RosBREED

Combining Disease Resistance with Horticultural Quality in New Rosaceous Cultivars

VOLUME 5 | NO. 2

In This Issue

RosBREED 2 Kicks Off 2015 With Three Critical Meetings

Amy Iezzoni, Project Director, Michigan State University

RosBREED's foundation is the community of participants dedicated to increasing effectiveness and creativity in rosaceous crop improvement. Achieving this goal requires hard work and time to share ideas, learn from each other's wisdom and experience, and coordinate joint activities. RosBREED 2 began 2015 with an intense series of activities with three groups of participants: Advisory Panel (AP) members, international partners, and project participants.

Members of our Advisory Panel listen to Team Leaders describe project objectives.

First Annual Meeting with Advisory Panel Members, San Diego, California

8 January 2015

RosBREED 1 veterans met our new RosBREED 2 participants in San Diego, CA for the first annual meeting of Industry, Scientific, and Extension AP members. Thirty-six RosBREED personnel, including 24 AP members, spent the morning focused on project objectives and planned activities, outcomes, and impacts. Afternoon breakout sessions were devoted to small group discussions of stakeholder opportunities, needs, and limitations – an approach that has always provided invaluable guidance to adjust project activities. The experience has also proven to bring our AP members together and reinforce RosBREED's community-oriented framework.

Members of the RosBREED Extension, Industry, and Scientific Advisory Panels and some Team Leaders gathered for the Annual Advisory Panel Meeting, January 8, 2015.

Members of the apple group (top), berry and rose group (middle), and Prunus group (bottom) at the International Partner Meeting.

First Annual Meeting with International Partners, San Diego, California

9 January, 2015

At the first annual International Partner Meeting, Nahla Bassil, RosBREED 2's DNA Testing Team Leader, 20 RosBREED participants, and 19 international partners from 10 institutions in 8 countries focused on coordination of genotyping needs, including collaborating on the next generation of rosaceous crop high-resolution genotyping platforms. The outcome was a mutually developed series of strategies to enhance the current SNP genome scan capabilities and to develop low-density, highly targeted SNP genotyping capabilities for breeding use.

First Annual Participant Meeting, East Lansing, Michigan

9-11 February 2015

Technical strategizing dominated RosBREED 2's first annual meeting of 42 project scientists at the James B. Henry Center in East Lansing, MI. On day one, Project Director Amy Iezzoni and the RosBREED Team Leaders gave their own more specific updates on team goals before gathering with their teams to coordinate required activities. A "Meet and Greet" session showcased RosBREED breeders and exhibited fruit quality attributes that RosBREED is targeting. Invited attendees included Kali Fox, representing Senator Debbie Stabenow (D-MI), local RosBREED 2 Advisory Panel members, MSU Agriculture & Natural Resources College administration, and Michigan grower and fruit industry leaders. Participants left with much momentum to undertake critical field, lab, analytical, and conceptual work for the rest of 2015.

New Publications

Bassil N, Davis T, Zhang H, Ficklin S, Mittmann M, Webster T, Mahoney L, Wood D, Alperin E, Rosyara U, Putten H, Monfort A, Sargent D, Amaya I, Denoyes B, Bianco L, van Dijk T, Pirani A, Iezzoni A, Main D, Peace C, Yang Y, Whitaker V, Verma S, Bellon L, Brew F, Herrera R, van de Weg E. 2015. *Development and preliminary evaluation of a 90 K Axiom® SNP array for the allo-octoploid cultivated strawberry Fragaria × ananassa.* *BMC Genomics 16:155.* doi:10.1186/s12864-015-1310-1.
Note: The citation for this article should show the shared lead authorship (i.e., Bassil and Davis et al., 2015).

Ru S, Main D, Evans K, Peace C. 2015. *Current applications, challenges, and perspectives of marker-assisted seedling selection in Rosaceae tree fruit breeding.* Tree Genetics & Genomes 11:8. doi:10.1007/s11295-015-0834-5.

Harshman J, Evans K. 2015. *Survey of moldy core incidence in germplasm from the three U.S. apple breeding programs.* J. of Amer. Pomol. Soc. 69(1): 51-57.

RosBREED project participants gathered to plan activities for the year in East Lansing, MI. For most participants, the chilly February weather didn't bother them!

