

Improving Sustainability in Fruit Tree Production through Changes in Rootstock Use

NC-140 (2012-2017)

Fruit Tree Producers Suffer Losses, Seek Rootstocks for Higher Density Orchards



Pear tree. Photo by Kristine Paulus, Flickr. [CC License 2.0](https://creativecommons.org/licenses/by/2.0/).

In North America, fruit tree producers suffer losses due to cold temperatures, diseases, poor soil conditions, and graft incompatibility. With a highly competitive international market, consumer demand for high quality fruit, and strong pressure to reduce chemical use, fruit tree growers are seeking economically and environmentally sustainable production schemes. Many fruit tree growers are adopting high-density systems. The central component of a high-density system is the rootstock, the part of the tree that controls final tree canopy size. Limiting canopy size allows for more trees per acre, but rootstocks can have serious weaknesses (rootstock may influence productivity, fruit quality, pest resistance, and stress tolerance), and though potential returns of high-density plantings far exceed those of low-density plantings, they cost 10 to 20 times more per acre to establish.

Conflicting information about rootstocks, diverse orchard practices, differing experimental procedures, and a poor relationship with the tree fruit industry have resulted in costly planting and management errors. Rootstocks cannot be recommended unless there is coordinated, uniform research investigating their suitability in a range of conditions. Furthermore, fruit trees are long-lived perennials, so a minimum of eight years must pass to obtain an indication of rootstock performance and potential for improved profitability.

Multistate Research Project Coordinates Research on Sustainable Rootstocks

Multistate Research Project NC-140 forged a viable international partnership between universities and the tree fruit community. Together, they leveraged federal and state dollars to conduct innovative research on fruit tree rootstock genetics, production, management, and economics. In recognition of the group's exceptional collaboration and research impacts, NC-140 received the 2015 *Experiment Station Section Excellence in Multistate Research Award* from the Experiment Station Committee on Organization and Policy.

Over the past five years, they evaluated rootstocks of temperate-zone fruit trees from around the world, regularly measuring tree growth, root anchorage, size control, soil and climatic adaptability, and pest and disease resistance. Based on their experimental plot results, the group used state-of-the-art genomic tools and breeding programs to develop improved rootstocks for temperate-zone fruit trees. The team also developed new protocols for screening rootstocks, improved propagation techniques, and facilitated acquisition of rootstocks to accelerate their adoption among growers. In addition, NC-140 offered detailed recommendations regarding use of these new rootstocks, distributing research-based information through Extension, web sites, written material, and educational programs.



NC-140 scientists tour a peach rootstock trial orchard. Photo by Jon Clements, University of Massachusetts.

Multistate Research Project Provides Rootstocks for Higher-Yielding, Easier to Manage, More Sustainable Orchards

NC-140's uniform, multi-location trials have drastically reduced evaluation time for new rootstocks from more than 40 years to just 10 years. Results from these trials are accelerating the process of identifying, propagating, and commercializing high-performing rootstocks, meaning new rootstocks are available to growers sooner. Education and Extension efforts have made reliable information on rootstock performance easier to access. Selecting more suitable rootstocks has led to higher yields for producers and improved fruit quality for consumers, ultimately enhancing the economic viability of tree fruit farms. Over the last 30 years, tree fruit growers in North America have transitioned to higher density orchards that

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Monumental shifts in orchards in every U.S. state where temperate fruit trees are grown (along with parts of Canada and Mexico) can be attributed to the collaborative efforts of NC-140 researchers, Extension educators, and industry partners. NC-140 recommendations have resulted in earlier returns, greater yields, and higher fruit quality, with a financial benefit to U.S. fruit tree producers of \$250,000,000. With combined state and federal investment in NC-140 of about \$10,000,000, cumulative measurable benefits to the U.S. temperate tree-fruit industries will be more than \$400,000,000. Less easily measured benefits, such as averted losses and enhanced environmental quality, will increase the financial value of NC-140 to well beyond \$500,000,000 over the next five years.



