RosBREED: Combining Disease Resistance with Horticultural Quality in New Rosaceous Cultivars

Amy Iezzoni
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“RosBREED 2”
Specialty Crop Research Initiative

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- $10M, 5 years, SEP 2014 – AUG 2019

RosBREED

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Breeding Programs

DNA Information

Genomics Resources

Genomics Research

More effective development of new cultivars

Bridging the Chasm

RosBREED 1

“Enabling marker-assisted breeding in Rosaceae”
**Crops Targeted in RosBREED 1**

**DNA Information Use in U.S. Breeding is Now Conventional**

- Multiple DNA tests

- cheap, simple DNA extraction – Silica Bead Method
  (Edge-Garza et al. 2014)

- DNA test results in 8x12 format

- easy culling

- Honeysuckle's two alleles

- Known effects on other traits

**Need Addressed**

Rosaceous cultivars must consistently exceed consumer expectations with satisfying appearance, aroma, flavor, market life, and texture **AND** also meet industry needs for durable disease resistances and productivity.

These cultivars have remained elusive despite breeders’ best efforts.

**RosBREED 2**

“Combining disease resistance with horticultural quality in new rosaceous cultivars”

**RosBREED 2**

**Vision**

*Provide a coordinated national effort to enable U.S. rosaceous crop breeders to routinely apply genomic tools to effectively deliver cultivars with producer-required disease resistances and market-essential horticultural quality*
### Disease Threats Targeted

<table>
<thead>
<tr>
<th>Crop</th>
<th>Disease</th>
<th>Causal agent</th>
<th>Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Scab</td>
<td>Venturia inaequalis</td>
<td>defoliation, reduced fruit quality</td>
</tr>
<tr>
<td>Apple</td>
<td>Blue mild</td>
<td>Penicillium expansum</td>
<td>postharvest fruit decay</td>
</tr>
<tr>
<td>Apple</td>
<td>Fire blight</td>
<td>Erwinia amylovora</td>
<td>tree death</td>
</tr>
<tr>
<td>Peach</td>
<td>Bacterial spot</td>
<td>Xanthomonas arboricola</td>
<td>defoliation, reduced yield &amp; fruit quality</td>
</tr>
<tr>
<td>Peach</td>
<td>Brown rot</td>
<td>Monilia spp.</td>
<td>blossom blight, pre- and postharvest fruit decay</td>
</tr>
<tr>
<td>Pear</td>
<td>Fire blight</td>
<td>Erwinia amylovora</td>
<td>tree death</td>
</tr>
<tr>
<td>Prunus rootstock</td>
<td>Alternaria rot rot</td>
<td>Alternaria spp.</td>
<td>tree decline &amp; death</td>
</tr>
<tr>
<td>Rose</td>
<td>Black spot</td>
<td>Ophiostoma nasutum</td>
<td>defoliation, plant decline &amp; death</td>
</tr>
<tr>
<td>Strawberry</td>
<td>Bacterial angular leaf spot</td>
<td>Xanthomonas fragaria</td>
<td>reduced yield &amp; quality</td>
</tr>
<tr>
<td>Strawberry</td>
<td>Root &amp; crown rots</td>
<td>various</td>
<td>plant decline, death &amp; reduced yield</td>
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<tr>
<td>Sweet cherry</td>
<td>Powdery mildew</td>
<td>Podosphaera clavata</td>
<td>reduced tree vigor &amp; fruit quality</td>
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<tr>
<td>Tart cherry</td>
<td>Leaf spot</td>
<td>Blumeriella jaapii</td>
<td>defoliation, reduced hardness &amp; fruit quality</td>
</tr>
</tbody>
</table>

### Germplasm Levels Addressed

- **“Pre-breeding” generations** → End-point = elite parents
- Cultivar-generating families → End-point = selections for field trials
- Selections in field trials → End-point = released cultivars

### RosBREED 2 Objectives

- **Incorporate Durable Disease Resistance in Breeding Parents**
- **Advance Selections with Improved Confidence**
- **Increase Routine Use of DNA Information**
- **Combine Disease Resistance and Horticultural Quality**

### RosBREED 2 Support “Services”

- **Breeder & Industry Partnership**
- **On Our Horizon**

- Additional DNA tests for major-effect alleles
- Genomic data
- “Haploblocking”
- “Genome-wide selection”

- Integrate G x E x M
- All large- & small-effect alleles

**RosBREED**

- Centering disease resistance with horticulturally superior cultivars
A. Additional DNA Tests for Major Effect Alleles

- QTL discovery
  - RosMAP
  - Pedigree-Based analysis
- DNA test development
- MAPS & MASS in breeding program

"Design Approach"

Myb10 in peach and apple (S. Jung)

B. Genome-Wide Breeding Utility – “Haploblocking”

Amy Lawton-Rauh & Steve Kresovich

C. All Large & Small-Effect Alleles – “Genome-Wide Selection”

“Predictive approach”

Genome-wide DNA Markers are used to predict the best individuals that exist in the population

Rex Bernardo

D. Integrate G x E x M into Trait Performance Predictions

- DNA marker and performance data for individuals in un-replicated trials at multiple locations is used to estimate genetic and non-genetic effects
- Trait performance predictions will be adjusted with predictions of non-genetic effects for the target environment

Genomic Relationship Matrix

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
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<td>0.56</td>
<td>0.26</td>
<td>0.06</td>
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<tr>
<td>B</td>
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<td>1</td>
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<td>0.03</td>
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<tr>
<td>C</td>
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<td>0.30</td>
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</table>

Craig Hardner

Mission

Combining superior horticultural quality, durable disease resistance, and productivity into new cultivars will be achieved through the coordinated application and implementation of new scientific advances

What will success look like?

- Consumers are satisfied, repeat customers
- Rosaceous crop industries are more profitable and sustainable
- Plant breeding programs are more efficient, effective, creative, and rapid

Craig Hardner
Acknowledgements

Bear Mountain Orchards