RosBREED By the Numbers

9+
Crops covered in this project

6,250
Individual plants to be disease-screened in 2015

95,062
Number of markers on the strawberry SNP array

11
Trainees at the 1st participant meeting

16
Diseases targeted in RosBREED

Featured Team Member: Stan Hokanson

Audrey Sebolt, Project Manager, MSU

Rose is a member of the Rosaceae family and because of its shared ancestry with RosBREED 1's crops, we have the ability to leverage information across crops. The RosBREED 2 team is excited to now include rose. The two RosBREED rose breeders are David Byrne of Texas A&M, who will continue to be involved with the peach breeding team, and a new team member, Stan Hokanson of the University of Minnesota.

Prior to his current position, Stan was a small fruit research geneticist and breeder at the USDA-ARS fruit lab in Beltsville, MD, where he primarily worked on strawberry. Because Stan desired to mentor and teach graduate and undergraduate students, he sought and was accepted for the woody landscape position at the University of Minnesota in 2001.

In addition to rose breeding, Stan breeds several other woody landscape plants, including the 'Lights' series of deciduous azaleas. Stan inherited a rose breeding program developed over the course of 10 years by his former project scientist, Kathy Zuzek. The project was based largely on the use of cold hardy cultivars that had been developed in the upper midwestern U.S. and Canada.

Dr. Stan Hokanson, with one of his prized rose varieties.

Recently, the program's primary objective has shifted from cultivar development to the development of black spot-resistant donor parents. Black spot (Fig. 1) is the most serious disease worldwide of outdoor-grown roses due to the potential for rapid leaf yellowing, defoliation, and subsequent disfigurement of the plant. Leaves become infected if wet over prolonged periods of time and the fungus is difficult to control because it can survive winters and re-infect plants the following growing season if not controlled.

Figure 1. Rose bush infected with the rose black spot fungus (Diplocarpon rosae Wolf). Eventually leaves will yellow and defoliate.

The University of Minnesota's breeding program will be utilizing multiple black spot resistant cultivars as donor parents for resistance to three races (3, 8, and 11). Cultivars that have already or will be used in this effort include: 'BAIine' (Yellow Submarine™), 'George Vancouver', 'Folksinger', 'Ramblin Red', and 'Love and Peace'. Other cultivars will be screened for potential use. Unfortunately, the original source of the resistance carried by these modern cultivars is unknown. While there are more than 120 species of roses, only seven to eight species have been extensively used in breeding programs, primarily because many of the species have low fertility, difficulties with seed set, overabundance of thorns and vigorous shoots, often with small flower size, and mostly flower once per season. Furthermore, there is little to no pedigree information about most cultivars developed and released.

So, how will Stan be working with the RosBREED project?

Why did you choose to be involved with RosBREED?

The primary objective of my program is to develop and enhance current germplasm for black spot resistance. From RosBREED 1's successes, I saw how RosBREED connected with their constituent industries and were able to "get

in front" of industry needs. I would like to expose the rose industry to how a Land Grant institution could allow for their breeding program to become more efficient by routinely DNA- testing parents, advanced selections, and seedlings.

What successes do you hope to see from RosBREED?

With RosBREED's help, we hope to 1) develop robust DNA tests for the two identified black spot resistance loci (Rdr1 and Rdr3). Methodologies for performing these DNA tests could then be shared with the private sector and we would include contact information for vetted DNA-testing providers; 2) identify at least one more additional resistance source to black spot for Race 11 and develop a DNA test for this new locus; 3) streamline the steps to identify resistance loci so that in the future these efforts will be realized at a faster pace (the Rdr3 resistance locus took more than three years for our lab to identify!); and 4) establish a network and systematic means for getting new DNA tests to the private sector more efficiently.

How have you already benefited from RosBREED?

We have had more regular interactions with colleagues working in the genomics and bioinformatics realm and that has opened our thinking to new possibilities and pathways to progress.

What is one thing your colleagues don't know about you?

I have been growing plants since I was a young boy. I planted my first rose and strawberry plants while I was still in elementary school. I grew up in southwest Michigan and some plants I put in the landscape of our family home are still there.

Stan is the Rose Breeding Team Leader for RosBREED 2 and he and his team are coordinating efforts with multiple other teams to develop DNA tests for black spot resistance. To achieve this aim, cultivars, advanced selections, and seedlings will be genotyped using the Affymetrix SNP array. The resulting data will be integrated with phenotypic data to identify and confirm the presence of resistance loci, characterize the effects of alleles and their distributions in breeding germplasm, and develop DNA tests.

