Getting the Most out of Your Cereal Fungicide: A Western Canadian Perspective

Acknowledgements

• Scientific colleagues and technical staff
• Industry staff
• Provincial Producer Commissions, Rahr Malting Inc., DU
• Barley, Wheat, & WW DIAPs/Clusters
• Aussie colleagues
  – M. McLean, N. Poole, K. Porker, K. Jayasena
• Top Crop Manager
  – Field Crop Disease Summit Organizers
Agricultural Scientist in training, sclerotinia project, AAFC Melfort, 1985
The Plant Disease Playing Field

Your heavy hitters/1st line of defence: rotation with at least 2 years between host crops and resistant varieties

Your secondary defence/last line of defence: good agronomics, balanced fertility, scouting, fungicides
A single year between host crops (e.g. canola/wheat/canola/wheat) is not sufficient for adequate decomposition of infested crop residues.
# Leaf Spot Reaction of Barley Varieties For Alberta

Based on Varieties of Cereal and Oilseed Crops For Alberta - 2013, AARD Agdex 100/32

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\(^1\) Agriculture and Agri-Food Canada Lacombe, AB; \(^2\) Alberta Agriculture and Rural Development (AARD), Lacombe, AB

## Leaf Spot Reaction

<table>
<thead>
<tr>
<th>Barley (row type)</th>
<th>Scald</th>
<th>Net form Net</th>
<th>Spot form Net</th>
<th>Spot Blotch*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General purpose</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>AC Harper (6)</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>xx</td>
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<tr>
<td>AC Lacombe (6)</td>
<td>P</td>
<td>P</td>
<td>G</td>
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<tr>
<td>AC Ranger (6)</td>
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<td>F</td>
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<tr>
<td>AC Rosser (6)</td>
<td>VP</td>
<td>F</td>
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<tr>
<td>Busby (2)</td>
<td>F</td>
<td>P</td>
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<tr>
<td>CDC Austenson (2)</td>
<td>VP</td>
<td>P</td>
<td>VG</td>
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<td>CDC Coalition (2)</td>
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<td>CDC Cowboy (2)</td>
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<td>CDC Dolly (2)</td>
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<td>VP</td>
<td>P</td>
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<td>CDC Helgason (2)</td>
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<td>CDC Maverick (2)</td>
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<td>CDC Mindon (2)</td>
<td>VP</td>
<td>VP</td>
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<td>F</td>
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<td>CDC Trey (2)</td>
<td>P</td>
<td>F</td>
<td>VG</td>
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<td>Champion (2)</td>
<td>VP</td>
<td>VP</td>
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<td>P</td>
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<td>Chigwell (6)</td>
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<td>Conlon (2)</td>
<td>VP</td>
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<td>Gadsby (2)</td>
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<td>Muskwa</td>
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<td>Ponoka (2)</td>
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<td>Seebe (2)</td>
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<tr>
<td>Sundre (6)</td>
<td>VG</td>
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<td>TR07728 (2)</td>
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<td>VP</td>
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<td>Trochu (6)</td>
<td>F</td>
<td>VP</td>
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<tr>
<td>Xena (2)</td>
<td>VP</td>
<td>VP</td>
<td>F</td>
<td>VP</td>
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</tbody>
</table>
Tight rotation, susceptible variety ... no worries, choose the right target and hit it good, hit it real good with fungicide! Problem solved ... ???

Boise Gun Club
Thanksgiving Turkey Shoot,
Boise, Idaho, 2014

Brother: Brent T.
Nephew: Kyle W. – Armoury
Kelly T. Haul = 1 turkey and 1 ham

Photo by C. Fisher (Brother-in-law)
The need for a fungicide application

- Needs to be put into perspective
- Trace/low disease levels
  - Limited impact on crop productivity and quality
  - Limited to no benefits
- Moderate – high levels of disease
  - Reduced yield, kernel weight, grade, etc.
  - Can provide benefits
The producer

Host

Disease

Pathogen

Environment
Test 62, Beaverlodge, AB, 2014, AC
Metcalf barley, Grain Yield (bu/ac)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grain Yield (bu/ac)</th>
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<tbody>
<tr>
<td>Insure Seed Trt</td>
<td>NS</td>
</tr>
<tr>
<td>Ethrel PGR</td>
<td>NS</td>
</tr>
<tr>
<td>Twinline</td>
<td>NS</td>
</tr>
<tr>
<td>Prosaro</td>
<td>NS</td>
</tr>
</tbody>
</table>

