audience. Attendance 120.
- Parker, M.L. January 2018. Peach Production Orchard Tour and Workshop with an emphasis on peach rootstocks and subsequent management. Sandhills Research Station. Attendance 50.
- Parker, M.L. January 2018. North Carolina Peach Growers Society. Carthage, NC. Commercial grower audience. Attendance 85.
- Parker, M.L. February 2018. Western District Apple School, Hendersonville, NC. Commercial grower audience. Attendance 110.
- Parker, M.L. February 2018. Maximizing Orchard Productivity in the Brushy Mts., Wilkesboro, NC. Commercial grower audience. Attendance 40.
- Reighard, G.L. 2018. Peach tree survival and fruit yield on 17 Prunus species rootstocks in South Carolina. Southeastern Professional Fruit Workers Conference, McMinnville, TN. October.
- Reighard G.L. 2018. Panel: El futuro varietal y de los huertos de Durazno. Fruittrade conference. Santiago, Chile.
- Reighard G.L. 2018. Nuevas tendencias en el manejo de huertos de durazno. Fruittrade conference. Santiago, Chile.
- Reighard G.L. 2018. Innovacion en genetica para el desarrollo de variedades. Fruittrade conference. Santiago, Chile.
- Reighard G.L. 2018. Strategies for producing temperate tree fruit under increasing winter temperatures. 30th International Horticultural Congress. Istanbul, Turkey.

- Reighard G.L. 2018. Co-convenor for Symposium 9: Symposium on Evaluation of Cultivars, Rootstocks and Management Systems for Sustainable Production of Deciduous Fruit Crops. 30th International Horticultural Congress. Istanbul, Turkey.
- Reighard G.L. 2018. Avancos no manejo de PTSL associado a *Mesocriconema xenoplax* em pessegueiro. 35th Congresso Brasileiro de nematologia. Bento Gonsalves, Brazil.
- Schupp, J. 2018. Trials and tribulations of 2017 chemical thinning. Mid Atlantic Fruit and Vegetable Conference, Hershey, PA.
- Schupp, J. 2018. Does 6BA at FB “Pre-select” Fruits to Respond to Post-bloom Thinners? Northeast Plant Growth Regulator Working Group, Wilkes-Barre, PA.
- Schupp, J., K. Peter, B. Lehman, M. Schupp and E. Winzeler. 2018. Effects of low-dose prohexadione on shoot growth and fire blight susceptibility of young Crimson Crisp apple trees. Northeast Plant Growth Regulator Working Group, Wilkes-Barre, PA.
- Schupp, J., E. Winzeler and M. Schupp. 2018. Preliminary apple thinning results. Plant Protection Field Day. PSU Fruit Research and Extension Center, Biglerville, PA.
- Schupp, J., H. E. Winzeler and M. Schupp. 2018. Effect of Single or Split Applications of Prohexadione, With and Without Gibberellin 4+7 on Scarf Skin of Buckeye Gala. Cumberland-Shenandoah Fruit Workers Conference, Winchester, VA.
- Schupp, J., E. Winzeler, M. Schupp, and L. Kime. 2018. Pruning by the numbers. Adams County Fruit School, Biglerville, PA.
- Shengrui, Y., 2018. Fruit pruning demonstration (with 2015 organic apple rootstock trial included).
- Shengrui, Y., 2018. Fruit production tour during NMSU Alcalde Field Day with organic apple rootstock trial.
- Sherif, S., K. Yoder and G. Peck. 2018. Effects of dwarfing and semi-dwarfing apple rootstocks on the growth and yield of Gala, Fuji and York apple trees. International Horticultural Congress, Istanbul, Turkey (Oral Presentation). Attendance: 29.
- Sherif, S. and K. Yoder. 2018. Effects of apple rootstocks on bitter pit incidence at harvest, and after cold storage. On-orchard meeting at Saunders Bros. Orchard. Piney River, VA. 30 Aug, 2018. Attendance: 70.
- Sherif, S. and K. Yoder. 2018. Discussion of NC-140 2014 ‘Honeycrisp’ planting. Central Virginia orchard meeting series. Attendance: 33.
- Stasiak, M. 2018. What Can a Research Station Do For You: A 25-year Perspective. 2018 Wisconsin Fresh Fruit & Vegetable Conference. Wisconsin Dells, WI. Attendance: 200.
- Wolfe, D. 2018. Growing apples on the tall slender spindle system. Apple Grower Meeting. Homeowner / grower audience. Attendance 20.
- Yoder, YU , and S. Sherif. 2018. Open House at the Alson H. Smith, Jr. AREC: Tour of the Horticulture and Pathology plantings. Winchester, VA. Attendance: 55.