Don't forget!

We are on Facebook and Twitter!

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RosBREED on Facebook OR @rosbreed

Featured Team: Pathology

This RosBREED 2 project adds more traits, additional crops, expanded germplasm, new science, and an entire new team: Pathology. The Pathology Team will lead the project's focus on incorporating disease resistance into new cultivars. This team will work with breeders to develop standardized phenotyping protocols, review current sources of resistance, identify new resistance sources, and advise on combining these resistances with product quality. The Pathology Team is therefore key to the project goal of developing superior cultivars that have excellent horticultural quality combined with disease resistance.

We are excited to have the following pathologists as members of this new Pathology Team:

- Jay Norelli, USDA-ARS, Kearneysville, WV (Team Leader)
- Kelly Ivors, Cal Poly San Luis Obispo, CA
- Guido Schnabel, Clemson University, Clemson, SC

Jay Norelli, USDA-ARS

Kelly Ivors, Cal Poly San Luis Obispo

Guido Schnabel, Clemson University

Rosaceae Nemesis:

Strawberry Root and Crown Rot Diseases

Kelly Ivors, Pathology Team member, Cal Poly-SLO, and Lisa DeVetter, Extension Team member, Washington State University

Strawberry is plagued by several pathogens that cause root and crown rot (abbreviated RCR), which can lead to reductions in plant vigor as well as yield loss and even plant death. The responsible organisms vary regionally in the United States and depend on climate, soils, and presence of pathogen inoculum. In California, *Verticillium dahliae*, *Fusarium oxysporum* f. sp. *fragariae* and M*acrophomina phaseolina* are the primary organisms contributing to RCR. In contrast, the primary causal organisms of RCR in Florida include *Phytophthora cactorum*, *Colletotrichum* spp., and *Macrophomina phaseolina*. Regardless of the specific microorganism, the symptoms are similar and the impact of root and crown rot can be equally devastating. California and Florida are the leading national producers of strawberry and struggle with management of RCR, mainly due to the recent loss of methyl bromide and additional restrictions on the use of other soil fumigants. Improved disease resistance through targeted breeding approaches will be a significant contribution to integrated disease management strategies less reliant on fumigants.

The symptoms of RCR on strawberry are similar for all of these pathogens. Growers may first notice discoloration of foliage, stunting, production of small leaves, and reduced vigor. Symptoms become more apparent as the growing season progresses, especially when plants start producing fruit. At this stage, plants may wilt rapidly, collapse and then die (Fig. 1). Examination of the crown and roots often reveals discoloration, internal browning (Fig. 2), and poor root growth. Fruit rot may also occur in some cases. Although knowledge of the field history and cultivar susceptibility can be helpful, accurate diagnosis of the causal organism(s) is best done through laboratory isolation, culture, and microscopic examination. Identification of the pathogen(s) is required for mitigating further disease damage, as different RCR pathogens respond differently to chemical and cultural control.

Figure 1. Collapse and decline of strawberry due to root and crown rot.

While all root and crown rots are potentially devastating, RosBREED 2 will be focusing particularly on *Phytophthora* root and crown rot. This disease is particularly problematic in Florida, where rainfall, saturated soils, and warm temperatures favor the development of *Phytophthora*. Symptoms of this disease are usually most readily observed in low, poorly drained areas of a field and extend to other areas as the season progresses. The disease cycle begins when overwintering spores (oospores) of the pathogen, *Phytophthora cactorum*, germinate to form structures that subsequently produce motile spores (zoospores) capable of swimming through wet areas towards host tissue. Once infection of host tissue occurs, the pathogen can reproduce and infect neighboring plants.

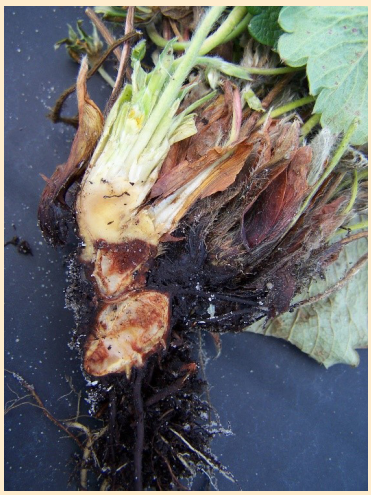


Figure 2. Internal browning due to root and crown rot.
Photo: J. Mangandi and V. Whitaker, UF.

