Dedicated to the genetic improvement of U.S. rosaceous crops

August 31, 2012   **Volume 3 Issue 3**

MAB In Action!

Dedicated to the genetic improvement of U.S. rosaceous crops, RosBREED thrives to enable marker-assisted breeding in apple, peach, strawberry, sweet cherry, and tart cherry by sharing the project outcomes and success stories with the fellow breeder community. Toward achieving this goal, RosBREED recently held a participatory workshop for Rosaceae community breeders and allied scientists called "Marker-Assisted Breeding in Action" (or MAB in Action). This one-day workshop was held on July 30, a day before the 2012 annual conference of the American Society for Horticultural Science (ASHS) in Miami, Florida.

Among the 44 participants were RosBREED Demonstration Breeders, Community Breeders, Breeding Trainees and other graduate students, as well as allied scientists. Breeders represented the Rosaceae crops of apple, peach, strawberry, cherry, blackberry, and raspberry, from both the public and the private sectors.

The content lead of the workshop, Cameron Peace from Washington State University, was instrumental in engaging the audience with a step-by-step approach to what it takes to conduct MAB in each breeder's program. RosBREED's MAB Pipeline, the process that translates previously discovered marker-locus-trait associations (aka QTLs) into ready-to-use breeding tools and knowledge, was the main topic. Software components of the Breeding Information Management System underlying Pipeline stages were also explained. Understanding this big picture is useful for Community Breeders who are enthused about attending the upcoming crop-specific RosBREED breeder workshops (see page 3 for more information).

Overall, participants left satisfied with the content covered, heads full of both practical knowledge and conceptual understanding, and excited and energized to enable marker-assisted breeding in their own programs.

On behalf of all the participants in RosBREED, we appreciated the opportunity to meet with the wider community of rosaceous crop breeders and we look forward to seeing you at the upcoming crop-specific breeder workshops.

Inside this Issue

USDA

NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

RosBREED by the numbers

82,936

Number of phenotypic data points collected by University of Minnesota, Washington State University, and Cornell University apple Breeding Trainees from the 2011 harvest that will be archived in the Breeders Toolbox.

Yingzhu Guan, Washington State University, 2011

815

Total number of people who participated in the RosBREED clicker surveys, conducted at 12 grower meetings. Survey participants were asked to prioritize their trait preferences for strawberry, peach, apple, tart cherry, and sweet cherry. The Socio-Economics Team is currently analyzing this data and will summarize their findings in two HortScience manuscripts and the industry/grower magazine 'Good Fruit Grower', soon to be released. Stay tuned.
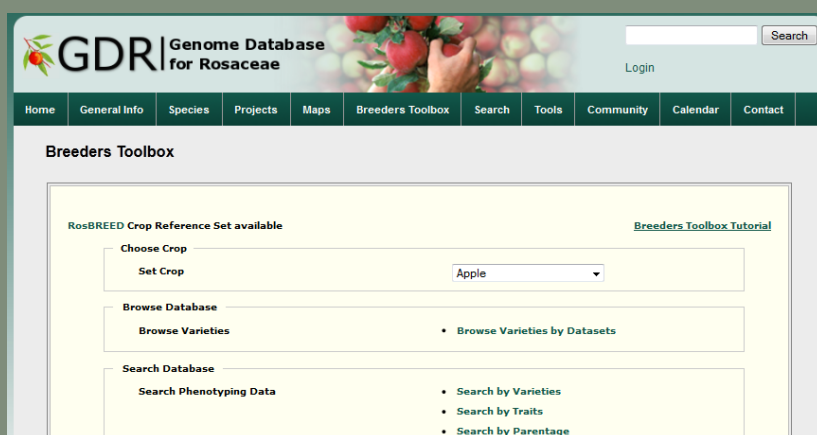

Great Lakes Expo Strawberry Session, December 2011

1,321

Number of unique pageviews for the Breeders Toolbox worldwide since January 1, 2012. 801 pageviews were from the United States.

www.rosaceae.org/breeders_toolbox

MAB In Action! Part 2 - Crop-Specific Breeder Workshops are being planned

Attention Rosaceae community breeders and industry leaders!!!