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

- Autio, W, R Marini, J Cline, I Minas, G Lang, and T Einhorn. 2018. NC-140 Rootstock Research Trial Coordinators. International Fruit Tree Association. \$12,000.
- Beckman, T.G. (Co-PI), D.J. Chavez and J. Cook, J. 2018. Establishment of a prototype nursery at the middle Georgia latitude to demonstrate the feasibility of commercial

propagation of peach on semi-dwarf rootstocks in a one year growing cycle. USDA Innovation Fund. \$25,000.

- Bradshaw, T. 2017-2020. Rootstock and tree training systems for unique apple production systems. Vermont Agriculture Experiment Station Hatch Grants Program. \$64,084.
- Cheng, L. (Cornell UniversityZ), L. Kalcsits and S. Musacchi. 2016-2021. Accelerating the Development, Evaluation and Adoption of New Apple Rootstock Tech to Improve Apple Grower Profit and Sustainability.USDA- SCRI. Total budget 5 M. Total budget WSU: \$841,598. Musacchi budget: \$412,061
- Chavez, D.J. 2018. 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. 2018. Development of peach and nectarine cultivars for Georgia. Cultivar Development Research Program – UGARF – University of Georgia. \$14,100.75
- Cline, J. 2017. Canadian Horticultural Council. \$25,000
- Crassweller, R.M. 2018. Evaluating mycorrhizal enhancement of new apple tree growth. Valent USA Corporation. \$3,260
- Crassweller, R.M. & J. R. Schupp. 2018. Apple rootstock & cultivar evaluations 2018. State Horticultural Association of Pennsylvania (SHAP) Research Committee. \$22,285.
- Crassweller, R. M. and D. E. Smith. 2018. Third generation apple system trials from SHAP Research Committee. \$9,000
- Crassweller, R. M., J. R. Schupp, D. Choi, and L. He. 2018. Small equipment grant from PSU College of Agricultural Sciences Research & Graduate Education office. \$5,600
- Crassweller, R. M, D. Choi, and D. E. Smith. 2018. Effects of maintenance of training systems to a hedgerow. SHAP Research Committee. \$13,753.
- Crassweller, R. M. and H. J. Sommer. 2018. Buy-and-fly orchard management using unmanned aircraft (UA). SHAP Research Committee. \$14,401.
- Einhorn, T. Z(MSU) and S. Musacchi. 2018-2021. Field Evaluation of Pear Cultivars on Cold Hardy Quince Rootstocks.. NWPB (Northwest Pear Bureau) Project - Total budget: \$220,007. Musacchi budget: \$132,035.
- Evans K. and A. Dhingra. 2015-2018. Developing the foundation for U.S. pear rootstock breeding. PNW Pear Bureau. Role: Budget. \$273,253.
- Fallahi, E. 2018. Pest and disease control of rootstock projects. Wilbur Ellis Company. Contributed \$ 8,000 worth of product.
- Fallahi, E. 2018. Labor and equipment (in-kind) from Idaho fruit industry. Received approximately \$8,000.
- Fallahi, E. Our program has been a member of a team of NC140 scientists who secured considerable funding from SCRI. Our share has been about \$160,000 over five years.
- Fallahi, E. 2018. ‘Honeycrisp’ apple fruit. Henggeler Packing Co., Inc, Fruitland, Idaho. Received a contribution of \$6,200.
- Hao Xu. 2018. Apple rootstock evaluation in British Columbia conditions. Costs of supporting the 2010 NC-140 apple rootstock trial were covered by the start-up funding for new scientists, provided by Agriculture and Agri-Food Canada.
- Hao Xu. 2018. 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, jointly funded by AAFC and the BC Fruit Growers' Association.

