

Multidisciplinary Evaluation of New Apple Cultivars: The NE-183 Regional Project

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Abstract

A multidisciplinary regional project for the evaluation of new apple cultivars was established in 1994 and given the designation of NE-183. Apples are and will continue to be an important fruit crop grown in much of the world. New cultivars are continually being discovered as chance seedlings or generated as the result of controlled crosses. There is no uniform system in place to systematically and uniformly evaluate and identify the most promising cultivars that are suitable to plant in specific climatic regions and that have a high probability for success. Apples are one of the most costly fruit crops to establish and bring into production; thus a mistake in cultivar selection may be economically catastrophic. This project was initiated to aid growers in making intelligent and information-based decisions about which new apple cultivars to grow. The NE-183 project "Multidisciplinary Evaluation of New Apple Cultivars" is unique in that it unites horticulturists, plant pathologists and entomologists and their individual expertise in selecting cultivars that not only have outstanding horticultural qualities but may also have resistance to important diseases and insects that afflict apples.

Apples are Important. Apples are an important crop in the United States and they are grown on more than 180,000 ha (10). The USDA National Agricultural Statistics Service reports apple production statistics for 36 states. Apple production exceeds 25,000 metric tons per year in at least 18 states. Total U.S. production of apples was approximately 4.5 million metric tons per year during the years 1999-2001. Further, significant quantities of fresh market apples and apple juice concentrate are also imported each year (10).

Increasingly, U. S. apple growers are competing with other apple producers in a worldwide market. Apple production in Chile, China, Brazil, South Africa, New Zealand, the European Economic Community, and eastern Europe are substantial and all impact apple prices and sales in the United States. In recent years, China has dramatically increased its production to the point that it is now the world's leading apple producing country (7). The future viability of the U.S. apple industry will depend on the ability of U.S. producers to capitalize on increased consumer interest in new and improved apple cultivars. O'Rourke (6) estimates that world apple production could rise about 30%, by

2005, while world population will grow by only 13% during that period of time. Per capita consumption is projected to rise modestly (7).

Apple Cultivar Evaluation. Apple cultivar evaluation was being conducted in at least 25 experiment stations throughout the United States and Canada when the NE-183 project was initiated in 1994. Often these evaluations were performed informally as part of larger projects, and results were infrequently published in scientific journals. The largest ongoing cultivar evaluation programs were in the Pacific Northwest (1, 4, 5, 9). The results of these programs were most useful to growers in that geographical region. Apple cultivar trials are rarely coordinated across broad geographic regions. Consequently, data from existing trials usually cannot be directly compared because of differences in planting dates, rootstocks used, orchard management, combinations of cultivars chosen for evaluation, and data collection methods. Independent trials in individual states are usually beneficial primarily to apple growers in the state where the trials are performed.

Apple Quality and Uniqueness Are Important. Most of the apples imported into

the U.S. for fresh-market sales are relatively new apple cultivars with distinctive color, improved flavor, and higher quality; examples include 'Granny Smith', 'Gala', 'Braeburn', and 'Fuji'. Consumers have accepted these new cultivars and have demonstrated a willingness to pay higher prices for the new cultivars than for traditional cultivars grown domestically. These consumers are looking for apples that have an appropriate size, are crisp, juicy and flavorful, and above all, have outstanding taste and shelf-life (2). Many new cultivars are rated considerably higher than traditional older cultivars by taste panelists (8). In the United States, interest in growing new apple cultivars increased dramatically over the past few years as growers realized that they could receive higher returns for new cultivars than the standard cultivars. Further, many apple growers are looking for alternatives to standard regional cultivars such as 'McIntosh' in the Northeast, 'York Imperial' in the Mid-Atlantic, and 'Delicious' in the Pacific Northwest. These cultivars have historical weaknesses such as fruit softening and preharvest drop for 'McIntosh', biennial bearing for 'York Imperial', and mediocre taste for 'Delicious'.

Necessary Pesticides Will be Lost and Pesticide Use Change. There is a very high potential that important pesticides necessary for disease and insect control on apples will be lost under the Food Quality Protection Act (FQPA). There are concerns about development of resistance to the ergosterol biosynthesis inhibitor (EBI) and strobilurin fungicides used for disease management. Although several new experimental fungicides with different modes of action are on the horizon, the new classes of fungicides are also at risk for development of fungal resistance. Broad spectrum fungicides are needed for early and late season apple disease management programs due to the possible loss of essential fungicides related to FQPA which may reduce the availability of many broad-spectrum fungicides (11).