NC-140 scientists tour a commercial grower's sweet cherries grown from NC-140 rootstock in tunnels (top photo by Jon Clements, University of Massachusetts) and a rootstock trial at Clemson University to discuss training approaches.

Want to know more?

NC-140 was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. For more information, visit <http://ncra.info/>.

Administrative Advisor: Ronald Perry (perryr@anr.msu.edu)
Project Website: www.nc140.org
Participating Institutions:
 Auburn University, University of Arkansas, University of California, Davis, California Cooperative Extension, Clemson University, Colorado State University, Cornell University, University of Georgia, University of Guelph, Ontario, Canada, University of Idaho, University of Illinois, Iowa State University, University of Kentucky, University of Maine, University of Maryland, University of Massachusetts, Michigan State University, University of Minnesota, University of Missouri, New Mexico State University, North Carolina State University, Ohio State University, Oregon State University, Pennsylvania State University, Purdue University, Rutgers University, Utah State University, Virginia Polytechnic Institute and State University, Washington State University, University of Wisconsin, Agriculture and Agri-Food Canada, British Columbia, Canada, Agriculture and Agri-food Canada, New Brunswick, Canada, Atlantic Food and Agric-Food, Kentville, Nova Scotia, Canada, Center for Advanced Studies in Fruit Production, Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias (National Institute of Forestry, Agriculture and Livestock Research), Mexico, USDA-ARS, USDA-ARS Plant Genetic Resources Unit

This Impact Summary was compiled and designed by Sara Delheimer.

take up less land, increase production efficiency, accommodate automation technology, and rely on fewer chemicals. For example:

- With NC-140 recommended rootstocks, yields will increase by 20% per acre, and fruit size will increase by 10%, and tree losses due to disease will decline by 10%.
- By utilizing NC-140 recommended rootstocks, farmers will receive significantly earlier returns on investments related to tree establishment, moving the average break-even year from eight to five years after planting.
- Transitioning from large, unwieldy apple trees spaced far apart to compact rows of high-yielding, small trees, has eased apple orchard maintenance and harvesting labor and increased profitability.
- 98% of all New Jersey orchards now use apple, pear, peach, and cherry dwarfing rootstocks as a direct result of NC-140 research and Extension, particularly through Rutgers Cooperative Extension outreach.
- Over the last 15 years in Indiana, use of superior performing rootstocks from NC-140 trials has increased 660%, with an estimated crop value increase of more than \$12,000 per acre.
- Sweet cherry acreage has increased by 10,000 acres since 1995, in large part due to the plantings of dwarfing Gisela rootstocks, first tested on a large scale by NC-140. Planting density has jumped from 100 to 415 trees per acre, with an estimated annual increase of \$260 million of fresh fruit.
- Based on NC-140 results, 200 acres of trees in Massachusetts were planted with dwarfing rootstock in 2014. On this acreage, pruning and harvest labor declined by 50%, fruit quality and size increased by 20%, and profit increased by 50%.
- NC-140 trials have helped Utah peach growers select rootstocks that are more tolerant of alkaline soils.
- With apples alone, NC-140 science and outreach has increased mature orchard yields by 20%, enhanced fruit size by 10%, increased highest grade fruit by 20%, decreased time on investment return by 30%, and provided estimated economic gains of \$200 million.
- The use of NC-140 recommended dwarfing rootstocks will result in a 50% reduction in canopy volume and a concomitant 50% reduction in pesticide usage on 200,000 acres. The reduction in pesticide use will net environmental benefits and save \$150,000,000 in pesticide cost and application. For example, chemical and pesticide cost and application is down by nearly 40% among apple orchards using dwarf rootstocks, and on 200 acres planted with dwarfing rootstock in Massachusetts, reduced tree canopy volume has led to a 70% decline in pesticide use.