Developing the Genomic Infrastructure for Black Raspberry Breeding Improvement: An UPDATE!

Jill M. Bushakra and Nahla V. Bassil
National Clonal Germplasm Repository, Corvallis, OR
Chad E. Finn
Horticultural Crop Research Unit, Corvallis, OR

An SCRI Collaborative Project taking place in Oregon, North Carolina, New York, and Ohio
Authors & Collaborators

- Chad E. Finn
  - Research Geneticist & Plant Breeder, USDA-ARS
- Nahla V. Bassil
  - Research Geneticist, USDA-ARS
- Jungmin Lee
  - Research Food Technologist, USDA-ARS
- Jill M. Bushakra
  - Post-doctoral Research Assoc., USDA-ARS
- Michael Dossett
  - Plant Breeder, B.C. Blueberry, Canada
- Gina Fernandez
  - Small Fruit Breeder, NC State U.
- Christine Bradish
  - Doctoral Student, NC State U.
- Penelope Perkins-Veazie
  - Postharvest Physiologist, Plants for Human Health Institute, NC State U.
- Courtney Weber
  - Small Fruit Breeder, Cornell U.
- Jerry Weiland
  - Plant Pathologist, USDA-ARS
- Todd Mockler
  - Geneticist, Donald Danforth Ctr., St. Louis, MO
- Doug Bryant
  - Bioinformaticist, Donald Danforth Ctr. St. Louis, MO
- Sergei Filichkin
  - Plant genomics, Oregon State U.
- Kelly Vining
  - Bioinformaticist, Oregon State U.
- Robert Agunga
  - Human & Community Resource Dev., Ohio State U.
- Emily Buck
  - Human & Community Resource Dev., Ohio State U.
- Joseph Scheerens
  - Food Chemistry & Quality, Ohio State U.
- Kim Lewers
  - Research Geneticist, USDA-ARS
- Julie Graham
  - Molecular Geneticist & Plant Breeder, James Hutton Institute, UK
- Felicidad Fernández Fernández
  - Molecular Geneticist & Plant Breeder, East Malling Research, UK
- Song Joong Yun
  - Molecular Geneticist, Chonbuk National U., South Korea
Participants

• Growers
  • Sandy Farms (OR)
  • Oregon Berry Packing, Inc.
  • Riverbend Farm (OR)
  • Townsend Farms (OR)
  • Wyckoff Farms (WA)
  • Orchard Dale Farm (NY)
  • SunnyRidge Owl’s Den Farm (NC)
Research Focus Areas

1. Plant Breeding
2. Molecular Biology
3. Genomics
4. Analytical Chemistry
5. Product Evaluation
6. Communication & Marketing
Main Goals

1. Identify aphid resistance
2. Develop tools for breeders to combine (pyramid) sources of resistance
3. Identify what consumers want from black raspberries
4. Communicate research
Background & Introduction

• Industry decline
  • Lack of adapted and disease resistant cultivars
  • Lack of variability in elite germplasm
• ‘Munger’ most common planting
  • Since 1975, only 4 cultivars have been developed
• Wild germplasm being explored for genetic diversity
Current production areas involved in this research project

Eastern US explored for wild germplasm

Shading indicates native range of black raspberry (*Rubus occidentalis*) (PLANTS database)
Background & Introduction

• Resurgence of interest in this fruit and a renewal of breeding efforts
  • High anthocyanin content
  • Potential cancer fighting compounds
Research Objectives: Plant Breeding

• Identify genetic diversity in wild plants
• Breed aphid/disease tolerant cultivars
• Develop cultivars for fresh market and processing
Research Objectives: Plant Breeding

• Aphid-resistance identified in wild-collected individuals
  • Crossed with ‘Jewel’
  • Two progeny grown, replicated, and planted in fields (April-June 2012)
• Photo: USDA June 2014
Sources of aphid resistance

