Colloque sur la pomme de terre
Une production à protéger

13 novembre 2009, Québec

Une gestion réussie des maladies des pommes de terre durant l’entreposage

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Note : Cette conférence a été présentée en anglais lors de l’évènement et la présentation PowerPoint a été publiée dans le cahier du participant.

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Pour commander le cahier du participant, consultez le catalogue des publications du CRAAQ
Silver Scurf and Black Dot

Courtesy of Cornell University
Silver scurf = *Helminthosporium solani*

Black dot = *Colletotrichum coccodes*

Courtesy of Cornell University

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**Black Dot – Disease Cycle**

- Overwinters as sclerotia on tubers or in plant debris in the field
- Infects other Solanaceous crops
- Acts in combination with other pathogens
- Most severe with continuous moisture and warm temperatures; plant injury or stress
- Tuber infection at stem end related to aboveground disease
Silver Scurf – Disease Cycle

• Seed-borne inoculum most important
• Soil-borne inoculum a factor in some cases
• Spores can spread in storage and cause infection

Silver Scurf – *Helminthosporium solani*

• Resistance to thiabendazole and thiophanate-methyl reported in western Canada in mid-1990s (Kawchuk et al.)
• By late 1990s, resistance prevalent in central Canada and some in eastern Canada
Prince Edward Island Survey – 2006

- 20 storages sampled (5 -10 tubers per sample)
- 3 isolates obtained in pure culture per sample
- Total of 60 isolates collected, stored and tested for sensitivity to thiabendazole (Mertect)

Results

- 11 isolates (18%) sensitive to thiabendazole (TBZ)
- 49 isolates (82%) insensitive to thiabendazole (TBZ)

Cross resistance to thiophanate-methyl (TPM)
Response of isolates collected across Canada in 2008 to various fungicides in fungicide-amended agar plate assays

<table>
<thead>
<tr>
<th>Species</th>
<th>No. isolates</th>
<th>Azoxystrobin</th>
<th>Fludioxonil</th>
<th>Thiabendazole</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sensitive</td>
<td>Insensitive</td>
<td>Sensitive</td>
</tr>
<tr>
<td><em>C. coccodes</em></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><em>H. solani</em></td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>8</td>
</tr>
</tbody>
</table>

Evaluation of products applied post-harvest for control of silver scurf in storage

**Treatments:**

1. Untreated check (tubers from clean seed) - 200 ml of tap water/ 100 kg tubers
2. Untreated check (tubers from scurfy seed) - 200 ml of tap water/ 100 kg tubers
3. Azoxystrobin (Quadris 250SC) – 0.245 g a.i. in 200 ml water/100 kg tubers
4. Azoxystrobin (Quadris 250SC) – 0.49 g a.i. in 200 ml water/100 kg tubers
5. Fludioxonil (Scholar 230SC) – 1.47 g a.i. in 200 ml water/100 kg tubers
6. Azoxystrobin + Fludioxonil – 0.49 + 1.47 g a.i. in 200 ml water/100 kg tubers
7. Phosphorous acid (Confine) – 40 ml product in 160 ml water/100 kg tubers
8. Azoxystrobin + Phosphorous acid - 0.49 g a.i. + 40 ml product in 160 ml water/100 kg tubers
9. Thiabendazole (Mertect) – 4.4 g a.i. in 200 ml water/100 kg tubers
10. Azoxystrobin + Thiabendazole - 0.49 + 4.4 g a.i. in 200 ml water/100 kg tubers
Evaluation of products applied post-harvest for control of silver scurf in storage

**Treatments:**

11. Azoxystrobin + Fludioxonil + Thiabendazole - 0.49 + 1.47 + 4.4 g a.i. in 200 ml water/100 kg tubers

12. Azoxystrobin + Fludioxonil + Phosphorous acid - 0.49 + 1.47 g a.i. + 40 ml product in 160 ml water/100 kg tubers

13. Bio-Save 10LP – mix 4.22 g of product per liter of water; then use 200 ml of this solution/100 kg tubers

14. Bio-Save 11LP - mix 4.22 g of product per liter of water; then use 200 ml of this solution/100 kg tubers

15. Bio-Save 10LP + Thiabendazole - mix 4.22 g of product per liter of water; then use 200 ml of this solution + 4.4 g a.i. (thiabendazole) /100 kg tubers

16. Bio-Save 11LP + Thiabendazole - mix 4.22 g of product per liter of water; then use 200 ml of this solution + 4.4 g a.i. (thiabendazole) /100 kg tubers

Evaluation of products applied post-harvest for control of silver scurf in storage