No to limited disease development (<2.0% for check)

Similar results in 2015 at Beaverlodge
Making the most of a fungicide application: the host

• Host resistance or susceptibility
  – Influences fungicide need/rate/timing
  – Influences key disease issues
    • Can influence fungicide choice and timing

• Is there a key host growth stage where disease has the biggest impact
  – Influences timing and application technology

• What is the crop yield potential
  – Influences the economics of spraying
Test 65, Melfort, SK, 2013, Interaction of Barley Variety and Fungicide, % Leaf Area Diseased With Net-form Net Blotch, Flag – 1, Soft Dough Stage

P < 0.0001

% leaf area diseased

<table>
<thead>
<tr>
<th></th>
<th>Sundre (VS-S)</th>
<th>Chigwell (MRMS)</th>
<th>Vivar (MR-R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Twinline</td>
<td>A</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Twinline applied</td>
<td>B</td>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>
Test 65, Melfort, SK, 2013, Interaction of Variety and Fungicide, Grain Yield (bu/ac)

Grain yield (bu/ac)

<table>
<thead>
<tr>
<th>Variety</th>
<th>No Twinline</th>
<th>Twinline applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundre (VS-S)</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Chigwell (MRMS)</td>
<td>AB</td>
<td>A</td>
</tr>
<tr>
<td>Vivar (MR-R)</td>
<td></td>
<td>AB</td>
</tr>
</tbody>
</table>

P = 0.0012
Contribution to yield from upper leaves of the cereal canopy

Cereal growth stages and their importance to fungicide application, 2003, Colin Hacking and Nick Poole, Hi-Grain Update

i) Winter Wheat

Diagram 3. Approximate contribution of top 3 leaves in winter wheat

- Leaf 2 23%
- Leaf 3 7%
- Leaf 4 3%
- Ear 22%
- Flag 43%

ii) Winter barley

Diagram 4. Approximate contribution of top 3 leaves in winter barley

- Leaf 2 20%
- Leaf sheath 25%
- Leaf 3 10%
- Ear 13%
- Flag 9%
Making the most of a fungicide application: the pathogen

• Monocyclic or polycyclic disease
  – Influences fungicide efficacy/timing

• Are symptoms due to a pathogen
  – Influences the need for fungicide

• Nature of the pathogen and extent of development
  – Influences the ability of the pathogen to adapt to the fungicides being used
  – Influences fungicide efficacy
Fall symptoms of stripe rust in winter wheat

Source: Randy Kutcher – AAFC Melfort
 cv. CDC Buteo, 2010

Source: Mike Gretzinger – SARA
 Lethbridge, cv. CDC Buteo, 2010
Early spring symptoms of stripe rust in winter wheat, mid April 2015, AAF plots, Olds, AB
Later season symptoms of stripe rust
Early season issues – do I need to spray?
Early season issues – do I need to spray?
Importance of spray timing and latent period

Spore lands on leaf → Fungus penetrates leaf → Fungus grows inside leaf → Symptoms appear on leaf

Latent period: Fungicides effective in this period → Fungal growth beyond chemical control

No disease symptoms visible

Latent periods can be as short as 4–5 days for mildew and brown rust. Strategies to manage these diseases depend largely on protecting leaves as they emerge.
Pathogens with a high risk of being able to rapidly adapt have the following characteristics:

- Mixed reproduction
  - Asexual and sexual
- An outcrossing mating system
- High genetic and pathogenic diversity
Sensitivity of the net and spot forms of the barley net blotch pathogen to propiconazole and pyraclostrobin on the Canadian prairies, Akhavan et al., 2016, WGRF project.