- Ingram, D.L and T.A. Woods. 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.
- Ivey, M.L, (Plant Pathology), H. Zhu (USDA-ARS Agricultural Engineering), D. Miller (Horticulture and Crop Science) and E. Long (Entomology). 2018. Tall spindle high density apple orchard for rootstock, variety and disease evaluations. OARDC/OSU. \$7400 support from and \$2000 supplies donation from Ohio Fruit Growers Marketing Association
- Jayanty, S. S., Minas, I., Bartolo, M. E., Grant, 2016-2018. Postharvest handling strategies for Colorado specialty crops to increase marketability and improve consumer quality. Agricultural Experiment Station, Colorado State University, \$26,065.00.
- Kon, T.M. 2018. Private industry support. \$22,085.68
- Minas, I. 2016 - Establishment of a Tree Fruit Physiology and Quality Program at Western Colorado. Western Colorado Horticultural Society, \$10,000.00.
- Minas, I. 2016. WCRC Pomology", Colorado Apple Administrators Commission. \$7,414.50
- Musacchi, S., K. Lewis, K. Gallardo, and T. Auvil. 2014-2017. WA 38 Rootstock and Systems Trial. Washington Tree Fruit Research Commission (WTFRC). \$242,519.
- Musacchi, S., L. Kalcsits, D. Layne, S. Serra and K. Gallardo. 2015-2018. Cosmic Crisp™: Training system and orchard management to optimize vigor control and quality. Specialty Crop Block Grant Program. \$249,191.
- Parker, M.L. 2018. NC Apple Growers Association. \$5,100.
- Parker, M.L. NC Legislature/Special Bill funding for apple research. \$6,000.
- Reighard, G. 2018. Guardian® rootstock seed sales. South Carolina Foundation Seed. \$231,000.
- Reighard, G. 2018. Screening peach rootstocks for adaptability, productivity, and tolerance to *Armillaria* and bacterial canker. South Carolina Peach Council research grant. \$4,000.
- Reighard, G., K. Gasic, C. Sasaki, et al. 2017-2021. Short and long-term solutions for *Armillaria* Root Rot in *Prunus*." USDA Multi-State Specialty Crops Block Grant with the Pennsylvania Dept. of Ag. \$927,000
- Robinson et al. 2018. Strategies to improve root development, tree growth and management of apple nursery trees. - Sponsored by International Fruit Tree Association. \$10,000.
- Robinson et al. 2018. Evaluation of the Cornell-Geneva Apple Rootstocks and Other Promising Apple Rootstocks. - Sponsored by International Fruit Tree Association. \$10,000.
- Robinson et al. 2018. Orchard management systems for improved yield and fruit quality. 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.
- Shapiro-Ilan, D.I., and D.J Chavez, et al. 2018-2020. Biocontrol with Benefits: Enhancing Sustainability by Adding Value. Southern Sustainable Agriculture Research & Education (SARE). Funding: \$260,000.00 (Chavez lab: \$18,060.00).
- Stasiak, M. 2018. Door County, WI extension support funding for commercial cherry and apple rootstock fruit research and outreach. \$2,500.
- Stasiak, M. Wisconsin Cherry Board funding for maintenance of the 2017 NC140 Tart Cherry High Density Rootstock and Irrigation Trials. \$2,000.
- Stewart, J. E., and I. Minas. 2017-2019. Cytospora management in peach orchards through cultural practices, cultivar selection, and stress mitigation. Specialty Block Grants, Colorado Department of Agriculture. \$91,218.
- Wolfe, D. Bayer Corporation donation for the NC-140 rootstock trials. \$500.
- Villani, S.M. and T.M. Kon. 2017-2018. Defining rapid apple decline: gaining insight into the relationship between abiotic stressors and disease-driven death of apple trees in high-density systems. CALS NC Agricultural Foundation Grant; North Carolina State University. Funding: \$24,800.00
- Villanueva, R. Bessin, J. Obrychi, and W. Dunwell. 2017-2018. Studies on Ambrosia Beetles Affecting Nursery Crops and Fruit Trees in Kentucky. Kentucky Specialty Crop Block Grant Program. About \$500 from this grant were used to cover the cost of labor for maintenance and harvest of NC-140 rootstock trials.
- Warmund, M.R. Fruit research. Private gifts from Missouri producers. \$2500.
- Yoder, K.S., and S. Sherif. 2018-2019. Support for 2018; New Rootstocks, Cultivars, and Training Systems for Virginia. Virginia Apple Research Program. \$8,240.
- Yoder, K.S. and S. Sherif. 2018-2019. Apple rootstock susceptibility to Tomato Ring Spot Virus (TmRSV) and latent viruses. Virginia Apple Research Program. \$9,508.