RosBREED will soon be leading three crop-oriented breeder workshops focused on helping you use DNA-information to plan your spring crosses. We welcome all Rosaceae crop breeders to come to the workshops to work hand in hand with RosBREED's Demonstration Breeders and Marker-Assisted Breeding (MAB) Pipeline Team Leader Cameron Peace to use the latest DNA information to increase the efficiency and success of your breeding program. The three breeder workshops will be at the venues listed below and we welcome you to participate in the "breeder session" as we work through examples of "clever crosses to make" and "which bad seedlings to throw away".

If you are interested in attending one of these workshops, contact Audrey Sebolt (grantzau@msu.edu).

Supporting Breeding Decisions

Which traits to target?
Which parents to use?

Which combinations to create?

Which seedlings to advance?

Which selections to trial?

Which advanced selections to commercialize?

Peach Breeder Workshop This workshop will showcase the use of MAB in Ksenija Gasic's peach breeding program at Clemson University. The meeting will also provide an opportunity for interaction with industry stakeholders.

Venue: Madren Center of the James Martin Inn at Clemson University, South Carolina

Date: October 16-17, 2012

Apple Breeder Workshop This workshop will be held in conjunction with the International Plant and Animal Genome Conference and the RosBREED Advisory Panel Member Meeting. It will focus on gathering apple breeders from the U.S. and Europe to discuss MAB opportunities in apple. We will showcase success stories from both the RosBREED (www.rosbreed.org) and FruitBreedomics (for more information about this project: www.fruitbreedomics.com) projects. From the U.S., we will feature the apple breeding programs of RosBREED's Demonstration Breeders, Jim Luby (University of Minnesota), Susan Brown (Cornell University), and Kate Evans (Washington State University).

Venue: DoubleTree Hotel, San Diego, California

Date: January 11, 2013

Strawberry Breeder Workshop This workshop will bring together RosBREED's strawberry Demonstration Breeders and community breeders from the U.S. with a focus on the use of MAB in enhancing the efficiency of improving the genetically notorious octoploid strawberry and showcasing the strawberry breeding program of Chad Finn.

Venue: Oregon State University, Corvallis, Oregon

Date: January 30-31, 2013

RosBREED's ASHS presentation series highlights

By: Cholani Weebadde, Extension Team Leader

RosBREED recently hosted a half-day workshop at the 2012 Annual Conference of the American Society for Horticultural Science (ASHS) in Miami, Florida. The August 1 workshop, entitled "**RosBREED: Discoveries and breeding databases for the fruit research community**", was sponsored by the Fruit Breeding Working Group at ASHS. The following talks were delivered with a full-room audience of about 125 Rosaceae breeders, allied scientists, academics, students, industry leaders, and growers.

1. <u>**RosBREED Mission – Jewels in the Genome**</u> Amy Iezzoni (Project Director, Michigan State University) began the workshop with an overview of RosBREED. She emphasized our vision for transforming Rosaceae crop improvement. She also mentioned how RosBREED enables the breeding application of specific marker-locus-trait associations ("Jewels in the Genome") that influence critical production and fruit quality traits.

2. <u>**RosBREED's breeding germplasm used for validation of promising trait loci**</u> In his talk, Jim Luby (University of Minnesota) described how RosBREED uses comprehensive reference germplasm sets to validate and assess the utility of high-value jewels in the genome to transform fundamental discoveries into breeding decision support. His entertaining presentation used the analogy of a jewel mine for RosBREED's germplasm, the unrefined ore brought out as being QTL discoveries, and the miners themselves being RosBREED's Breeding Trainees – doing the work and getting dirty, all for a great cause of course!
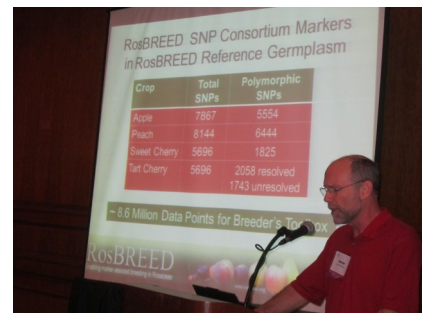
3. <u>**Loci important for apple fruit quality: What is known about their functional alleles?**</u> Cameron Peace (Washington State University) went on to explain the "jewels of the apple genome" that help provide the delicious taste, excellent texture, and attractive appearance to apple fruit. He presented our current understanding of the controlling loci for these traits and the practical application of this knowledge to date. Functional alleles at trait loci such as *Md-ACS1*, *Md-ACO1*, *Ma*, and *Rf* for taste, texture, appearance, and other components of apple fruit quality were described in a practical breeding context.
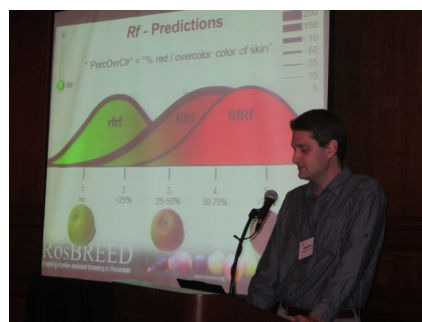
4. <u>**Loci important for peach and cherry fruit size and quality: What is known about their functional alleles?**</u> Ksenija Gasic (Clemson University) focused on "jewels of the genome" for fruit quality traits in the stone fruit crops of peach and cherry. Among the traits discussed in her talk were fruit texture (melting vs. non-melting flesh) and pit adherence to the flesh (clingstone vs. freestone) in peach and fruit size in sweet cherry. She described the genetic tests currently available to detect functional alleles for these traits that can be used to predict peach fruit texture types and cherry fruit size.