Several features of *P. cactorum* make it particularly challenging to control, including production of mobile zoospores capable of spreading in water in the soil and the ability to produce overwintering oospores that are long-lived and persist in the soil for many years, rendering short crop rotation relatively ineffective. Furthermore, suitable land for growing strawberry is limited and crop rotation is not economically viable for strawberry growers.

Current management techniques are not very effective at limiting losses caused by *P. cactorum*. Soil fumigation and fungicide applications are also facing increasing scrutiny and regulatory pressure. New cultivars that combine disease resistance with high fruit quality would be a powerful tool in integrated disease management programs. Breeders and pathologists are making progress in this endeavor and RosBREED 2 will help foster continued work as we collectively combat these important Rosaceae nemeses.

CAL POLY
SAN LUIS OBISPO

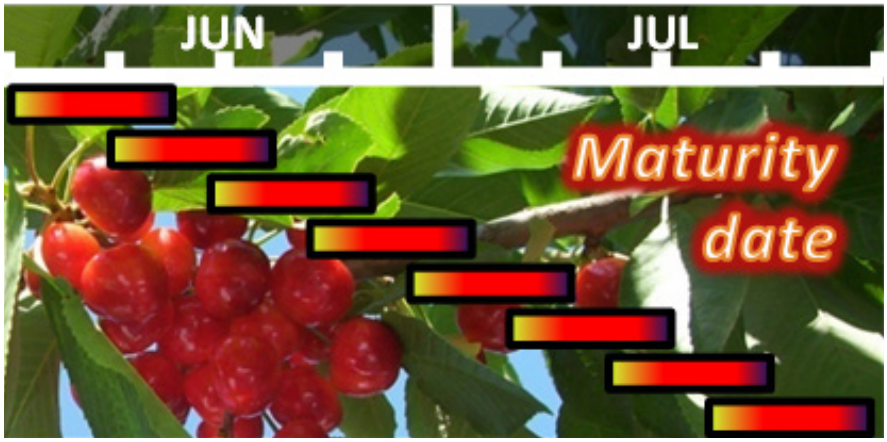
WASHINGTON STATE UNIVERSITY

Jewels in the Genome

Cherry Maturity Date

Amy Iezzoni, Project Director, Michigan State University

Maturity date differences among fresh market sweet cherry cultivars allow growers to choose cultivars that will allow them to capitalize on high prices at the start or end of the fresh market season. Having a range of maturity dates also benefits consumers seeking a continuous summer supply of sweet cherries. Sweet cherry breeders target specific maturity dates to fill gaps where only less desirable cultivars are available.



Range of maturity dates targeted by the Pacific Northwest sweet cherry breeding program, WSU-Prosser, Washington

Having genetic knowledge of what crosses will yield a higher proportion of seedlings predicted to be in target maturity date classes would help breeders more efficiently reach their maturity date goals. In peach, an important locus was identified on peach chromosome 4 (Dirlewanger et al., 2012; *http://bit.ly/1xnSvqp*). In sweet cherry, a maturity date locus was also identified in the same genomic position. This locus is heterozygous in 'Lapins' and was identified based on segregation in the cross 'Regina' × 'Lapins', where it explained ~20% of the phenotypic variation. Alleles for this locus uncovered in other sweet cherry cultivars also contribute to maturity date variation, such as the very early ripening of 'Cristobalina' and 'Early Burlat', and the late ripening of 'Sweetheart' (P. Sandefur and C. Peace, pers. comm.).

With genetic knowledge of which cherry seedlings will ripen at specific maturity times, breeders can plan crosses to maximize the probability of obtaining candidate cultivars that mature at the desired time of the season. Such an approach helps redirect resources to other critically important consumer-related traits. Therefore, because knowledge of this genetic region will lead to the more efficient breeding of sweet cherry cultivars, it is chosen as one of RosBREED's "Jewels in the Genome."

References

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 109: 280-292.

