Welcome to the webinar!

• The webinar will start at the top of the hour.

• To type in a question, use the question box on your control panel. We will read the questions aloud after the c. 45 minute presentation.

• The webinar is being recorded and you can find all recordings as well as upcoming NAPB webinars at http://www.extension.org/pages/60426

Patrick Moore
WSU Puyallup
Raspberry Breeding for the Pacific Northwest

Patrick Moore, Professor
Wendy Hoashi-Erhardt, Scientific Assistant
Washington State University Puyallup Research and Extension Center

Cooperators
Chad Finn, USDA/ARS, Corvallis, OR
Michael Dossett, BC Blueberry Council
In partnership with: AAFC

Program support
• Washington State University
• USDA-ARS NW Center Small Fruits Research
• Washington Red Raspberry Commission
• Washington Strawberry Commission
• Oregon Strawberry Commission
• Oregon Raspberry and Blackberry Commission
• Plant Royalties
• This work was partially funded by USDA/NIFA through Hatch Projects #WNP0038 and 0640
2013 Raspberry Production (tonnes)

Source FAO

Red Raspberry Production (million pounds)

Noncitrus Fruit and Nuts 2013 Summary
**Red Raspberry**

Rosaceae - family

*Rubus* - genus

*Ideobatus* – subgenus

**R. idaeus** L. - species

* R. idaeus* L. subsp. *vulgatus* Arrh. European red raspberry *(R. idaeus)*


**R. idaeus** – diploid 2n=14

* R. cockburnianus*
* R. coreanus*
* R. crataegifolius*
* R. flosculosus*
* R. innominatus*
* R. laesiostylus*
* R. niveus*
* R. occidentalis* – black raspberry*
* R. odoratus* – flowering raspberry
* R. parviflorus* – thimbleberry
* R. phoenicolasis*
* R. pungens*
* R. spectabilis* - salmonberry
* R. sumatranus
* PI 305308*
Rubus parviflorus (thimbleberry) 3 selections

Rubus innominatus 6 selections

Rubus sumatranus 3 selections

PI 305308

PI 305308 x WSU 930 6 selections

Have 4 selections of BC₆
Plant - perennial  
Canes - biennial  

Floricane fruiting – summer fruiting  
• First year canes - vegetative only  
• Fruit on second year canes  
• Then canes die  

Primocane fruiting  
• Fruit on tips of first year canes  
• Can harvest fruit both first and second year  

Clonally propagated – genetically identical from root cuttings or tissue culture  

Need to be self fertile
Raspberry Breeding Goals
Flavor, Firmness, Color for processing
Machine harvestable
High yield
Virus resistant
Root Rot tolerant
IQF quality (Individual Quick Frozen)
Select parents
Make crosses
Grow seedlings
Make selections
Evaluate for traits of interest
If still promising
  Grower Trials
Possible release

<table>
<thead>
<tr>
<th>Cross</th>
<th>Cross Year</th>
<th>Release Year</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tahoma</td>
<td>1931</td>
<td>1938</td>
<td>7</td>
</tr>
<tr>
<td>Washington</td>
<td>1931</td>
<td>1938</td>
<td>7</td>
</tr>
<tr>
<td>Goldenwest</td>
<td>1931</td>
<td>1953</td>
<td>22</td>
</tr>
<tr>
<td>Sumner</td>
<td>1935</td>
<td>1956</td>
<td>21</td>
</tr>
<tr>
<td>Puyallup</td>
<td>1940</td>
<td>1953</td>
<td>13</td>
</tr>
<tr>
<td>Meeker</td>
<td>1950</td>
<td>1967</td>
<td>17</td>
</tr>
<tr>
<td>Centennial</td>
<td>1974</td>
<td>1989</td>
<td>15</td>
</tr>
<tr>
<td>Cascade Gold</td>
<td>1979</td>
<td>2010</td>
<td>31</td>
</tr>
<tr>
<td>Cascade Dawn</td>
<td>1988</td>
<td>2005</td>
<td>17</td>
</tr>
<tr>
<td>Cascade Delight</td>
<td>1989</td>
<td>2003</td>
<td>14</td>
</tr>
<tr>
<td>Cascade Nectar</td>
<td>1990</td>
<td>2003</td>
<td>13</td>
</tr>
<tr>
<td>Cascade Bounty</td>
<td>1992</td>
<td>2005</td>
<td>13</td>
</tr>
<tr>
<td>Cascade Harvest</td>
<td>1998</td>
<td>2013</td>
<td>15</td>
</tr>
</tbody>
</table>

15.8
Pollinations
Average 74 crosses/year in past 5 years
Generally emasculate 3-5 flowers/bag, 2-3 bags/cross
Goal 200 seeds/cross

Seed Treatment
Scarify seed - sulfuric acid
Stratify – cold, moist 6 weeks
Sow seed in greenhouse
Goal 100 seedlings/cross

Plant seedlings
Average 5,500 seedlings
5,500 = 3.0 A, 3.125 miles of row

Make selections
Evaluate two years after planting
Evaluate all fruiting seedlings at least once a week
Select ≈ 1% of seedlings

Subjectively evaluate for
• Vigor – health
  • Root rot tolerance
• Yield
• Growth habit
• Color, size, appearance
• Firmness, ease of fruit release
• Flavor
• Flag desirable seedlings (selections)
• Propagate Selections
Propagate via tissue culture

Evaluation of selections
Root tc plants in greenhouse
Plant with cooperating growers

Grown under (mostly) commercial practices by cooperating grower
Harvested commercial schedule
Breeding for machine harvestability

Harvest every 1 ½ - 3 days (15-20/season)