5. <u>**Data overload - Breeding decision-support software to the rescue!**</u>
   With DNA-informed breeding, crop improvement programs are becoming increasingly sophisticated, requiring breeders not only to keep track of pedigree records and phenotypic data but also genotypic data and its meaning. Sook Jung from Washington State University concluded the presentations of the workshop with a talk emphasizing the online [software-based Breeding Information Management System (BIMS)](#) that RosBREED has designed to organize and handle these overwhelming breeding data in a systematic manner to support breeding decisions. She specifically mentioned two modules of the system that could save thousands of dollars for breeders: *[Cross Assist](#)* and *Seedling Select*.

The presentation series ended with a discussion session on the future of Rosaceae crop breeding – where we are and where we are headed. Community input was gathered and followed up from the previous morning's open RosEXEC (U.S. Rosaceae Genomics, Genetics, and Breeding Executive Committee) meeting. In addition to this presentation series, RosBREED participants presented numerous other talks and posters at the ASHS conference.

"**RosBREED: Discoveries and breeding databases for the fruit research community**" was another successful RosBREED event that achieved its specific target of engaging the scientific community with RosBREED's progress and plans.

Breeder profile: Vance Whitaker
By Audrey M. Sebolt, Project Assistant

Vance Whitaker, University of Florida

Strawberries planted in late September and grown from plug plants with no chilling. Picture was taken on December 9, 2011.

Florida ranks second in the United States for strawberry production, and the number of acres planted each year continues to increase. The 2011 Florida strawberry crop year yielded 277,200,000 pounds of fresh berries which were valued at $366 million on 9,900 acres, an increase of 1,100 acres from 2010 (USDA/National Agricultural Statistics Service). Florida strawberry production is unique compared to many other production states in that its strawberries are grown as an annual crop on a raised bed system versus a perennial crop. Each year, 180,000,000 transplants are planted on about 10,000 acres. Transplants for Florida are grown primarily in Canada and the North Carolina mountains. These are dug and planted in late September and early October.

Weather conditions during the Florida strawberry growing season (November through March) can be rainy, and freezes occur on average about three times per season. Pests can include fungal diseases such as grey mold and powdery mildew, nematodes, and even birds. It's therefore no surprise that production costs for Florida strawberry growers can average $27,000 per acre (VanSickle et al. 2009) and strawberries are considered to be the most costly crop to produce in Florida. Faced with these numerous challenges, it is in growers' best interest to plant cultivars developed locally and/or specifically for their environment. Last season 75% of Florida acreage was planted with University of Florida (UF) cultivars, namely 'Festival' (45%) and 'Radiance' (30%). The number of UF cultivars planted will most likely increase with the release of the newest University of Florida cultivar, 'Winterstar™' (see image next page).

Vance Whitaker is the UF strawberry breeder, and he is challenged with developing cultivars that meet the needs of Florida growers and satisfy consumers' taste preferences. Vance was hired in 2009 to replace his predecessor, Craig Chandler. Vance considers himself fortunate to have had a one-year overlap with Craig. The overlap was a decision that the University implemented and demonstrates the support the strawberry breeding program enjoys from administration. Craig Chandler is currently an Emeritus professor and therefore is still involved part-time with the UF strawberry breeding program.

