Loss of sensitivity to strobilurin fungicides in *Mycosphaerella pinodes*

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Disease management activities should be almost complete **BEFORE** any crop is planted.

Plan for a diverse crop rotation
- 3- to 4-yr, alternating cereals with dicots. Even different cultivars can be useful if they carry different sources of resistance.

Use the best genetics for your region.
- High yield, suitable days to harvest, good disease resistance.

Don’t plant problems with the crop.
- Use seed with high germination and vigour, treated & inoculated, minimal / no pathogens with seed.

Provide isolation from last year’s heavily infected fields.
Scout fields and apply a foliar fungicide only if required.
Disease Management – Past and Present

- Crop residue was buried.
- Windbreaks, pastures, and headlands for diversity.
- Crop rotation largely for weed management.
  - Provided interval for residue breakdown.
  - Also provided natural biological control.
- Improved herbicides facilitate short rotations, reduced tillage, few windbreaks / pastures.
- Disease management increasingly reliant on major gene resistance and fungicides.
## Fungicide Usage on the Canadian Prairies

<table>
<thead>
<tr>
<th>Province</th>
<th>Production area (M ha)</th>
<th>Fungicide applied (%)</th>
<th>▲△ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>2011</td>
</tr>
<tr>
<td>Alberta</td>
<td>7.0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>10.9</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Manitoba</td>
<td>3.5</td>
<td>23</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>21.3</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Ontario</td>
<td>2.4</td>
<td>11</td>
<td>17</td>
</tr>
</tbody>
</table>
History of Fungicide Usage

- Initially, persistent actives with multi-site modes of action, e.g., copper, heavy metals.

- Shift to focus on reduced-risk actives (usually non-persistent, single-site modes of action).

- Reduced sensitivity usually detected first under high selection pressure.

- Viticulture, golf courses, orchards > hort crops > intensive field crops > extensive field crops
Loss of Efficacy From Fungicide Insensitivity

Fusarium dry rot

Early blight

Silver scurf

Pink rot

Late blight
Fungicide resistance development: Selection models for Qol and DMI fungicides

Monogenic, single allelic resistance at target site, disruptive selection, high risk

Loss of Control
Factors Affecting Risk of Insensitivity

Pathogen
- No. of generations
- Spore production
- Spore dispersal
- Occurrence of disease
- History of resistance

Fungicide
- Single/multi-site
- Persistence
- Intrinsic activity
- Resistance factors

Agronomic
- Alternation/Combination
- No. of different MOAs
- No. of applications
- Resistant cultivars
- Cropping system
- Residue management

Overall Resistance Risk

Source: K. Polziehn, BASF
Risk of insensitivity to strobilurins was high:

- Genetically diverse pathogen.
- Air-borne sexual spores.
- Several fungicide appl. / yr.
- Insensitivity in related fungi.
Increase of Insensitive Isolates in SK

<table>
<thead>
<tr>
<th>Year</th>
<th>Isolates</th>
<th>Susceptibility</th>
<th>Insensitive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004–2005</td>
<td>Headline 53 isolates</td>
<td>Susc</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Quadris 4 R, 49 S</td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td>2006</td>
<td>Headline 20 R, 17 S</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Quadris 23 R, 14 S</td>
<td></td>
<td>68%</td>
</tr>
<tr>
<td></td>
<td>Control failures</td>
<td>6 of 7 fields</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 field</td>
<td>0%</td>
</tr>
<tr>
<td>2007</td>
<td>132 R, 4 S</td>
<td></td>
<td>97%</td>
</tr>
<tr>
<td>2008</td>
<td>74 R, 7 S</td>
<td></td>
<td>92%</td>
</tr>
</tbody>
</table>
Conclusions

- Rapid increase in insensitivity in SK, AB, and across the Northern Great Plains in 2007.
- Cross-resistance within the strobilurin group.
- Insensitivity resulted in loss of control.
- Industry moved quickly to inform producers and minimize potential for losses.
- No evidence of reduced fitness in insensitive isolates – likely to persist.
Mycosphaerella pinodes from field pea

- Pathogen at high risk of loss of sensitivity to strobilurins.
- Baseline isolates from before 2003.

- 8% of isolates from SK & AB insensitive, 0% from ND & WA.
- Populations in SK & AB at risk of loss of efficacy using strobilurins.
Fungicide insensitivity in SK 2013–2016

- 72% (46/64) isolates of *M. pinodes* insensitive.
  - Strobilurins likely no longer effective in the field.

- Crop health benefit assessment
  - No benefit on pea or chickpea.
  - Early season benefit at one site-yr on lentil.

- 24% (13/54) isolates of *A. lentis* from lentil insensitive.
  - Levels only slightly higher than baseline from 10 yr ago.

- 10% (2/22) isolates of *Colletotrichum lentis* from lentil insensitive (baseline).

- 25% (2 of 8) isolates of *A. rabiei* insensitive
Crop health, lentil cultivars, Guelph 2014

- Dazil
- Maxim

Greenness (0-5)

- Water
- Bravo
- Headline
- Quadris

Lentil cultivar
Solutions

- Alternate fungicides with different MOA.
- Tank mix high-resistance risk products with a multi-site partner or different MOA.
- **N.B.** Most of the multi-site actives will be removed / limited this year!!!
- Research to identify pathogen systems at risk.
- Develop cheap, rapid screening methods for high-risk pathogens, for use in local labs.
Conclusion

- Mycosphaerella blight on pea and ascochyta blight on lentil ARE at risk of failure.

- Most field crops are NOT at immediate risk of management failures due to insensitivity.
  - Crop rotation provides adequate disease reduction.
  - Multi-site actives effective (old / cheap, no insensitivity).
  - Pathogens with no air-borne phase, so spread is slow.
  - Pathogens with low genetic diversity.

- Actives will last longer if used less frequently.
Acknowledgements

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Questions?