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Surface Lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH</td>
<td>a</td>
</tr>
<tr>
<td>AZ</td>
<td>defg</td>
</tr>
<tr>
<td>AZ</td>
<td>hi</td>
</tr>
<tr>
<td>FL</td>
<td>defg</td>
</tr>
<tr>
<td>AZFL</td>
<td>cde</td>
</tr>
<tr>
<td>PA</td>
<td>defg</td>
</tr>
<tr>
<td>AZPA</td>
<td>bcd</td>
</tr>
<tr>
<td>TH</td>
<td>efgh</td>
</tr>
<tr>
<td>AZTH</td>
<td>phi</td>
</tr>
<tr>
<td>AZFLPA</td>
<td>i</td>
</tr>
<tr>
<td>THAZ</td>
<td>cde</td>
</tr>
<tr>
<td>AZFLTH</td>
<td>de</td>
</tr>
<tr>
<td>AZFLPA</td>
<td>bio</td>
</tr>
<tr>
<td>THAZTH</td>
<td>bio</td>
</tr>
<tr>
<td>AZFLTHPA</td>
<td>bio</td>
</tr>
<tr>
<td>THAZTH</td>
<td>bio</td>
</tr>
<tr>
<td>AZFLTHPA</td>
<td>bio</td>
</tr>
</tbody>
</table>

Legend: % Surface Lesions
Black dot Management

• Our plate test work shows that C. coccodes is sensitive to strobilurins and fludioxonil; some resistance to benzimidazoles
• Mixed results for control of black dot on daughter tubers for field studies where seed tubers were treated with fludioxonil
• Some evidence that foliar application of strobilurins reduces black dot on stems
• Much more research on this disease needs to be done in Canada – incidence in field and on tubers
  – management

Black dot and Silver scurf - DISEASE MANAGEMENT

AT PLANTING

1. Plant clean seed

2. Use a registered fungicide seed treatment, but utilize resistance management strategies
   - value of Senator or Maxim or mancozeb?

3. Crop rotation

4. In-furrow applications of azoxystrobin may suppress soil inoculum
IN SEASON
1. Adequate moisture and fertility
2. Protective fungicides to reduce foliar infection
3. Strobilurins may reduce stem infection
4. Grow early cultivars if black dot is a concern
5. What is the incidence of black dot in Canada? (particularly in the tuber phase)

AT HARVEST and IN STORAGE
1. Monitor storage conditions
2. Reduce storage temperatures and humidity where possible
3. Clean and disinfect storage facilities
4. Post-harvest treatments with TBZ will likely be ineffective for silver scurf
5. New post-harvest treatment options - azoxystrobin and phosphorous acid look like good candidates
Part B: Fusarium Dry Rot and Seed Piece Decay – *Fusarium* spp.

- External symptoms – shrinking and shriveling of lesions
- Internal symptoms – light to dark brown dry rot with mycelium-filled cavities

![Image of rot lesion](image1.png)

![Image of mycelium](image2.png)

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**Percent of tubers with dry rot sampled from seedlots and in storages 2001**

<table>
<thead>
<tr>
<th>Field</th>
<th>Seed</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65%</td>
<td>70%</td>
</tr>
<tr>
<td>2</td>
<td>55%</td>
<td>60%</td>
</tr>
<tr>
<td>3</td>
<td>45%</td>
<td>55%</td>
</tr>
<tr>
<td>4</td>
<td>35%</td>
<td>45%</td>
</tr>
<tr>
<td>5</td>
<td>25%</td>
<td>30%</td>
</tr>
<tr>
<td>6</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>7</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>8</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>9</td>
<td>0%</td>
<td>5%</td>
</tr>
</tbody>
</table>
10 Percent of isolates of various species of *Fusarium* obtained from seed tubers and from tubers in storage 2001

### Fusarium Pathogenicity Studies

**Isolates from Forages**

- *Fusarium avenaceum*
- *Fusarium oxysporum*

**Isolates from Cereals**

- *Fusarium sportrichiodes*
- *Fusarium graminearum*
THE BIG THREE

*Fusarium sambucinum*
Dominant spp. in
70% of tuberlots in 2001
40% of tuberlots in 2003

*Fusarium coeruleum*
Dominant spp. in
20% of tuberlots in 2001
40% of tuberlots in 2003

*Fusarium avenaceum*
Dominant spp. in
10% of tuberlots in 2001
20% of tuberlots in 2003

Canadian Survey – 2008
Percent of isolates of each species recovered
Total isolates = 122

Other comprised of: *F. torulosum, F. acuminatum, F. sporotrichioides, F. bullatum, F. equiseti, F. cerealis, F. avenaceum, F. crookwellense, F. solani*
First report of *F. graminearum* causing potato tuber dry rot in Canada in 2008

- MB, QC, NB

**TBZ (Mertect) and TPM (Senator) Resistance**

- First reported in western Canada in mid-1990s (Kawchuk et al.)
- Spread to eastern provinces
- Past 5 years - all isolates of *Fusarium sambucinum* recovered from Maritime tubers were resistant to TBZ and TPM
- All isolates of other *Fusarium* spp. recovered from Maritime tubers were sensitive to TBZ and TPM
### 2005 Seed Treatment Trial

Seed inoculated, treated and placed in storage

**Inoculation:** *F. sambucinum* resistant to Senator  
*F. coeruleum* sensitive to Senator  
Both isolates sensitive to Maxim