The FQPA will undoubtedly influence the use of other important pesticides, particularly organophosphates and carbamates (11). While registration of some pesticides may be lost, it is equally

problematic to have reentry times or preharvest intervals increased for presently-used pesticides to the extent that they will no longer be useful to growers. These groups account for 75% of the insecticides used in tree fruits (11). Development of new chemical controls for apple diseases and insects is hampered by the high costs of developing new agrichemicals, by the stringent criteria currently used to assess safety and environmental impact of new pesticides, by the relatively small size of the market for pesticides on apples, and by the current agrochemical registration bottleneck imposed by the FQPA.

Pressures to reduce pesticide use are likely to continue for the foreseeable future, thus apple cultivars with genetic resistance to diseases may become more important as the options for chemical control of apple pests become more limited. Cultivars that are resistant to apple scab can be grown with fewer fungicide sprays and may also require fewer miticide sprays. Some fungicides affect mite populations by interfering with biological control of mites by predators (3). Broad new management strategies that are more dependent on biological controls for insects and mites may be feasible for cultivars which require less fungicide.

An Integrated and Regional Approach to Apple Cultivar Evaluation. In the past, plant pathologists and entomologists have generally had little impact on cultivar selection and evaluation. Instead, scientists in these disciplines were expected to solve pest control problems after cultivars had been selected and widely planted. This approach may become less viable in the future if chemical control options become more limited. Concurrent evaluation of both horticultural qualities and pest susceptibilities will allow a more rational approach for selecting new cultivars for commercial adoption. Cultivars that are highly susceptible to certain pests may still be promoted by nurseries, and planted in commercial orchards, if horticultural characteristics and marketers make them appear very desirable. However, the data generated by NE-183 will at least make pest managers and growers aware of the kinds of problems likely to occur when these cultivars

are planted.

A unified regional approach to evaluation of both horticultural characteristics and pest susceptibilities of new apple cultivars provides information that can be used to predict profitability of the cultivars evaluated. Cultivars and strains with high quality, packout and yield as well as good horticultural characteristics will help to enhance grower profit. In order for growers to use new cultivars most effectively, characteristics such as mature tree size, winter hardiness, bloom period, pollination requirements, productivity, adaptability to climate, growth habit, and fruit quality after storage must be determined. The present gap in knowledge of these characteristics has led to a haphazard and frequently costly approach for cultivar selection and planting. Growers who plant cultivars not adapted to their region frequently incur six to eight years of costs (usually greater than \$24,000/ha) before the deficiencies of their cultivar selections become apparent. Uniform cooperative testing will result in more efficient, rapid, and systematic evaluation of cultivar characteristics and will allow the industry to more quickly recognize both the limitations and the advantages of new cultivars.

The NE-183 Regional Project. The NE-183 project was approved by Northeast Experiment Station Directors in 1994. The primary objective of this project was to evaluate horticultural characteristics and pest susceptibility of new apple cultivars and advanced selections at numerous locations throughout the United States to determine both limitations and positive attributes of these cultivars.

In the spring of 1995, 28 plantings of cultivars and advanced selections were planted in 18 states (AR, CT, GA, MA, ME, MI, MO, NC, NJ, NY, OH, OR, PA, VA, VT, WA, WI, WV) and two Canadian provinces (British Columbia, Ontario). Plantings had the primary designation of either horticultural or pest susceptibility. Plantings for horticultural studies were located in AR, GA, MA, ME, MI, NC, NJ, NY-Geneva, NY-Ithaca, OH, OR, PA-Biglerville, PA-Rock Springs, VT, WA, WI, WV, BC and ON. Plantings for pest susceptibility were located

in CT, MI, MO, NC, NY-Geneva, VA, and WV. Horticultural data were collected only from plantings designated as horticultural and pest susceptibility data were collected only from Pest Susceptibility plantings. Maintaining Horticultural and Pest Susceptibility plantings as dedicated units eliminated the possibility of observing interactions. For example, extensive foliage damage in pest susceptibility plots might influence fruit quality assessment and horticultural data, whereas susceptibility of cultivars to insects or diseases might be masked by pest control sprays required to maintain healthy trees in the horticultural plantings.

