NC-140, Rootstock and Interstem Effects on Pome- and Stone-fruit Trees

IMPACT AND RESEARCH NEEDS STATEMENT

Theme: Product-based Agriculture

Issue: With the increasingly competitive international market, the growing demand for higher quality fruit by consumers, the strong pressure to reduce chemical use, and an ever increasing need to enhance the economic efficiency of production, tree-fruit growers must look to economically and environmentally sustainable management strategies for fruit production. Growers who want to stay profitable must establish high-density plantings with much smaller trees with new cultivars as rapidly as possible to maintain economic viability. These high-density plantings may cost several times more to establish than low-density plantings, thus greatly increasing the economic risk. A rapid return on investment is vital for growers to allow for changing cultivars in response to market. The central component of high-density systems is the rootstock. The root system imparts many characteristics to the mature tree such as size, precocity, productivity, fruit quality, pest resistance, stress tolerance, and thus profitability.

As the industry moves from low- to high-density plantings, several rootstock-related problems must be addressed. New pome- and stone-fruit rootstocks cannot be recommended to commercial growers without reservations until there is sustained research as to soil and climatic adaptability, root anchorage, size control, precocity, productivity, pest resistance, and propagation ability. In general, field testing of rootstocks in an orchard setting requires a minimum of ten years to assess accurately the potential for improved profitability, reduction of inputs, and enhancement of production efficiency. With year-to-year variation in weather, this time span is necessary to obtain a true indication of rootstock performance. Through the uniform cooperative testing undertaken by NC-140, new rootstocks can be exposed quickly and systematically to widely varying soil and climatic conditions to shorten the time necessary for thorough evaluation.

Resolution: The objectives of NC-140 are: 1) to evaluate the field performance of pome- and stone-fruit rootstocks in various environments and under different management systems, and to optimize experimental design for such evaluations; 2) to assess and improve asexual propagation techniques of pome- and stone-fruit rootstocks; 3) to develop and improve pome- and stone-fruit rootstocks through breeding and genetic engineering, and to acquire new rootstocks from worldwide sources; and 4) to understand the developmental and abiotic stress physiology of rootstock/scion interactions in pome- and stone-fruit trees.

NC-140 oversees the development, acquisition, and evaluation of new rootstock material. Rapid evaluation of that material results in the ability of North American orchards to benefit from its use with a better understanding of performance (productivity, precocity, efficiency, and pest susceptibility) and therefore less risk of failure. Full understanding of the propagation characteristics of new rootstock material, allow nurseries to be more efficient. Understanding the physiology of the rootstock allows tree-training systems to be tailored to specific tree characteristics and feeds critical information back into rootstock breeding programs.

The results of all NC-140 projects are presented in peer-reviewed, scientific journals, resulting in

the last 5 years in about 20 articles from the project as a whole and more than 120 from cooperative research. Extension outreach is an integral part of the NC-140 project. Therefore, results are disseminated quickly and widely as soon as they are ready. As an example of the outreach effort, nearly 200 grower-oriented publications were developed, about 450 talks were given, nearly 150 field days were conducted, and more than 50,000 grower contacts were made in the last 5 years to disseminate information from NC-140 projects. Because of the extensive output of NC-140 and the widespread participation, all modern North American recommendations regarding rootstocks for fruit crops have their basis in NC-140.

Impact:

- Overall, the work of NC-140 resulted in recommendations and educational programs which guided planting of 170,000 acres of fruit trees over the last five years in the U.S.

- Utilization of NC-140 recommendations resulted in significantly earlier returns on investments related to tree establishment.

- Mature yields increased by 20% per acre, fruit size was 10% greater, and the percent meeting the highest grade category increased by 20%.

- The financial benefit to U.S. fruit growers from earlier returns, greater yield, and higher fruit quality was $200,000,000 over the 5-year period.

- Because of most new plantings being primarily in the dwarf category (with substantially reduced canopy volume per acre), pesticide usage on the new acreage was reduced by nearly 40%, with the associated environmental benefit plus $100,000,00 saved over the 5-year period in pesticide cost and application.

- Because of the use of disease-resistant rootstocks and better selection of susceptible rootstocks, tree losses declined by 10% over the 5-year period.

- NC-140 output guided propagation of fruit trees in nurseries, allowing them to tailor better their output to grower demands and to avoid problematic rootstocks. As an example, a series of cherry rootstocks from Russia were gaining a great deal of interest, but NC-140 work found them to be hypersensitive to Prunus Necrotic Ringspot virus, reducing their suitability for U.S. production.

- Individuals from Canada and Mexico are integral to NC-140, therefore expanding its influence throughout all North America. The project and its output, however, are valued worldwide.

- NC-140 continues to develop advanced experimental design approaches to reduce the costs of rootstock research.

- NC-140 cooperators introduced molecular approaches to the breeding programs, enhancing the efficiency of development and selection of the next generations of tree-fruit rootstocks.

- Cumulative state and federal investment in NC-140 for the last 5 years was about $5,000,000. Cumulative, measurable benefits to the U.S. temperate tree-fruit industries were more than $300,000,000. Less easily measured benefits, such as averted losses and enhanced environmental quality, certainly increase the financial value of NC-140 to well beyond $300,000,000 in the last 5 years.

Research Needs:

- Nearly all NC-140 productivity results from long-term (10-year) studies, which are necessary to obtain meaningful rootstock data on which to base recommendations. Therefore, long-term allocation of resources (personnel, land, equipment, and supplies) is critical to the success of NC-140.

- While continuation of long-term studies is essential, we must continue to enhance research efficiency. Presently, our severely limited resources are better expended on current trials. New resources, however, would allow us to establish trials to study the needs of replication, the necessary term of trials, and the number and variety of locations required to acquire the highest-quality data with the fewest inputs. The result would be an increased number of NC-140 research projects, greater productivity of NC-140, and greater environmental and economic impact of NC-140.

- NC-140 has always worked to improve the propagation capability of desirable rootstocks; however, additional scientist time and resources need to be focused on this objective. Improved propagation will save the nurseries money in production and will ultimately save the growers money.

- More resources are needed for rootstock breeding. Molecular techniques need continued refinement, such that breeding can be efficient and more quickly result in products beneficial to tree-fruit growers.

- We must focus more on rootstock physiology to understand better the reasons for dwarfing and susceptibility or resistance to abiotic stresses. This understanding must be integrated into recommendations for rootstock use and tree management to enhance production efficiency. It also must be tied to the molecular understanding of rootstock genotypes so as to more effectively advance the breeding of new and valuable rootstocks for tree-fruit crops. This increased effort will require additional scientist effort and operating resources across the U.S.