<table>
<thead>
<tr>
<th>Treatment</th>
<th>FS % diseased sprouts</th>
<th>FS % surface rot</th>
<th>FC % diseased sprout</th>
<th>FC % surface rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseased seed control</td>
<td>75 a</td>
<td>7 a</td>
<td>86 a</td>
<td>23 a</td>
</tr>
<tr>
<td>Senator (TPM)</td>
<td>63 b</td>
<td>3 b</td>
<td>16 b</td>
<td>0 b</td>
</tr>
<tr>
<td>Maxim (Fludioxinil)</td>
<td>13 c</td>
<td>0 c</td>
<td>16 b</td>
<td>0 b</td>
</tr>
</tbody>
</table>

### 2005 Seed Treatment Trial

Seed inoculated, treated and planted in the field

<table>
<thead>
<tr>
<th>Treatment</th>
<th>FS kg Total weight</th>
<th>FS kg Canada #1 weight</th>
<th>FC kg Total weight</th>
<th>FC kg Canada #1 weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseased seed control</td>
<td>16.4 b</td>
<td>12.7 b</td>
<td>13.7 b</td>
<td>10.6 b</td>
</tr>
<tr>
<td>Senator (TPM)</td>
<td>17.7 ab</td>
<td>13.4 b</td>
<td>18.7 a</td>
<td>14.6 a</td>
</tr>
<tr>
<td>Maxim (Fludioxinil)</td>
<td>19.2 a</td>
<td>15.8 a</td>
<td>20.1 a</td>
<td>16.1 a</td>
</tr>
</tbody>
</table>
Fludioxonil (Maxim) Resistance

- First reported in 2007 (PE, SK)
- Survey in 2008 showed fludioxonil resistance is widespread in Canada

Response of isolates collected across Canada in 2008 to various fungicides in fungicide-amended agar plate assays

<table>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sensitive</td>
<td>Insensitive</td>
</tr>
<tr>
<td>F. crookwellense</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>F. oxysporum</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>F. coeruleum</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>F. sambucinum</td>
<td>20</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>F. cerealis</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>F. graminearum</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>F. equiseti</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F. solani</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F. sporotrichioides</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F. bullatum</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Response of isolates collected across Canada in 2009 (seed tuber survey) to various fungicides in fungicide-amended agar plate assays

<table>
<thead>
<tr>
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<th>Thiabendazole</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sensitive</td>
<td>Insensitive</td>
</tr>
<tr>
<td><em>F. sambucinum</em></td>
<td>38</td>
<td>14</td>
<td>24</td>
</tr>
</tbody>
</table>

2008 and 2009 Seed Treatment Trials
Seed inoculated, treated and placed in storage

Inoculation: Isolate of *F. sambucinum* resistant to Senator and Maxim

Treatments: 1. Healthy control
            2. Diseased control
            3. Drying agent
            4. Senator (10% thiophanate-methyl)
            5. Maxim PSP (0.5% fludioxonil)
            6. Maxim MZ PSP (0.5% fludioxonil; 5.7% mancozeb)
            7. Tuberseal (16% mancozeb)
            8. EXP
2008 and 2009 Seed Treatment Trials
Seed inoculated, treated and placed in storage

[Bar chart showing % Rot for different treatments: DIS, MAX, SEN, DRY, MMZ, TUB, HEAL, EXP]
Evaluation of products applied post-harvest for control of Fusarium dry rot (F. sambucinum) in storage

Treatments:

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Evaluation of products applied post-harvest for control of Fusarium dry rot (*F. sambucinum*) in storage (fungicide-resistant strain)

Summary:
- Azoxystrobin, thiabendazole, fludioxonil ineffective
- Phosphorous acid ineffective
- Some control with biologicals (Bio-Save)
- A need for new post-harvest options (EXP)

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**Fusarium - DISEASE MANAGEMENT**

**AT PLANTING**
1. Use clean seed; store in a disinfected facility
2. Warm seed tubers prior to cutting to promote rapid healing
3. Remove diseased tubers prior to cutting
4. Disinfect seed cutting and handling equipment often and ensure that cutters are sharp to make a clean cut that heals quickly
5. Don't store cut seed for too long (no longer than 10 days)
6. Use a registered fungicide seed treatment, but follow a resistance management strategy; treatments containing mancozeb are currently the best option (late blight as well)
7. Seed disease diagnosis if available
8. Plant when soil and temperature conditions promote rapid sprout growth and emergence
**Fusarium - DISEASE MANAGEMENT**

**AT HARVEST and IN STORAGE**

1. Reduce tuber injury during harvest and handling operations
2. Provide conditions for rapid wound healing early in storage, then drop temperatures
3. Monitor storage conditions
4. Post-harvest treatments with TBZ will control most *Fusarium* spp. (but not *F. sambucinum*)
5. New post-harvest treatment options are needed

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**Acknowledgments**

**Funding**

Agriculture and Agri-Food Canada
Pest Management Centre – Ottawa
Industry Support

[www.gov.pe.ca](http://www.gov.pe.ca)
Acknowledgments

AAFC Charlottetown

Participating Potato Growers

Rick Peters
Kathy Drake
Ian Macdonald
Roger Henry

Harrington Farm Staff

Provincial Government Reps & Diagnostic Clinics

Industry Reps

www.gov.pe.ca

Thank you!

For more information:
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