Cultivar selection was done by a Cultivar Selection subcommittee which solicited nominations for inclusion in the first planting from apple breeders, apple cultivar experts, and members of the technical project. 'Golden Delicious' (Gibson strain) was included in all plantings as a standard control. Additionally, 'McIntosh' was included in all Pest Susceptibility plantings since it is known to be extremely susceptible to apple scab. The cultivars selected for the first planting included: 'Arlet', 'Braeburn', 'Cameo', 'Creston', 'Enterprise', 'Fuji' (Nagafu #2), 'Gala Supreme', 'Ginger Gold', 'Golden Supreme', 'GoldRush', 'Honeycrisp', 'Fortune', NY 75414-1, 'Orin', 'Pristine', 'Shizuka', 'Suncrisp', 'Sunrise', and 'Yataka'.

All trees for the project were propagated by Adams County Nursery, Aspers, PA. Bud wood was collected from reliable sources and shipped to Adams County Nursery for budding during a 5-day period. All cultivars were propagated on Malling 9 (M.9) T337 rootstock, with 'Yataka', 'Golden Delicious', and 'Braeburn' also being propagated on Mark rootstock. There was some concern that M.9 may be a sub-optimal rootstock for the northern and southern extremes of the apple growing regions represented in this project. Although many areas experienced difficulties with Mark, it has performed well in northern and southern areas, thus providing an internal check where M.9 may be marginal. Each planting was designated to have 5 single-tree replications in a randomized block design. There were fewer

than 5 trees per cultivar in some instances because of poor bud take in the nursery.

Horticulture, Fruit Quality, and Pest Susceptibility subcommittees were appointed and they developed protocols to ensure uniform sampling and data recording. Protocols and procedures were reviewed annually and adjustments were made where appropriate. Fertilizer application, ground cover management, and pest control in horticultural plantings were done according to local commercial recommendations.

Dr. Ron McNew from the Agricultural Statistics Laboratory at the University of Arkansas was the project statistician. He oversaw data management and conducted all statistical analyses for the project.

NE-183 Report of Results. This report details the background and reason for initiating the NE-183 project and provides background information on the setup, structure and details in establishing the first NE-183 planting. The four papers that follow this are the first of two groups that report on the results of the NE-183 Multidisciplinary Evaluation of New Apple Cultivars in areas of: growth and yield, fruit quality, rootstock interaction, flowering and nutrition.

Literature Cited

1. Ballard, J. K. 2002. 2002 annual report, Pacific Northwest Fruit Testers Assoc. Selah, WA.
2. Barritt, B. H. 2001. Apple quality for consumers. *Compact Fruit Tree* 34:54-56.
3. Bower, K. N., L. P. Berkett, and J. F. Costante. 1995. Non-target effect of a fungicide spray program on phytophagous and predacious mite populations in a scab resistant apple orchard. *Environ. Entomol.* 24:423-443.
4. Norton, R. A. 1993. Effects of second and third generation apple varieties on the Northwest industry: potentials and problems. *Penn. Fruit News* 73:37-41.
5. Norton, R. A. 1997. Apples for the 21st century. *Good Fruit Grower* 48(17):39-43.
6. O'Rourke, A. D., 1998. World apple marketing dynamics. *Compact Fruit Tree*. 31:46-48.
7. O'Rourke, A. D. 2003. World production, trade, consumption and economic outlook for apples, p. 15-29. In: D. C. Ferree and I. J. Warrington (eds.). *Apples: botany, production and use*, CABI Publishing, Cambridge, MA.
8. Stebbins, R. L., A. A. Duncan, O. C. Compton, and D. Duncan. 1991. Taste ratings of new apple cultivars. *Fruit Var. J.* 45:37-44.
9. Stebbins, R. L. and R. A. Norton. 1991. Current situation and future trends in apple cultivars in the Pacific Northwest. *Fruit Var. J.* 45:79-83.
10. USDA. 1997. *Fruit and nut yearbook*. usda.manlib.cornell.edu/data-sets/specialty/89022 Document tbla-09.wkl.
11. Warner, G. 1998. Familiar pesticides may become a thing of the past. *The Good Fruit Grower* 49(6): 10-11.



Apple Fruitlet Size and Position Within the Cluster Affect Susceptibility to Thinner

Fruitlet diameter, but not position, affected the percentage of fruitlet retention. Carbaryl thinned in four of six experiments and was most effective on fruitlets less than 14 mm diameter. Ethephon consistently thinned regardless of fruitlet size (8-31 mm diameter) or position. Ethephon was the only thinner that consistently reduced days from treatment to cessation of fruitlet growth. Overall, the number of days from treatment to growth cessation was 13-18 days on untreated and carbaryl-treated trees, and 8-9 days on ethephon-treated trees. The number of days from treatment to fruitlet abscission was 14-23 days on untreated and carbaryl-treated trees and 10-12 days on ethephon-treated trees.

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