- ORUS 4305
  - ORUS 3021-2
    - NC 84-10-3
  - ORUS 4153-1
    - ON Res.
    - ORUS 3778-1
      - wild, Ontario, Canada
- ORUS 4304
  - ORUS 4158-2 ME Res.
  - ORUS 3021-2
    - NC 84-10-3
- ORUS 3817-2
  - wild, Gardiner, ME
  - Jewel
- ORUS 4811
  - Munger
  - ORUS 4310-1 MI Res.
  - ORUS 4109-1 wild, Michigan
Progress: Plant Breeding

- Plants performing well in most sites (11 total)
- Starting to see some disease pressure – mainly verticillium
- New crosses for 3\textsuperscript{rd} potential source of aphid resistance
  - Screened in greenhouse
Research Objectives: Molecular Biology/Genomics

Develop molecular breeding tools

- Sequence the DNA of black raspberry (genome)
- Create a diagram of the genome (linkage map)
- Identify proteins produced under certain stresses
- Identify genes involved in traits
Progress: Molecular Biology/Genomics

- DNA variation (genotyping)
- Linkage map construction

http://www.science.howstuffworks.com,
wildmanstevebrill.com, vegtalk.org,
naturebenefits.us
Next Step: Molecular Biology/Genomics

- Fine mapping Ag4
- Progressing with 2\textsuperscript{nd} population
- Starting on 3\textsuperscript{rd} source of aphid resistance
Progress:
Aphid Resistance

Progeny 4305 pop
Next Step: Molecular Biology/Genomics

- Phenotyping = measuring traits
- Flowering
- Fruiting
- Plant architecture
- Disease tolerance

http://genome.iastate.edu
Research Objectives: Analytical Chemistry

Identify phytonutrients in fruit

• What compounds in what proportions are present?

• What is the variation in the populations?
Progress:
Analytical Chemistry

- Sugars: average 46% glucose, 54% fructose
- Soluble solids: 9.2-10.8%
- Titratable acidity: 0.93-1.3%
- Total anthocyanins:
  - 330-610mg/100g C3G equivalents
  - 315-364 mg/100g Gallic Acid equiv.
- More detailed Anthocyananin work to come
Research Objectives: Product Evaluation/Communication

How can we promote consumer and grower interest in:

- Availability
- Consumption
- Demand
- Profitability
Research Objectives: Product Evaluation/Communication

Understand consumer preferences
• sensory panels
• focus groups
• other social science assessment techniques
Progress: Research Objectives: 
Product Evaluation/ Communication

Two consumer panels: Corvallis
• Total 8 puree samples
• Definite preferences

Trained panel evaluation: Ohio
• Total 8 IQF fruit (same samples as Corvallis)
• Similar results to Corvallis

More surveys will be conducted this year
Research Objectives: Education

- Presentations
- Workshops
- Tours
  - Growers
  - Industry
  - Breeders
  - Students
Research Objectives: Education

- 2014 Summer student intern Sabrina Teo
- 2013 Summer student intern Jamie Willard
- Lab and field
- Association between torus shape and picking
Research Objectives: Education

ASHS New Orleans 2015

Symposium Aug 3, 8am-4pm
• Michael Dossett: Germplasm evaluation using genotypic and phenotypic methods
• Jill Bushakra: Marker development, genetic linkage mapping, QTL analysis
• Paul Sandefur: Marker Assisted Breeding in action.

• 10 Graduate Student travel funding opportunities: See me!
  Dead line is tomorrow! www.black-raspberries.com
Project Status Summary

- Last year of phenotype data collection
- 1st linkage map finished!
- Genotyping to focus on aphid locus
- Genome assembly well-advanced
- Protein sequence well-advanced
Long-Term Social & Economic Benefits

- Pyramiding of aphid resistances
- New disease resistant cultivars
- Cultivars that meet current and future industry needs
Long-Term Social & Economic Benefits

Major benefits reaped by not only the black raspberry, red raspberry and blackberry industries, but also all of the Rose Family!
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Thank you!