Potato Breeding and Genetics Program

Isabel Vales and Solomon Yilma

Potato Breeding and Genetics
Dept. of Crop and Soil Science
Corvallis, OR
Overview

• Who are we?
• What is our goal?
• What are our research priorities?
• Host genetic resistance
• Late blight
• Insects
• Specialty potatoes
• Potato clones for organic growers
OSU Potato Team

- Isabel Vales, Al Mosley, Solomon Yilma, Jeff McMorran, and Ryon Ottoman, Dept. of Crop and Soil Science (CSS), Corvallis

- Steve James, Central Oregon Agricultural Research Center (COARC), Madras/Powell Butte

- Dan Hane, Laurie Leroux, Hermiston Agricultural Research and Extension Center (HAREC), Hermiston

- Brian Charlton Klamath Experiment Station (KES), Klamath Falls

- Clint Shock & Eric Eldredge, Malheur Experiment Station (MES), Ontario
Program Goal

To develop high yield and high quality potato varieties for processing, chipping, fresh market, and specialty uses with genetic resistance to diseases, pests, and environmental stresses
Oregon Potato Breeding Program

Yr. 1
- Crosses: Aberdeen, Prosser, and Corvallis

Yr. 2
- Seedling tuber production: Corvallis (~100,000 in GH)

Yr. 3
- Single Hills (evaluation and increase): Powell Butte (~100,000 A tubers in field)
- Single Hills (evaluation and increase): MN and TX (~100,000 B and C tubers in field)

Yr. 4
- 4-hills (~1,000): Hermiston
- 18-hills (~1,000): Powell Butte (SI)
- 4-hills (~300 specialty): Klamath falls

Yr. 5
- 17-hills, 2 reps: Hermiston
- 24-hills, 2 reps: Powell Butte (SI)
- 20-hills, 2 reps: Ontario
- 20-hills, 2 reps: Klamath falls

Yrs. 6-7
- Powell Butte (SI)
- Oregon Statewide trials: 5 experimental stations

Yrs. 7-9
- Powell Butte (SI)
- Tri-State, growers trials: 10-12 locations

Yrs. 9-10
- Powell Butte (SI)
- W. Regional, grower trials: 14-15 locations

Yrs. 11-13
- Powell Butte (SI)
- W. Regional, grower, processor trials

Yrs. 13-15
- Powell Butte (SI)
- Name: Tri-State release, PVP

Generation of clean material (foundation seed)

Eye-indexing
Research Priorities

• Disease/pest/abiotic stress/quality improvement
  – Tuber moth
  – Viruses: PVY, PLRV, corky ring spot, etc.
  – Late blight
  – Columbia root nematode
  – Frost resistance
  – Specialty potatoes
  – Biofortification and biopharmaceuticals?
Approaches

- **Identify and use sources of resistance/quality**
  - Elite germplasm
  - Primitive cultivars, landraces, wild relatives, related species
  - Multi-trait recurrent selection combined with MAS
  - Genetic transformation

- **Development and use of genetic markers and mapping populations**
  - Identification of qualitative and quantitative genes involved in the traits of interest
  - Genetic studies

- **Genetic fingerprinting**
  - Genetic diversity evaluation and parental selection
  - Variety identification
Integrated disease/pest management

The causal agent

The disease/pest triangle

Environment

The host plant

Integrated approach: agronomic, chemical, biological, genetic
Genetics of cultivated potato

- Tetraploid (2n= 4x= 48 chromosomes)
  - Four copies of the basic chromosome number (12)
## Disease/Pest Resistance Traits

### Mapping of Qualitative and Quantitative Traits

<table>
<thead>
<tr>
<th>Disease</th>
<th>No. of genes/QTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato late Blight</td>
<td>26</td>
</tr>
<tr>
<td>Soft rot</td>
<td>13</td>
</tr>
<tr>
<td>Potato wart</td>
<td>1</td>
</tr>
<tr>
<td>Potato cyst nematode</td>
<td>12</td>
</tr>
<tr>
<td>Columbia root-knot nematode</td>
<td>1</td>
</tr>
<tr>
<td>Potato virus Y</td>
<td>2</td>
</tr>
<tr>
<td>Potato virus A</td>
<td>1</td>
</tr>
<tr>
<td>Potato virus X</td>
<td>4</td>
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</tbody>
</table>