In addition to conducting elite crosses in a program of phenotypic recurrent selection, Vance has attempted to introgress wild germplasm and germplasm from different U.S. breeding programs into UF breeding germplasm. Vance conducts crosses to target an early ripening season so that the Florida harvest window does not compete with fruit harvested from California and the South Eastern U.S. (primarily North Carolina and Louisiana). Fruit ripening in the months of November and December allow for a greater return on investment for Florida strawberry growers. UF cultivars must have low chill requirements and must grow and flower well under short-day conditions in order to fruit early and continuously.

Target traits also include the ability to pollinate well in Florida's variable climate; resistance to anthracnose diseases; plants that produce a robust open canopy and long pedicels for ease of picking; and excellent fruit storage. Vance's predecessors had made a lot of progress with these traits, so Vance is putting renewed

Breeder profile cont.
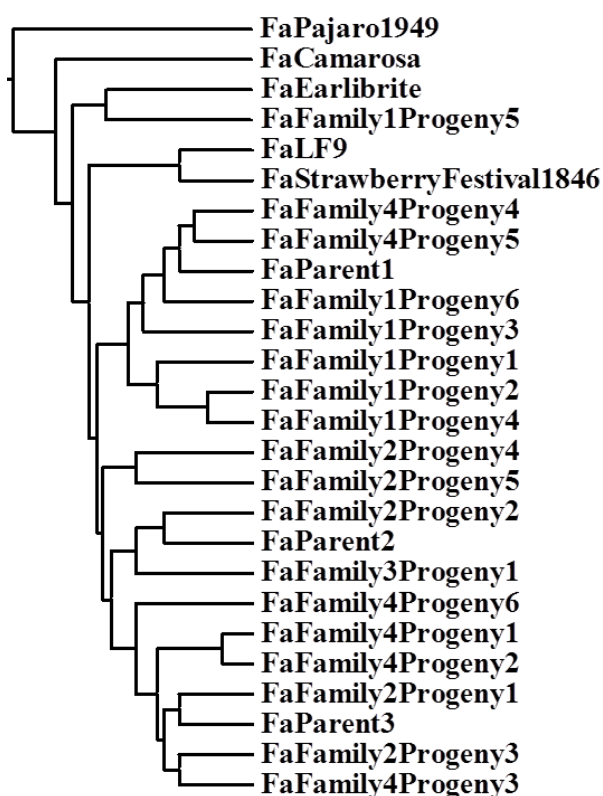

UF's newest cultivar, 'Winterstar™'

Figure shows a neighbor-joining tree of UF strawberry genotypes constructed using information obtained from DNA diagnostic markers (SSRs). This figure demonstrates that even closely related materials, such as individuals with both parents in common, may be differentiated with a single PCR reaction using the multiplexing protocol.

emphasis on improving flavor. Flavor, however, is a complex trait influenced primarily by sugars, acids, and hundreds of volatile compounds. In order to determine a target "recipe" of these chemical components, Vance has partnered with other faculty in the departments of Horticultural Science and Food Science at UF. Analytical chemistry and consumer taste panels are being combined to identify the most important volatile contributors to the perception of sweetness.

University of Florida selections that make it to the advanced stage can be grown in many winter and spring production regions around the world. UF cultivars are grown in 42 countries around the world, including unusual locations such as Bangladesh and Iraq. Some of the biggest growers of UF cultivars outside of the U.S. include Australia, Egypt, Mexico, Morocco, and Spain.

Currently, Vance uses DNA diagnostic markers to distinguish cultivars that have been or will be released from his program. Vance has been collaborating with Kevin Folta's lab (University of Florida) and their graduate student Alan Chambers to develop a protocol for multiplexing up to eight SSR markers in a single reaction (see figure on left). With valuable input from Nahla Bassil, this protocol has proved very reproducible and has already been useful in the breeding program for diversity analyses and for sorting out labeling mistakes.

Although Vance is not officially a RosBREED Demonstration Breeder, his contributions to RosBREED have been numerous and are very much appreciated. Over the last two years, Vance has generated phenotypic data for the RosBREED Crop Reference and Breeding Pedigree Sets, which includes more than 600 individuals. Vance has also conducted Grower Clicker Surveys with the California strawberry growers in Watsonville last December and again this month with the Florida strawberry growers. He was interested to see that flavor consistently ranked highly as a priority trait for growers in both regions, which was a nice validation of the renewed emphasis on flavor in the UF strawberry breeding program. Vance stated that he is very excited to utilize the marker platforms that are being developed by RosBREED for strawberry and looks forward to involvement in RosBREED efforts in the coming years.