Green arrow denotes a *P. teres* f. *teres* (net form net blotch) isolate from Saskatchewan with tolerance to 10 µgr/ml propiconazole in potato dextrose broth.
Making the most of a fungicide application based on the environment

• Are weather conditions conducive or restrictive to disease development
  – Influences inoculum production, infection potential, and disease development

• Weather conditions prior to, during, and after the fungicide is applied
  – Influences ability to spray the field and/or type of application used
  – Influences fungicide application success, persistence, and period of activity
Making the most of a fungicide application: the fungicide

• What is the nature of the fungicide and multiple versus single modes of action
  – Influences efficacy and range of activity
  – Influences risk of fungicide resistance

• How mobile is the fungicide in the plant
  – Influences fungicide efficacy, persistence, and period of activity
  – Influences application technology
  – Influences the extent to which target plant tissues are protected
Fungicides for cereal leaf disease management, Prairies

Late 1980’s

• Tilt (propiconazole)
  – Sterol biosynthesis
    • DMI
• Generally limited use
  – Seed growers
  – Malt barley producers

2017

• Over 20 products registered for one or more of the cereal leaf spots/rusts
  – Comprising 6 chemical groups
    • Carboxamides, strobilurins, demethylation inhibitors, not classified, dithiocarbamates, chloronitriles
• More routine use
Survey data from last year indicate that the Septoria present in these fields are resistant to strobilurin fungicides.

In addition, resistance is building to the triazole fungicides.

So, only apply early fungicides to fields where stripe rust is present.

Christ Mundt, Mike Flowers, Nicole Anderson and Clare Sullivan, OSU
• Also it is important to limit applications of the new SDHI fungicides to 1 per year

• Apply the SDHI fungicides at flag leaf emergence in combination with strobilurin and/or triazole fungicides
Fungicide movement in wheat leaves and control of powdery mildew


Plate 1. Redistribution of strobilurins in wheat to control powdery mildew (Source: Syngenta)

Net blotch symptoms on Harrington barley at the 3 leaf stage (June 18th) at Melfort, 2004
Percentage leaf area diseased, penultimate leaf, AC Metcalfe, herb./fungicide exp., 13 site yrs, 2010-2012

Herbicide/Fungicide Treatment
- Hrb2-3 (early weed)
- Hrb5-6 (late weed)
- Hrb2-3 + HRFun
- Hrb5-6 + HRFun
- Hrb2-3/FRF-Flg
- Hrb5-6/FRF-Flg
- Hrb2-3 + HRFun/FRF-Flg
- Hrb5-6 + HRFun/FRF-Flg

Fungicide at flag leaf stage
- No fungicide at flag leaf stage
- Fungicide at flag leaf stage

% leaf area diseased

LSD = 4.0

Herbicide/Fungicide Treatment
- Herb only
- Herb + 1/2 rate Tilt
- Herb only & Full rate Tilt at flag
- Herb + 1/2 rate Tilt & Full rate Tilt at flag
- Herb + 1/2 rate Tilt & 1/2 rate Tilt at flag

P < 0.001
Yield (bu/ac) and herb./fungicide treatment, 13 site years, AC Metcalfe barley, 2010-2012

- Hrb2-3 (early weed)
- Hrb5-6 (late weed)
- Hrb2-3 + HRFun
- Hrb5-6 + HRFun
- Hrb2-3/FRF-Flg
- Hrb5-6/FRF-Flg
- Hrb2-3 + HRFun/FRF-Flg
- Hrb5-6 + HRFun/FRF-Flg

Grain yield (bu/ac)

No fungicide at flag leaf stage

Fungicide at flag leaf stage

LSD = 4.1

Herbicide/Fungicide Treatment

P <0.001
Stripe rust, AAFC Lacombe, winter wheat fungicide timing trial, 2015

Twinline @ 202 ml/ac (40L water vol)

Striped rust severity

AC Bellatrix  
Radiant

Check  Fall  Spring  Fall + Spring

A  A  B  BC  D  D  D

Twinline

@ 202 ml/ac (40L water vol)
Yield, AAFC Lacombe, winter wheat fungicide timing trial, 2015

Twinline @ 202 ml/ac (40L water vol)

Yield (bu/ac)
Fusarium head blight, fungicides and timing

Currently the recommendation is: “...proper time to apply is when 75 per cent of the wheat heads are fully emerged to when 50 per cent of the heads on the main stems have visible anthers”

So what does it mean if you apply fungicide for FHB when 75% of the heads are fully emerged?