## Potato clones with resistance to late blight

<table>
<thead>
<tr>
<th>Variety</th>
<th>Status</th>
<th>Country</th>
<th>Type</th>
<th>Resistance</th>
<th>Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Island Sunshine</td>
<td>comm. avail.</td>
<td>US</td>
<td>dark yellow flesh</td>
<td>Highly resistant: late blight</td>
<td>late-very late</td>
</tr>
<tr>
<td>Sante</td>
<td>comm. avail.</td>
<td>US</td>
<td>light yellow flesh</td>
<td>mod foliar strong tuber</td>
<td>mid-season</td>
</tr>
<tr>
<td>Jacqueline Lee</td>
<td>comm. avail.</td>
<td>US</td>
<td>yellow flesh</td>
<td>mod foliar and tuber</td>
<td>med-late</td>
</tr>
<tr>
<td>Defender</td>
<td>comm. avail.</td>
<td>US</td>
<td>russet/baker/proc</td>
<td>strong foliar and tuber</td>
<td>med-late</td>
</tr>
<tr>
<td>MSJ456-4</td>
<td>research (MI)</td>
<td>US</td>
<td>round white</td>
<td>strong foliar resistance</td>
<td>med-late</td>
</tr>
<tr>
<td>AO96141-3</td>
<td>research (PNW)</td>
<td>US</td>
<td>russet/baker/proc</td>
<td>mod foliar mod tuber</td>
<td>med-late</td>
</tr>
<tr>
<td>NDA5507-3YF</td>
<td>research (PNW)</td>
<td>US</td>
<td>yellow flesh</td>
<td>mod foliar strong tuber</td>
<td>Early-med</td>
</tr>
<tr>
<td>VC1009-1W/Y</td>
<td>research (PNW)</td>
<td>US</td>
<td>yellow flesh</td>
<td>mod foliar strong tuber</td>
<td>Medium</td>
</tr>
<tr>
<td>AC97521-1R/Y</td>
<td>research (PNW)</td>
<td>US</td>
<td>red skin yellow flesh</td>
<td>mod foliar strong tuber</td>
<td>Medium</td>
</tr>
</tbody>
</table>

### EUROPE

<table>
<thead>
<tr>
<th>Variety</th>
<th>Status</th>
<th>Country</th>
<th>Type</th>
<th>Resistance</th>
<th>Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarpo Mira</td>
<td>comm. avail.</td>
<td>EU</td>
<td>red skin cream flesh</td>
<td>complete foliar resistance</td>
<td>late maincrop</td>
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<tr>
<td>Sarpo Axona</td>
<td>comm. avail.</td>
<td>EU</td>
<td>red skin cream flesh</td>
<td>complete foliar resistance</td>
<td>late maincrop</td>
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<tr>
<td>Orla</td>
<td>comm. avail.</td>
<td>Ireland</td>
<td>early white boiler</td>
<td>moderate foliar resistance?</td>
<td>early</td>
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<tr>
<td>Lady Balfour</td>
<td>comm. avail.</td>
<td>UK</td>
<td>elongated white pink spots</td>
<td>mod foliar mod/high tuber</td>
<td>late maincrop</td>
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<tr>
<td>Eve Balfour</td>
<td>comm. avail.</td>
<td>UK</td>
<td>round white</td>
<td>high foliar very strong tuber</td>
<td>early maincrop</td>
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</tbody>
</table>
Potato clones with resistance to late blight

Defender (A90586-11)
- High-Yielding Processor
- Released in 2004
- High Specific Gravity
- High Vitamin C
- Resistant to Late Blight
  - Foliage
  - Tuber
- Also Resistant to:
  - Tuber early blight, PVX, net necrosis
- Moderate Resistance:
  - Early dying, pink rot, corky ring spot, and soft rot

Defender

103 acres certified seed in 2005
Potato clones with resistance to late blight
Potato clones with resistance to late blight

Jacqueline Lee
Potato clones with resistance to late blight

AO96141-3

2005 Late Harvest Tri-State Trial - AO96141-3

<table>
<thead>
<tr>
<th>Tubers</th>
<th>Initials</th>
<th>48°F</th>
<th>44°F</th>
<th>40°F</th>
<th>Recond.</th>
</tr>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Washington</td>
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<tr>
<td>Idaho</td>
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<tr>
<td>Oregon</td>
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</tbody>
</table>
Potato clones with resistance to late blight

NDA5507-3YF
Potato clones with resistance to late blight

VC1009-1W/Y
Potato Tuber Moth
(Phthorimaea operculella)

Life cycle of the Potato tuber moth

- Eggs
  - 2-3 days

- Larva
  - 2-3 days

- Pupa
  - 18 days

- Adult
  - 6-8 days

- Temperature: 27°C ± 2°
- Humidity: 60% RH

J. Kalazich et al. INIA, Chile

• Problem
• Life cycle
• Control methods
• Genetic resistance

Damage in tubers
Non-transgenic sources of resistance to PTM

- *Solanum berthaultii*
- *S. pinnatisectum*
- *S. sparsipilum*

PTM resistant clones at OSU:
- Q174-2 (NY)
- NY131 (NY)
- Prince Hairy (NYL235-4) (NY)
- Q115-6 (Chile)

Average number of galeries and PTM pupa in potato clones resistant and susceptible (control) to PTM.

J. Kalazich et al. INIA, Chile
Examples of specialty Potatoes
Specialty potatoes

- Exotic
- Diversification of markets
- Antioxidants
  - Carotenoids (lutein, zeaxanthin, violaxanthin)
  - Phenolic compounds (chlorogenic acid)
  - Flavonoids (catechin, epicatechin, anthocyanins)
Thank you!