U.S. Dept. of Agriculture/National Agricultural Statistics Service. 2012. *Vegetables 2011 Summary*. National Agricultural Statistics Service. U.S. Dept. of Agriculture/National Agricultural Statistics Service. http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1183

VanSickle JJ, Smith S, Weldon R. 2009. *Impacts of EPA Proposed Buffer-Zone Restrictions on Profitability of Florida Strawberry Grower*s. Food and Resource Economics Department document FE795. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
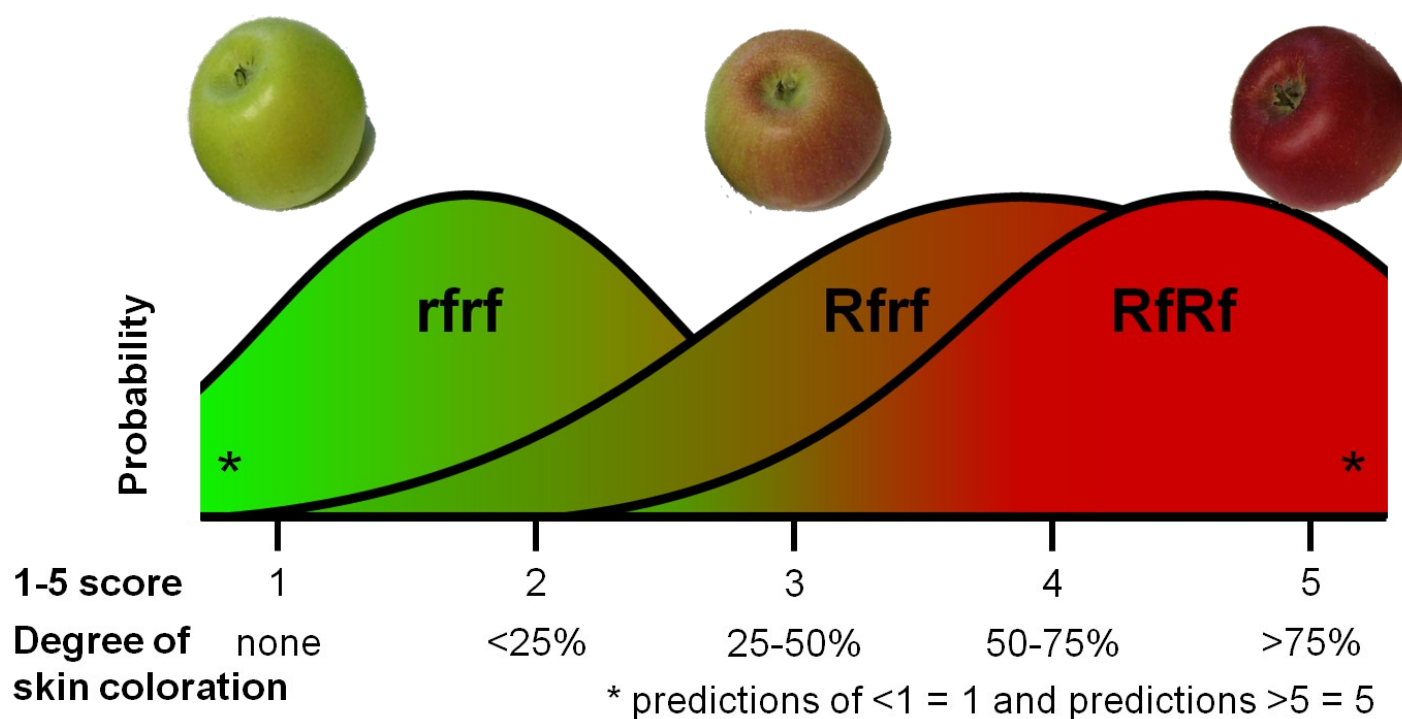
Community Breeders' Page

Predicting Performance in Fruit Crop Breeding
By Cameron Peace, MAB Pipeline Team Leader

During the MAB in Action workshop on 30 July 2012, frequency and probability distributions were often used to help elucidate concepts in merging DNA information with conventional breeding. Likewise, many statistical calculations within RosBREED's Breeding Information Management System rely on them. Wise use of these statistical instruments can support breeding decisions, from crossing to cultivar release and beyond, through formulating performance predictions for populations and individuals.

