Breeder profile: Amy Iezzoni

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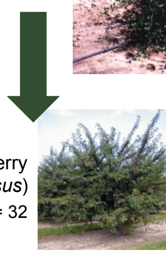
Box A. Origins of Tart Cherry

Sweet cherry (*P. avium*)
2n = 2x = 16

Ground cherry (*P. fruticosa*)
2n = 4x = 32



Sour cherry
(*P. cerasus*)
2n = 4x = 32

Box B. Amerello versus morello tart cherries

Amerello cherries (pictured left; Montmorency) have pigmented skin, yellow to pink flesh, and generally clear juice. Morello cherries (pictured right; Balaton™) have pigmented skin and flesh and generally pigmented juice.

Box C. Variation in flower bloom and fruit ripening exhibited in tart cherry.

Picture taken May 5, 2010: Tamaris tart cherry flowers (left) and Red Delicious apple flowers (right).

Emperor Francis sweet cherry (top), MSU tart cherry seedling (middle), and Montmorency tart cherry (bottom).

Breeding new and improved plant cultivars requires the availability of and access to a diverse germplasm collection. Such a collection is used to make crosses between divergent parents in hopes of recombining traits of interest to result in a superior cultivar. A diverse germplasm collection can be comprised of old landrace varieties collected from different growing areas around the world, as well as representatives from wild species relatives.

Tart cherry is a species that is in itself genetically diverse because it originated from hybridizations between two very different species. It is believed that multiple natural hybridizations between *Prunus fruticosa* (ground cherry) and *P. avium* (sweet cherry) occurred (see Box A) thousands of years ago in Central and Eastern Europe, giving rise to a new species, tart cherry, which exhibits a wide range of tree archetypes and fruit quality characteristics. Trees can range from small and bushy with willowy limbs to tall and upright with limbs that have wide branch angles. Fruit also exhibit a wide range in sugar content, acid and anthocyanin profiles, and size and shape (see Box B). Bloom and ripening time also vary widely among different selections (see Box C).

Amy Iezzoni is the only tart cherry breeder in the United States (both private and public). Amy was hired in 1981 by Michigan State University and her first tasks as the tart cherry breeder were to access the available germplasm and determine the industry needs for tart cherry.

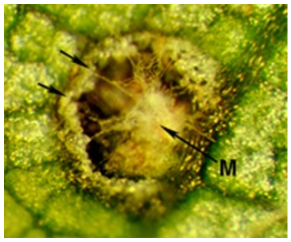
<u>The tart cherry industry:</u> Virtually all tart cherries are processed. Processed tart cherry products include jams, dried cherries, individually quick frozen (IQF), juice, with the largest portion for pie filling. Michigan produces approximately 75% of the tart cherries grown in the U.S. The tart cherry industry is a monoculture and consists of essentially only one cultivar, 'Montmorency', which is a 400-year-old cultivar from France. Why is tart cherry production in the U.S essentially a monoculture of this one variety? Two major reasons contribute to its dominance. First, most of the cherry germplasm and excellent varieties that would have provided alternatives to 'Montmorency' evolved or were bred in Eastern Europe, but prior to the Cold War they were essentially unavailable to the U.S. Secondly, 'Montmorency' is extremely productive. The trees flourish in the sandy soils of Western Michigan; they can withstand its harsh winters and set very heavy crops, even with up to 60% blossom freeze damage. 'Montmorency' requires very little horticultural management and can withstand trunk damage inflicted by mechanical harvesting. Fruit produced from this cultivar are generally uniform in size and have clear flesh and bright red skin, characteristics which have become the standard for "American cherry pie" (see Box B).

However, there are limitations to 'Montmorency' – the fruit can be soft and the trees are highly susceptible to cherry leaf spot (*Blumeriella jaapii*), which is a major financial cost for tart cherry producers. A grower, in the months of May through July, may have to spray as many as 14 times. Also, when an industry relies on only one cultivar to supply fruit to its various market sectors, the industry can be paralyzed if a freeze occurs during a critical bloom stage. This scenario unfortunately did occur – in 2002, the combination of an early bloom and a hard freeze resulted in a crop loss of over 95%. In an average year, Michigan produces approximately 180 million pounds of tart cherries valued at ~ $39 million. In 2002, production estimates were around 3 million pounds and valued at $7.2 million (Kleweno and Matthews, 2003)! The financial impact of the 2002 freeze was devastating to the industry and associated communities.