75% of the heads come in direct contact with fungicide and have some protection, while 25% of the heads receive no fungicide and are not protected at all.
A bit early (head just emerged, NO yellow anthers starting to protrude in middle part of head)

Ideal (plump yellow anthers starting to protrude out of middle part of head)

Too late (head has completed flowering, anthers no longer yellow, but dry, shrivelled and faded)

Stages of wheat at or near flowering

J. Ranson, A. Friskop, NDSU
Are the current fungicide timing recommendations too restrictive?

Fusarium head blight index
(%, mean proportion of diseased spikelets per spike)

Deoxynivalenol content of grain (ppm)

CK = no fungicide check, A = anthesis, A+2, A+4, A+6, = 2, 4, and 6 days after anthesis. Tebu+Prot = Prosaro, and Metc = Caramba

D'Angelo et al. 2014. Efficacy of fungicide applications during and after anthesis against Fusarium head blight and deoxynivalenol in soft red winter wheat. Plant Dis. 98:1387-1397.
Western Canada: Fungicide timing in relation to cereal growth stages and the appearance and severity of leaf disease and/or risk of FHB

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS13</td>
<td>Slow expansion phase: Green area of crop expands slowly (low N use)</td>
</tr>
<tr>
<td>GS24</td>
<td>Rapid expansion phase: Green area of crop expands to maximum (high N use)</td>
</tr>
<tr>
<td>GS30</td>
<td>Slow expansion phase: Green area of crop expands slowly (low N use)</td>
</tr>
<tr>
<td>GS39</td>
<td>Rapid expansion phase: Green area of crop expands to maximum (high N use)</td>
</tr>
<tr>
<td>GS59</td>
<td>Rapid expansion phase: Green area of crop expands to maximum (high N use)</td>
</tr>
<tr>
<td>GS71</td>
<td>Senescence phase: Green area declines as leaves senesce from base</td>
</tr>
<tr>
<td>GS80</td>
<td>Senescence phase: Green area declines as leaves senesce from base</td>
</tr>
<tr>
<td>Harvest</td>
<td>Senescence phase: Green area declines as leaves senesce from base</td>
</tr>
</tbody>
</table>
Seed Treatment and Scald Control on Barley Seedlings 1997-1998

Disease Severity (0-4 scale - leaf 2)

- Untreated
- Vitavax S
- Baytan L
- Baytan H

Isolate 1
- 4.0c
- 3.6c
- 1.5b
- 0.4a

Isolate 2
- 4.0c
- 4.0c
- 2.5b
- 1.0a
Barley Test 65, AB, 2013, Melfort, SK, Seed Treatment, Variety, Fungicide, % Leaf Area Diseased, Flag – 1, Soft Dough Stage

% leaf area diseased with net-form net blotch

- Sundre (VS-S)
- Chigwell (MRMS)
- Vivar (MR-R)

No seed trt No Seed trt No seed trt Yes Seed trt
No Twinline Yes Twinline No Twinline applied Yes Seed trt

P<0.01
Barley Test 65, Melfort, SK, 2013, Seed Treatment, Variety, Fungicide, Yield (bu/ac)

P = 0.0653

Grain Yield (bu/ac)

No seed trt | Yes Seed trt | No seed trt | Yes Seed trt
No Twinline | No Twinline | Twinline applied | Twinline applied

Sundre (S) | Chigwell (MRMS) | Vivar (MR-R)
A potential strategy for leaf disease and FHB management in western Canada

Xylem mobile + root focused non-triazole seed treatments

Canopy expansion in relation to growth

Foliar fungicide with triazoles for FHB suppression and later season leaf disease management

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| GS59         | Senescence phase
| GS71         | Green area declines as leaves senesce from base |
| GS80         | Harvest |

Cereal growth stages: the link to crop management, GRDC
Realistic expectations from foliar fungicide application

• Effective tool for some diseases
  – Prudent use and management will prolong effectiveness

• Timing can have a huge impact
  – Too late and disease established on key leaves
  – Too early and fungicide activity/concentration is limited or key plant tissues not protected
Realistic expectations from foliar fungicide application

• Is your target actually a fungal disease
  – Foliar fertilizer injury or abiotic/biotic issue?
  – E.g. foliar copper mixed with fungicide

• Environmental impacts/nature of fungicide

• Fungicide application does not mean a completely disease-free crop
Disease severity, herbicide/fungicide timing trial, AC Metcalfe barley, penultimate leaf, Lacombe late July 2010

Full rate Tilt at flag leaf stage

Check no fungicide
Try not to rely exclusively on fungicides as your only defence against plant diseases

Use multiple tools from your crop/disease management toolbox
Thank you!

For more information, please contact:

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