Update on the variation of the downy mildew pathogen

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Outline

- Biology of the downy mildew pathogen
- Race characterization
- New races documented
- Novel isolates - underway
- Susceptibility of R1 – R15 varieties
- Current status of races
- New Efforts
Working relationships

CLGRP: California Leafy Greens Research Program (2008)
Plantum NL: http://www.plantum.nl/english/articles.htm
NAKT: http://www.naktuinbouw.nl/engels/engels.html
Downy Mildew
*Peronospora farinosa f. sp. spinaciae* (Pfs) = *P. effusa*

- Global pathogen
- Obligate pathogen
- Spinach – only host
- Favored by cool-wet weather
- Tolerant of hot / dry
- Short latent period (6-8 days)
Disease cycle

Conidia dispersal
Wind rainsplash

Healthy

Germination
Cool - wet

Sporulation

Short latent period
6-8 days

Latent period

Germination and infection
Oospores?
Oospores - 2007
Spinach Downy mildew
Global pathogen

- Isolated villages in Nepal (>10,000 ft)
- Hot arid desert regions of Egypt
- Isolated virgin production areas in South Africa
Egypt 2013
How does the disease get started?

- Primary inoculum
- Wind blown asexual spores (short-lived)
  - “green bridge”
- Dormant sexual oospores (soil)
- Seed?
  - Demonstrated in Japan
  - Rare event
  - PCR test to ID on seed (2014)
Fresh Market Spinach in California

Harvested Acres vs. Total Value (x 1,000 USD)

- Red line: Harvested Acres
- Green line: Total Value

Data Source: USDA - NASS, 2011
Herd Immunity

- Flu / Influenza
- Measles
- Downy mildew
Heavy Mildew Pressure in CA and AZ in 2013-2014

Yuma / Imperial has had exceptionally high disease pressure

Many races, mixtures, and deviating strains
Heavy Mildew Pressure in Yuma/Imperial 2013-2014
Table 1. Disease reactions of spinach differentials for race identification of the spinach downy mildew pathogen *Peronospora farinosa* f. sp. *spinaciae*.

<table>
<thead>
<tr>
<th>Differential cultivar</th>
<th>Race(^1)</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Viroflay</td>
<td>+</td>
</tr>
<tr>
<td>Resistoflay</td>
<td>-</td>
</tr>
<tr>
<td>Califlay</td>
<td>-</td>
</tr>
<tr>
<td>Polka</td>
<td>-</td>
</tr>
<tr>
<td>Clermont</td>
<td>-</td>
</tr>
<tr>
<td>Campania</td>
<td>-</td>
</tr>
<tr>
<td>Dolphin</td>
<td>-</td>
</tr>
<tr>
<td>Avenger</td>
<td>-</td>
</tr>
<tr>
<td>Lion</td>
<td>-</td>
</tr>
<tr>
<td>Lazio</td>
<td>-</td>
</tr>
<tr>
<td>Whale</td>
<td>-</td>
</tr>
<tr>
<td>Pigeon</td>
<td>-</td>
</tr>
</tbody>
</table>
Disease management options

- Host resistance
  - Major (qualitative)
  - Minor (quantitative)

- Cultural
  - Crop Rotation
  - “Green Bridges”

- Chemical
  - Conventional: foliar and seed treatments
  - Organic, limited effective materials, coppers

- Biological - very limited efficacy
Six Hypothesized R Loci

- Each locus controls R to different races
- RPF1 has been characterized
- Others are being characterized
- Several “new” loci being used
### Deviating isolate

<table>
<thead>
<tr>
<th></th>
<th>UA1014A PLP</th>
<th>1914E</th>
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<tbody>
<tr>
<td></td>
<td>C</td>
<td>T</td>
</tr>
<tr>
<td>Caladonia</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Coati</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>E03D.0579</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Mandril</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Meerkat</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Platypus</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Plover</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>PV1053</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Scorpins</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Woodpecker</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>SSR-SP-29</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

C: cotyledons  
T: True leaves  
UA201502A has been tested once.
Race 1 -15 Resistance

- Several novel isolates
- New Resistances (x and y)
- Some newer resistance “leaky”?
- X and Y – temperature sensitive?
Managing Downy Mildew of Spinach: A Genomics-based Approach to the Host and Pathogen
Downy Mildew Project
USDA-NIFA-SCRI Funding

- ~ $1M
- Genetics of resistance
- Pathogen/race diversity
- Seed assays
- Outreach for Stakeholders
Downy Mildew Project
USDA/NFA 2013-2015

- Researchers
  - Jim Correll, U of Arkansas
  - Burt Bluhm, U of Arkansas
  - Chunda Feng, U of Arkansas
  - Kurt Lamour, U of Tennessee
  - Becky Lyon, U of Tennessee
  - Lindsey duToit, Washington State
  - Steve Koike, UCCE
  - Neil McRoberts, U. of California, Davis
In 2.5 years we, at University of Arkansas, will have answers to all the genetic questions regarding Spinach Mildew.

February 23, 2015

Signed: [Signatures]

Witnessed by: [Signatures]
Thank you...
Google “Spinach Portal” website – http://spinach.uark.edu/
Meeting updates
Financial Support
- CLGRB – Mary Zischke
- ASTA
- USDA/NIFA – SCRI Program
- U.S. and E. U. Seed Companies
- University of Arkansas Division of Agriculture
- UC Cooperative Extension

Field personnel (CA and AZ)
- Gowan Seed, Holaday Seed, Jay Schafer