Cherry Breeding: Striving to Make a Difference

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The goals of the cherry breeding programs in the U.S. are to increase grower profitability through the adoption of new cultivars. To reach these goals, it is imperative that breeding teams carefully assess grower needs to identify and rank priorities. In addition, due to the long time required to breed new cultivars, it is critical that the breeding team take risks to include fruit types that have the potential to open up future market opportunities. As the breeder is limited by what is genetically possible, cultivar development begins with an assessment and then accumulation of the genetic diversity needed to achieve these goals.

Access to cherry germplasm for U.S. breeding programs is a very long and cumbersome process for two reasons. The first reason is that USDA-APHIS quarantine regulations prohibit the direct importation of budwood due to virus concerns. Therefore, imported budwood must be sent to the USDA Plant Germplasm Quarantine Office for a minimum of three years for virus indexing. If clean, it will be released. Secondly, the center of diversity for cherry is in the Black Sea and Caspian Sea region, where travel, communication and even express mail access is difficult. Nonetheless, as knowledge of the germplasm and access to superior germplasm is critical for cultivar development, I made at least 10 trips to Eastern Europe from 1984 to 1998 to achieve these goals.

Tart Cherry

Approximately 50 Eastern European tart cherry varieties were imported as budwood between 1985 and 1998. These varieties were tested as part of the MSU tart cherry breeding program and resulted in the release of three varieties developed in Hungary: 'Balaton®', 'Danube™' and''Jubileum®'. These varieties were commercialized because they are uniquely different from 'Montmorency' in fruit quality attributes, and they open up opportunities for new product development. For example, all the varieties have firm fruit with higher sugar levels and natural pigments than 'Montmorency' (Table 1). These attributes have resulted in three new products for''Balaton®', the most widely grown of the selections: cherry port, pitted cherries in a glass pack, and fresh market. More information regarding 'Balaton®' is located at: www.hrt.msu.edu\balaton.html.

In total, the cherry germplasm introduced to the U.S. through the Michigan State University cherry breeding program provided a rich genetic base, which brought forth trait selection and an aggressive sour cherry breeding program. To date, it is through genetic improvement of the traits listed below that I am'"striving to make a difference":

- Cherry leaf spot resistance
- Possibly cherry fruit fly resistance
- Late-bloom time for spring frost avoidance
- Superior fruit quality traits: firm fruit, high soluble solids, freestone, and a range of skin and juice colors.

Approximately 30 MSU selections are in advanced trials on MSU or grower farms, or they are being propagated for advanced trials. We know they have excellent fruit quality from single tree evaluations, but the big questions are yield potential and processing capabilities of the fruit. These on-farm trials are designed to achieve this information by providing a range of environmental conditions and larger quantities of fruit.

To date, the most apparent negative attribute has been a tendency for lower yields in many seedlings. Therefore, intense selection pressure is being applied for high fruit set. Our research has shown that in certain cases, poor fruit set in sour cherry can be caused by the same self-incompatibility system that operates in sweet cherry. Therefore our

The Michigan State University tart cherry breeding program is striving to develop new varieties that are resistant to cherry leaf spot, and cherry fruit fly, that bloom late to avoid spring frost and that have superior fruit quality traits such as firm fruit, high soluble solids, freestone, and a range of skin and juice colors. Approximately 30 MSU selections are in advanced trials on MSU or grower farms.

TABLE 1

Evaluation of flower, fruit and pit traits for 'Montmorency', 'Jubileum™', 'Danube™' and''Balaton®' at the Clarksville Horticultural Experiment Station for 13 years (1988-2000).

Trait	'Montmorency'	'Jubileum™'	'Danube™'	'Balaton®'
Bloom datex	May 6	-1	-3	+1
Harvest datex	July 10	-9	-8	+8
Fruit weight (g)	4.9	5.8	6.2	5.8
Fruit length (mm)	17	19	20	19
Fruit width (mm)	20	23	22	22
Soluble solids (%)	14.2	19	17.3	16
Skin color	Bright red	Dark purple	Dark red	Dark red
Flesh/juice color	Clear	Purple/red	Dark red	Dark red
Pit length	9.6	10.2	11.3	10.4
Pit length/width	1.12	1.11	1.14	1.12
Pit wt./Fruit wt. (%)	6.2	5.7	6.3	6.4