Cultivar Corner

Desmond Layne, Extension Team Member, Washington State University

This quarter's Cultivar Corner features two newly released apple cultivars that have valuable attributes on which RosBREED is focused. Both of the breeders, Dr. Susan Brown from Cornell University and Dr. Kate Evans from Washington State University, are Apple Breeding Team members of RosBREED.

RUBYFROST™ APPLE (RELEASED AS 'NY 2')

Inventors: Susan K. Brown and Kevin E. Maloney, Cornell University

What is the pedigree of 'NY 2'?

The new cultivar was derived from crossing 'Braeburn' with 'Autumn Crisp' in 1992. 'Autumn Crisp' is 'Golden Delicious' x 'Monroe' ('Monroe' is 'Jonathan' x 'Rome Beauty').

What makes 'NY 2' special?

This new cultivar is very grower friendly, with a vigorous tree, long harvest window, and great red fruit coloration. Consumers appreciate its crisp, juicy snap and its balance of sweetness and tartness. 'NY 2' has good resistance to flesh browning after cutting, suggesting it will be good for fresh-cut slices. 'NY 2' is a good dual-use variety, great for eating out of hand, but also great for pies, sauce, and fresh fruit salads.

How long did it take to develop this cultivar?

The cross was made in 1992, so it was about 18 years from crossing to commercialization.

What is the size of the family from which 'NY 2' was chosen?

'NY 2' was selected from a population of 1017 seedlings, a relatively large cross.

Are there other siblings that have commercial potential?

Yes, several sister seedlings are still being evaluated for potential commercialization.

Will this variety be used in RosBREED and how?

'NY 2' was phenotyped and genotyped, along with some of its sister seedlings, ancestors and one offspring.

Other interesting notes…

'NY 2' was from a cross that was made to study the genetics of flesh browning after cutting and also vitamin C content. The pollen parent, 'AutumnCrisp' from Cornell, is known to be low in flesh browning and to have a good amount of vitamin C. Many offspring from this cross were as good as or better than their parents for resistance to flesh browning and many were intermediate for vitamin C content (which is higher than many commercial cultivars).

COSMIC CRISP™ APPLE (RELEASED AS 'WA 38')

Inventors: Kate Evans and Bruce Barritt, Washington State University

What is the pedigree of 'WA 38 '?

'Enterprise' x 'Honeycrisp'

What are the unique features of 'WA 38'?

'WA 38' is a firm, sweet, tangy, crisp, and very juicy apple, with dark red skin. The name comes from the lenticels on the skin that look like tiny starbursts.

How long did it take to develop this cultivar?

The original cross was made in 1997, and it took 16 years (2013) to release.

How much did 'WA 38' stand out among its fellow selections?

Considerably – originally we thought it might be too tart and too dark in color but it has always looked different from the others.

Did 'WA 38' inherit the scab resistance allele of 'Enterprise', originally derived from Malus floribunda and introgressed into U.S. apple breeding germplasm by the PRI program in previous decades?

No. There was a 50/50 chance it would inherit the resistance allele, and it did not.

How well does 'WA 38' stand out compared to standard cultivars grown in the same evaluation trials?

It continues to far outperform the standard cultivars in every site where 'WA 38' is evaluated.

Community Breeders' Page

Cameron Peace, DNA-Informed Team Leader

Parentage & Pedigree – a Technology Interfacing article

Parentages and pedigrees of breeding germplasm are essential knowledge for effective crop genetic improvement. They are within the larger field of genetic relationships. Using DNA-based diagnostics to confirm or reveal such genetic relationships is the simplest way that breeders can become DNA-informed.

Genetic relationship questions readily addressed with DNA-based diagnostics are:

1. Parents: What is the pedigree (and ancestry) of each member of your parent pool – where did their valuable alleles come from?

2. Crossing: How effective is the crossing method of your breeding program – is it providing the parental combinations you intended?

3. Selections: What truly are the parents of your advanced selections and your upcoming commercial releases – where did their elite performance come from and what can you tell the world?

RosBREED analyses reveal that for U.S. apple breeding germplasm, about 15% of historical pedigree records of cultivars are incorrect, about 15% of seedlings in breeding programs are typically not derived from the intended father, and about 15% of breeder pedigree records of elite selections are incorrect. In many cases, we have been able to ascertain true pedigree connections, and many previously unknown connections are now revealed. Apple breeders can make well-informed decisions with this knowledge.