Processing
Fruit quality

Littau
Oxbo
Evaluate subjectively for
Green
Overripe
Collapsed
Crumbly fruit
Yield
Color, Size, Firmness, Flavor
Fruit sample for analysis for most promising selections
Need
- Easy fruit release
- Firm, durable fruit
- Good lateral length
- Good lateral attachment

Traits affecting machine harvestability

Abscission of pedicel
Abscission from receptacle
Fruit cohesion
Receptacle shape
Drupelet position
Receptacle length
Fruit firmness
Size of drupelets
Break at fruit opening
Long, weak laterals
Traits affecting machine harvestability

Abscission of pedicel
Abscission from receptacle
Fruit cohesion
Receptacle shape
Drupelet position
Receptacle length
Fruit firmness
Size of drupelets
Break at fruit opening
Long, weak laterals

Cascade Dawn

Traits affecting machine harvestability

Abscission of pedicel
Abscission from receptacle
Fruit cohesion
Receptacle shape
Drupelet position
Receptacle length
Fruit firmness
Size of drupelets
Break at fruit opening
Long, weak laterals

Virus, weather, genetics
Traits affecting machine harvestability

Abscission of pedicel
Abscission from receptacle
Fruit removal force
Fruit cohesion
Receptacle shape
Drupelet positioning
Receptacle length
Fruit firmness
Size of drupelets
Break at fruit opening
Long, weak laterals
## Traits affecting machine harvestability

<table>
<thead>
<tr>
<th>Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abcission of pedicel</td>
</tr>
<tr>
<td>Abcission from receptacle</td>
</tr>
<tr>
<td>Fruit removal force</td>
</tr>
<tr>
<td>Fruit cohesion</td>
</tr>
<tr>
<td>Receptacle shape</td>
</tr>
<tr>
<td>Drupelet position</td>
</tr>
<tr>
<td>Receptacle length</td>
</tr>
<tr>
<td>Fruit firmness</td>
</tr>
<tr>
<td>Size of drupelets</td>
</tr>
<tr>
<td>Break at fruit opening</td>
</tr>
<tr>
<td>Long, weak laterals</td>
</tr>
</tbody>
</table>

### Traits affecting machine harvestability

<table>
<thead>
<tr>
<th>Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abcission of pedicel</td>
</tr>
<tr>
<td>Abcission from receptacle</td>
</tr>
<tr>
<td>Fruit removal force</td>
</tr>
<tr>
<td>Fruit cohesion</td>
</tr>
<tr>
<td>Receptacle shape</td>
</tr>
<tr>
<td>Drupelet position</td>
</tr>
<tr>
<td>Receptacle length</td>
</tr>
<tr>
<td>Fruit firmness</td>
</tr>
<tr>
<td>Size of drupelets</td>
</tr>
<tr>
<td>Break at fruit opening</td>
</tr>
<tr>
<td>Long, weak laterals</td>
</tr>
</tbody>
</table>
Traits affecting machine harvestability

Abscission of pedicel
Abscission from receptacle
Fruit removal force
Fruit cohesion
Receptacle shape
Drupelet position
Receptacle length
Fruit firmness
Size of drupelets
Break at fruit opening
Long, weak laterals
Machine harvestability

- Screen for MH as soon as possible.
- Combination of several unrelated traits.
- Need to be at least adequate for all traits.
- For now Empirical.

Seedling evaluation

- In grower field
- Fruit distribution – broad, bimodal
- Decision making time
- Concentration
- Finding correct plant – repeated selection
Two of the selections made while on the harvester are currently in grower trials. Would they have been selected w/o machine?

After MH evaluation – replant best in new MH trial and replicated plots at WSU Puyallup. Hand harvest twice each week at WSU Puyallup Measure good/rot fruit, fruit weight, fruit firmness
Raspberry Root Rot

*Phytophthora rubi*
More severe on wet, poorly drained sites
Cannot eliminate from soil
Recommended course of action
  - Raised beds
  - Gypsum
  - Fungicides
  - Plant tolerant cultivars

Goss Farm naturally infested with “good” levels of root rot.
Provides a natural screen for the seedlings, but some escapes.
Evaluate advanced selections after MH evaluations in a field, known to have root rot.

Raspberry Bushy Dwarf Virus (RBDV)

- RBDV Negative
- RBDV Positive
Raspberry Bushy Dwarf Virus

Pollen borne, systemically infects plant, including seeds
Causes partial sterility of fruit
fruit crumbles
Estimated impact of RBDV
Growing a susceptible cultivar
IQF quality
>$1,500/A/year
Losses in yield, fruit quality, replant
No cultural management options, other than replant with clean plants.
Currently no significant plantings of RBDV resistant cultivars
Resistance to RBDV conferred by a single dominant allele (Bu)

- Bu/Bu resistant
- Bu/bu resistant
- bu/bu susceptible

Should be simple to breed for RBDV resistance

Has been very difficult to breed for resistance

- Only symptom in fruit
- Uneven distribution of disease pressure
  - Seedlings fruit for first time two years after planting, when evaluated first time
- Don’t screen seedlings or new selections
- Grafting slow, only on elite selections
Use of markers in raspberry breeding

Would be valuable for
RBDV resistance
Root rot tolerance
Aphid resistance
Machine harvestability

Work at Cornell
2 markers correct
58/60, but …
2 QTL account for
25-60%

Have segregating populations in field that might generate some useful markers

Cascade Harvest
Further Resources

“We have all drunk from wells we did not dig and have been warmed by fires we did not build.”
• Find all upcoming and archived webinars at http://www.extension.org/pages/60426

• Find the recording for this webinar at http://www.extension.org/pages/72708

• Have a question about plant breeding? Use the eXtension Ask an Expert service at https://ask.extension.org/groups/1714/ask

• Thank you for coming!