The *Rf* locus in apple is strongly associated with the degree of red coloration (blush and/or stripes) on the fruit skin. Observed phenotypic distributions for the basic three SNP-determined functional genotypes of RfRf, Rfrf, and rfrf lead to useful predictions.

1-5 score	1	2	3	4	5
Degree of skin coloration	none	<25%	25-50%	50-75%	>75%

* predictions of <1 = 1 and predictions >5 = 5

Let's say you are aiming for seedlings with blushes or stripes covering at least half the fruit surface so that you can then focus on selecting for other traits within such well-colored seedlings. Obviously RfRf × RfRf would be best, but…

Q1) What proportion of seedlings from an RfRf × RfRf cross would you expect to achieve your skin color target?
Q2) How much more efficient would such a cross be than RfRf × Rfrf, especially if you had plenty of Rfrf parents but few RfRf?
Q3) How would you even know the functional genotypes of your potential parents?

To find out the answers to these questions and the general utility of combining frequency/probability distributions, trait target thresholds, and DNA information, visit the full article at *www.rosbreed.org/breeding/community-breeders*

Jewels in the Genome
By Amy Iezzoni, Project Director

What is a "Jewel in the Genome?"
- *An individual's genome is the full complement of genetic information that it inherited from its parents. Within this vast repertoire of genetic information, individual genes are being discovered that control critical production and fruit quality traits. As these valuable rosaceous gene discoveries are made and put into breeding applications, we will describe them in this column as "Jewels in the Genome."*

Maturity date for peach cultivars is a critical factor considered by growers so that they can provide a continuum of ripe peaches for an extended production season. Having a range of maturity dates not only benefits growers by spreading out market risks and production costs, but it also benefits consumers seeking a continual summer supply of peaches. Peach breeders therefore target cultivar development for specific maturity dates to fill gaps held by less desirable cultivars.

Having genetic knowledge of which crosses will yield a higher percentage of seedlings predicted to be in the targeted maturity date classes would help breeders more efficiently reach their maturity date goals. Many genetic studies have reported genomic regions containing genes influencing maturity date in peach (Etienne et al. 2002; Verde et al. 2002; Eduardo et al. 2011; and Dirlewanger et al. 2012); however, there is one consistently detected region that has been confirmed with RosBREED data to be important in U.S. breeding germplasm. This trait locus is on peach chromosome 4 at ~44 cM (based on the *Prunus* T×E reference map) and a putative candidate gene has been identified at ~10.5 Mbp based on v.1 of the peach genome sequence (Dirlewanger et al. 2012). In individual crosses, this trait locus has been shown to be associated with up to 70% of the genetic variation for maturity date. Peach chromosome 4 also contains trait loci for fruit texture, fruit stone-flesh adhesion, and bloom time, making this one of the most important genomic regions for peach breeders to consider.
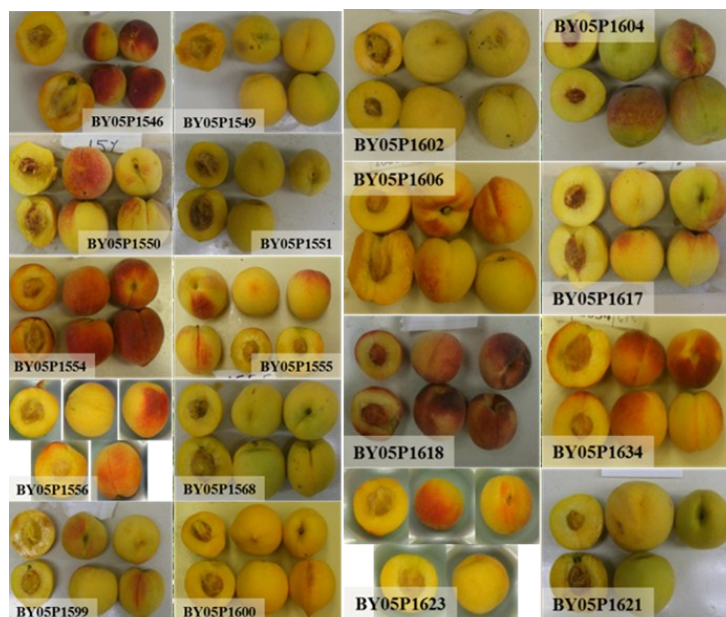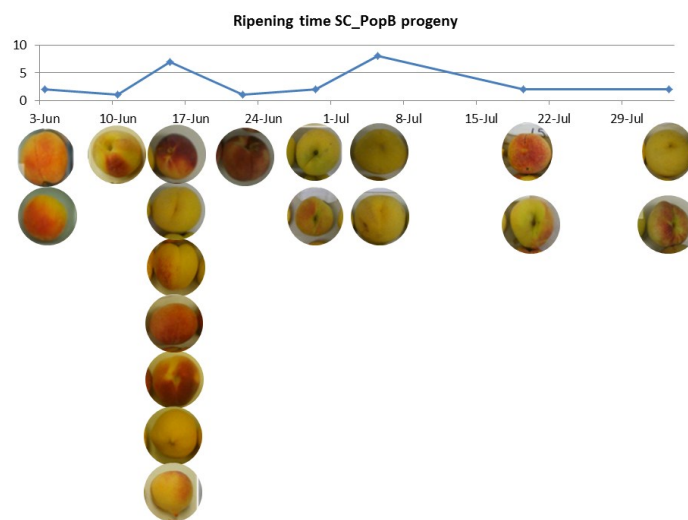
With genetic knowledge of what peach seedlings will ripen at specific maturity dates, breeders can plan crosses to maximize the probability of obtaining cultivars that target these maturity dates. Such an approach helps redirect resources to be spent on other critically important consumer-related traits such as the wonderful fruit flavors. Therefore, because knowledge of this genetic region will lead to the more efficient breeding of peach varieties, it is chosen as one of RosBREED's "Jewels in the Genome."