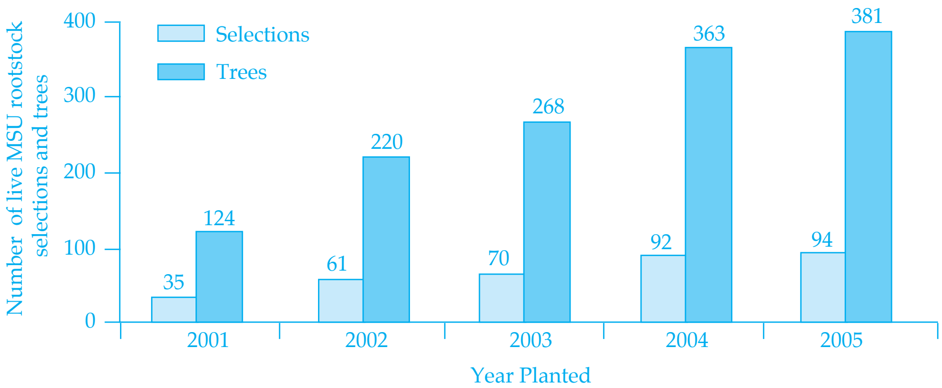

Figure 1. The cumulative number of live MSU rootstock selections and trees currently planted and projected to be planted in Clarksville, MI. The majority of rootstock selections have 'Hedelfingen' scions while some selections have 'Bing' scions.

goal is to develop molecular markers for early detection of highly self-fertile selections. We are currently using this genomics technology to address a production problem. In particular, we are attempting to determine if fruit set in 'Balaton®' would be increased with a pollinator cultivar, and if so, which one.

Cherry Rootstocks

Precocious and dwarfing rootstocks are available from Europe; however, the tendency for cherry cultivars to over-crop on these precocious rootstocks makes it difficult to achieve the large fruit size needed for maximum profitability. For example, 'Gisela 6' induces early and abundant fruiting in the scion. This is a result of an increased number of spurs per tree as well as fruit per spur compared to the standard 'Mazzard'. However, fruiting density (i.e., fruit per spur) on 'Gisela 6', and especially 'Gisela 5', is often excessive. This has created new difficulties in achieving the balanced crop load necessary for maximizing fruit size and quality. This challenge has limited the commercial adoption of these rootstocks.

By the mid-1990's the tart cherry collection at MSU was the largest such collection in the world. At the same time, two of the most successful cherry rootstock breeders in the world, Dr. Hanna Schmidt (Gisela series) and Dr. Brigitta Wolfram (PiKu series), were retiring and their programs were not being continued. According to these breeders, tart cherry and its related species were the most promising species from which to select superior rootstocks. Since dwarfing, precocious, sweet cherry rootstocks would significantly increase the profitability of fresh-market sweet cherry production, a rootstock selection program was begun in 1997 at MSU. The strategy was essentially to 'recycle' the MSU germplasm by selecting rootstock candidates among seedlings that were not suitable cultivar candidates. This effort was designed to sample the diversity within the MSU collection for its rootstock potential prior to its removal.

Due to the susceptibility of some of the international sweet cherry rootstocks to PDV and PNRSV, pre-screening for virus resistance was done. Additionally, for practical reasons, all rootstock candidates were tested for their ability to be propagated from vegetative cutting.

From this five year effort, 92 MSU rootstock selections are identified as having acceptable levels of vegetative propagation capability and virus tolerance (Figure 1). Surprisingly, the vast majority of the MSU rootstocks induced early scion flowering similar to that of a 'GI 6' budded tree. To date, only two rootstock candidates have been eliminated due to graft incompatibility. These results are sufficiently promising, and we propose to re-propagate the superior candidate rootstock selections in 2006 to provide trees for advanced testing in multiple test sites.

Since the initiation of the project, there has been an increased understanding of how a balanced cropping approach can be used to maximize fruit size while maintaining yield. As the rootstock has a direct effect upon fruiting density, our goal is to identify a rootstock that confers a fruiting habit characterized by well-balanced spurs possessing 2-4 fruit. We predict that this will reduce the number of years required to evaluate the rootstocks for yield and fruit size.

Sweet Cherry

The feasibility of sweet cherry breeding to produce commercially successful sweet cherry cultivars is widely accepted. For example,''Ulster' is from the cross 'Schmidt' x 'Lambert', 'Rainier' is from the cross 'Bing' x 'Van', and 'Brooks' is from the cross 'Rainier' x 'Early Burlat'. These three cultivars,''Ulster', 'Rainier', and 'Brooks' developed by Agricultural Experiment Station scientists at Cornell University, Washington State University, and the University of California, Davis, have contributed greatly to the success of the sweet cherry industries in their respective locations.

With the introduction of the self-fertile cultivar 'Stella' in 1968 from the Canadian Breeding program in British Columbia, a whole new series of hybrids were created using 'Stella' as a parent to transmit self-fertility. As in other programs, the Cornell breeders also made crosses with 'Stella' that led to the release of some very promising self-fertile sweet cherry cultivars for the Northeastern U.S. These cultivars have the potential to substantially impact the profitability of sweet cherry production in this region. It is this series of self-fertile cultivars that will represent a successful end to the legacy of the Cornell sweet cherry breeding program.

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