Ancestry: Know Thy Background
Pedigree: Know Thy Family
Parentage: Know Thy Parents
Identity: Know Thy Self

To read more on parentage and pedigrees, go to:
http://www.rosbreed.org/breeding/community-breeders

Know Thy Parentage...Uncovering Mysteries to Improve Breeding Efficiencies

'Bing' is one of the leading sweet cherry cultivars grown today because of its superior fruit quality. However, until recently, its paternal parent was not known and breeders, when using 'Bing' as a parent, were reaching for a new hue blindly, or in other words, not fully comprehending where its valuable alleles were derived from.

In 2014, the parental parent was identified as 'Napoleon' and with this new information, breeding programs are able to more effectively and efficiently plan future crosses.

'Black Republican'
Dark Red Flesh & Skin Color

'Napoleon'
Light Yellow Flesh & Skin Color

'Bing'
Red Flesh & Skin Color

Rosyara, U., Sebolt, A., Peace, C., and Iezzoni. A. 2014. *Identification of the Paternal Parent of 'Bing' Sweet Cherry and Confirmation of Descendants Using Single Nucleotide Polymorphism Markers.* J. Amer. Soc. Hort. Sci. 139(2):148–156. 2014.

Photos: D. Karp (left) J. Olmstead (middle, right), M. Olmstead (background)

RosBREED Personnel Updates

*Ph*inally *D*one!

Congratulations to Lise Mahoney, former graduate student and RosBREED research associate, who has completed her Ph.D. in Plant Biology at the University of New Hampshire (UNH) and has now transitioned to a postdoctoral research position as strawberry breeder at UNH! Lise will continue to closely work with RosBREED.

Lise Mahoney with her advisor, Dr. Tom Davis, UNH

Student Oral Competition Award

At the Southern Region American Society of Horticultural Sciences (SR-ASHS), held Jan 31-Feb 3 in Atlanta, GA, PhD student and RosBREED breeding trainee Alejandra Salgado Rojas (advisor John Clark) entered the Warren S. Barham PhD Student Oral Competition and placed first! Her presentation was "Integrating Phenotypic and Genotypic Data for Flesh Texture and Marker-Assisted Breeding in Peach". Congratulations to Alejandra on a job well done!

Alejandra Salgado Rojas was presented with the Warren S. Barham PhD Student Oral Competition award by Wayne A. Mackay (President of Southern Region ASHS).

Community Events

XIV Eucarpia Fruit Breeding and Genetics Symposium

Bologna, Italy, *14-18 June 2015*

For more information on registration: *http://tinyurl.com/lv24jg9*
Conference Website: *http://www.eucarpiafruit2015.org/*

11th International Rubus and Ribes Symposium

Asheville, NC, *21-24 June 2015*

For more information, contact: Gina Fernandez, at *Gina_Fernandez@ncsu.edu* (Phone: 919-513-7416) or Marietta Wheaton Ellis, Symposium Secretariat at *rubusribes2015@newbeginningsmanagement.com*.

National Association of Plant Breeders

Pullman, WA, *27-30 July 2015*

Conference website: *http://bit.ly/1xnL0Qp*

ASHS Symposium

From Wild Germplasm to Molecular Tools for Applied Breeding: Black Raspberry as a Case Study

New Orleans, LA, *3 August 2015, 9 am - 4:30 pm*

Contact: Jill Bushakra (*Jill.Bushakra@ars.usda.gov*) or Nahla Bassil (*Nahla.Bassil@ars.usda.gov*) with any questions.

ASHS Annual Meeting

New Orleans, LA

4-7 August 2015

For more information: *http://bit.ly/1IsVXnx*

New Resources

"Impacts of the Minnesota Breeding Program", University of Minnesota Agricultural Experiment Station, featuring Dr. Jim Luby and Mr. David Bedford.

Link: *http://bit.ly/1D7ljo4*

Coming up in the next issue:

- Meet new members of the Advisory Panel
- Introduction of a new column, "Industry Perspectives"
- Meet project members: Extension Team
- What will be the next Rosaceae Nemesis? Read next quarter's Newsletter to find out!

RosBREED Newsletter Staff:

Editor-in-chief: Mercy Olmstead, RosBREED Extension Team Leader

Design: UF-IFAS, Gainesville, FL

Contributing editors: David Karp, David Eddy, and Cameron Peace

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