Top photo: range of ripening dates for a Clemson University population. Bottom photo: peach hybrids from the same parentage exhibit a wide range of ripening dates. Photos courtesy of Terrence Frett.

Dirlewanger E, Quero-Garcia J, Le Dantec L, Lambert P, Ruiz D, Dondini L, Illa E, Quilot-Turion B. 2012. Comparison of the genetic determinism of two key phenological traits, flowering and maturity dates in three *Prunus* species: peach, apricot and sweet cherry. Heredity doi:10.1038/hdy.2012.38.

Eduardo I, Pacheco I, Chietera G, Bassi D, Pozzi C, Vecchietti A, Rossini L. 2011. QTL analysis of fruit quality traits in two peach intra-specific populations and importance of maturity date pleiotropic effect. Tree Genet Genomes 7:323-335

Etienne C, Rothan C, Moing A, Plomion C, Bodenes C, Dumas LS, Cosson P, Pronier V, Monet R, Dirlewanger E. 2002. Candidate genes and QTL for sugar and organic acid content in peach (*Prunus persica* (L.) Batsch). Theor Appl Genet 105:145–159

Verde I, Quarta R, Cerdrola C, Dettori MT. 2002. QTL analysis of agronomic traits in a BC1 peach population. Acta Hort 592:291–297

RosBREED: Enabling marker-assisted breeding in Rosaceae

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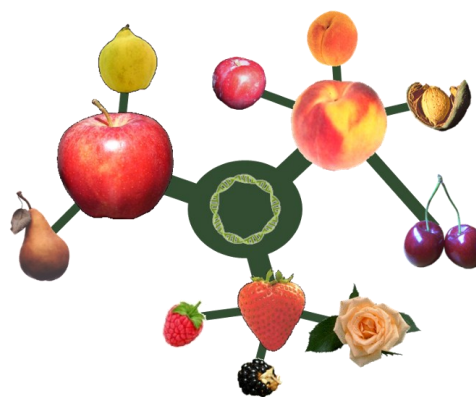E-mail address: iezzoni@msu.edu

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Jim McFerson	Industry	Washington Tree Fruit Research Commission
Dorrie Main	Genomics	Washington State University
Cameron Peace	Marker-assisted breeding pipeline	Washington State University
Eric van de Weg	Pedigree-based analysis	Plant Research International, The Netherlands
Cholani Weebadde	Extension	Michigan State University

Calendar of events

- **September 30 - October 4, 2012. Sixth Rosaceous Genomics Conference, San Michele all'Adige Trento province, Italy**

- **October 16-17, 2012. RosBREED Peach Breeder Workshop, Clemson, SC**

- **January 10, 2013. Annual RosBREED Advisory Panel Member Meeting, San Diego, CA**

- **January 11, 2013. RosBREED Apple Breeder Workshop, San Diego, CA**

- **January 30-31, 2013. RosBREED Strawberry Breeder Workshop, Corvallis, OR**