<u>Tart cherry germplasm collection at Michigan State University:</u> After reviewing the industry's needs, Amy evaluated the germplasm that was available to her. Unfortunately, all that was available was a small collection of 'Montmorency' sports and varieties from Western Europe. So during the Cold War, Amy sought permission to visit Eastern Europe, the center of diversity for tart cherry, to collect cherry accessions to enhance her germplasm base. Through the support of the USDA and bilateral agreements with the authorities in these former communist countries, Amy made multiple trips to Central and Eastern Europe, first to bring

Box D. Susceptible and resistant infection of cherry leaf spot in tart cherry.

Susceptible lesion showing large spore mass (S) in the center of the lesion.



Resistant lesion showing stunted mycelia (M) surrounded by an abscission zone (arrows).

P. Wharton and A. F. Iezzoni.

Traits that are the focus of the Michigan State University's Tart Cherry Breeding Program:

- Increased firmness
- Pit size and shape: most tart cherries are pitted and processed, therefore pits can not be too long (which could result in an increase in chip fragments found in the final product) and the pit weight to fruit weight ratio are key. If a new cultivar that has a long sharp pit and/or a large pit were to be released, it would not be accepted by the industry.
- Late bloom time
- Decreased pesticide use due to disease resistance
- Processing savings due to less use of colorants and/or sugar
- Freestone or "airfree", see picture to right.
- High yielding

An airfree seedling from Michigan State University's breeding program.

Example of the variation of fruit shapes and sizes found in progeny from a tart cherry cross:

Balaton™ (Újfehértói Fürtös; Hungary)

X

Surefire (New York breeding program)

pollen to the U.S. for making crosses, and then eventually to obtain budwood. Over a 15-year period, Amy scheduled her trips to coincide with bloom and fruit ripening in the countries she visited, including Bulgaria, Germany, Hungary, Poland, the former nation of Yugoslavia, Russia, Serbia, and Ukraine. The results of these efforts led to the establishment of the world's largest germplasm collection, which is located at Michigan State University's Clarksville Horticultural Research Station, as well as lifelong collaborations and friendships with many of the breeders from these countries. One such collaboration resulted in the joint release in the U.S. of three cultivars that Dr. Maliga Pál, from the Újfehértó Fruit Station in Hungary, developed. The three cultivars released in the U.S. are (listed with the U.S. trademarked name followed by the Hungarian name): Balaton™ (Újfehértói Fürtös), Danube® (Erdi Botermo), and Jubileum® (Erdi Jubileum).

Amy traveled specifically to Russia because Russian scientists had previously identified sources of resistance to cherry leaf spot in the wild small-fruited tetraploid cherry species, *P. maackii.* Scientists in Russia had made crosses with *P. maackii* in attempts to introgress cherry leaf spot resistance into domesticated tart cherry. The seedlings from these crosses were brought back to Amy's germplasm collection, to observe whether or not the resistant gene/s are dominant (highly heritable), characterize the resistance mechanism in the plant, and to make further crosses. Screening progeny derived from *P. maackii* and another wild species *P. canescens*, confirmed that these small-fruited species contained valuable genes for resistance to cherry leaf spot. Microscopic analysis of the infection sites revealed that in the resistant seedlings, the fungus enters the stomata but is not able to establish itself in the plant. Instead the plant "responds" by killing the infected cell and the leaf spot fungus along with it (Box D; Wharton et al, 2003)! To increase the efficiency of transferring this disease resistance into new tart cherry cultivars, Amy and her group, including Drs. Dechun Wang and Esther van der Knaap, embarked on a project to identify the major genes controlling fruit size in cherry. Amy reasoned that if they knew the controlling genes, that this would ultimately result in fewer generations required to combine the disease resistance with large fruited types. With USDA Plant Genome funding, Amy and her group were successful in identifying the location of a major gene for fruit size, which was a previously featured Jewel in the Genome (RosBREED Jewel in the Genome - Sweetcherry.pdf).

Amy began making crosses with the imported germplasm but soon encountered problems with fruit set that severely limited productivity. One of the culprits contributing to low fruit set turned out to be genetically controlled self-incompatibility, which was very prevalent in the hybrid seedlings (see page 8 - Jewel in the Genome for more details). Thanks to funding from the USDA-Plant Genome Program, Amy and her Team, which included Dr. Ryutaro Tao's group in Japan, were able to elucidate the genetic control of self-incompatibility and self-compatibility in tart cherry. Most importantly, the results can be used to plan crosses that do not result in any self-incompatible progeny. However, even with self-incompatibility solved, breeding for high yield continues to be challenging. One of Amy's motivations for involvement in RosBREED is to harness all of the available genetic knowledge to overcome this critical yield hurdle.

References

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