Foliar Fungicide Use and Management in Field Crops

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Assistant Professor, Department of Plant Pathology & Environmental Microbiology
Resistance is not the future...it’s already here

• Wake-up call!
  – Strobilurin resistance confirmed in *Cercospora sojina* populations in several states
First strobilurin resistance in CLS

Michigan State University | August 6, 2012

The first report of strobilurin resistance in populations of *Cercospora beticola*, the cause of Cercospora leaf spot (CLS) in Michigan and Nebraska, has now been published (View article). Growers are advised to read Poindexter's article, Follow guidelines for Cercospora leaf spot resistance management in sugarbeets, for management guidelines.

In 2011, fields from several areas in Michigan treated with strobilurins had severe CLS and diminished control was also noted in small plot trials. In addition to the fungicide sensitivity monitoring service, we are able to offer a fast turnaround of samples (about 48 hours) using a molecular diagnostic tool for QoI resistance in CLS. These isolates are compared against isolates known to be sensitive to QoI fungicides. The first samples were received on July 31, 2012, and results sent out on August 1 and both were insensitive to QoI fungicides.

Samples should be shipped for the attention of:

Dr. Noah Rosanzweig, Kirk Lab
612 Wilson Road, Room 35
Department of Plant, Soil and Microbial Sciences
Michigan State University
East Lansing, MI 48824-1325
Phone: (517)355-4754

Samples should consist of 5 to 6 lesions punched from an infected leaf, and can be placed into a seated collection tube. The samples cost $9 each to process.

Additional resources:
Strobilurin resistance in Septoria tritici in the UK

Septoria control in 2002

In general, field performance of fungicide programmes against Septoria tritici in the UK was good despite high disease pressure. However, control varied around the UK with high S. tritici levels in the south-west, south-east, west midlands, Scotland and Wales.

In a few areas, notably south-west Ireland, disease pressure was extreme and control poor. At some sites poor timing and very low fungicide doses may have been the cause of poor control. However, at some sites resistant isolates of S. tritici have been resistant isolates was found. Thus, the resistance gene has been present in S. tritici populations for at least two years. During this time very few problems of disease control were reported.

2003 monitoring

Samples of S. tritici from winter wheat crops from around the UK were tested in March 2003. The G143A resistance gene was found in most of the samples tested.

Of the samples tested to date, the range of resistance gene frequencies was between 0% and...
Disease Notes

First Report of Resistance to QoI Fungicides in North American Populations of Zymoseptoria tritici, Causal Agent of Septoria Tritic Blotch of Wheat

L. E. Estep, Department of Botany and Plant Pathology, Oregon State University, Corvallis, 97331 and Department of Entomology, The Connecticut Agricultural Experiment Station, New Haven, 06511; M. Zala, Institute of Integrative Biology, Swiss Federal Institute of Technology (ETH) Zürich, CH-8092, Switzerland; N. P. Anderson, Department of Crop and Soil Science, Oregon State University, Corvallis, 97331; K. E. Sackett, Department of Botany and Plant Pathology, Oregon State University, Corvallis, 97331; M. Flowers, Department of Crop and Soil Science, Oregon State University, Corvallis, 97331; B. A. McDonald, Institute of Integrative Biology, Swiss Federal Institute of Technology (ETH) Zürich, CH-8092, Switzerland; and C. C. Mundt, Department of Botany and Plant Pathology, Oregon State University, Corvallis, 97331

The G143A mutation in cyt b (cytochrome b gene) is associated with high levels of resistance to quinone outside inhibitor (QoI or strobilurin) fungicides that disrupt electron transport during cellular respiration (1). The G143A mutation in Zymoseptoria tritici (synonyms:
Effective Fungicide Usage

- Know the disease!
- Proper timing of fungicide application
  - Know the crop growth stage
  - Understand disease threshold levels
- **Scout** the fields
- Understand the growth stage, disease level, and yield relationship
Mode of Action (MOA)

• Why should I care how a fungicide works, as long as it does?
  – Product efficacy
  – Resistance management
  – Incorporate fungicides with different modes of action into a disease management program
Modes of Action

• Electron transport chain inhibition
  – **Strobilurins** or QoI fungicides (azoxystrobin, kresoxim-methyl, pyraclostrobin, trifloxystrobin)
    – eg. Quadris, Headline

• Sterol inhibition
  – **Triazoles** or DMI fungicides (propiconazole, myclobutanil, tebuconazole, triflumazole)
    – eg. Tilt, Caramba

• Multiple MOA
  – eg. Stratego, Quilt, Twinline
FRAC Code List®: Fungicides sorted by mode of action (including FRAC Code numbering)

INTRODUCTION

The following table lists commercial fungicides according to their mode of action and resistance risk. The most important bactericides are also included.

The Table headings are defined as:

MOA Code
Different letters (A to I, with added numbers) are used to distinguish fungicide groups according to their biochemical mode of action (MOA) in the biosynthetic pathways of plant pathogens. The grouping was made according to processes in the metabolism starting from nucleic acids synthesis (A) to secondary metabolism, e.g. melanin synthesis (I) at the end of the list, followed by host plant defence inducers (P), recent molecules with an unknown mode of action and unknown resistance risk (U, transient status, mostly not longer than 8 years, until information about mode of action and mechanism of resistance becomes available), and multi-site inhibitors (M).

Target Site and Code
If available, the biochemical mode of action is given. In many cases the precise target site is not known. However, a grouping can be made due to cross resistance profiles within a group or in relation to other groups.

Group Name
The Group Names listed are based on chemical relatedness of structures which are accepted in literature (e.g. The Pesticide Manual). They are based on different sources (chemical structure, site of action, first important representative in group).
<table>
<thead>
<tr>
<th>MOA</th>
<th>TARGET SITE AND CODE</th>
<th>GROUP NAME</th>
<th>CHEMICAL GROUP</th>
<th>COMMON NAME</th>
<th>COMMENTS</th>
<th>FRAC CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1:</td>
<td>complex I NADH Oxido-reductase</td>
<td>pyrimidinamines</td>
<td>pyrimidinamines</td>
<td>difumetorim</td>
<td>Resistance not known.</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>phenyl-benzamides</td>
<td>benodanil</td>
<td>flutolanil</td>
<td>mepronil</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>pyridinyl-ethyl-benzamides</td>
<td>fluopyram</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>furan-carboxamides</td>
<td>fenfuram</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>oxathin-carboxamides</td>
<td>carboxin</td>
<td>oxycarboxin</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>thiazole-carboxamides</td>
<td>thifluzamide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>pyrazole-carboxamides</td>
<td>bixafen</td>
<td>fluaxapyroxad</td>
<td>furametpyr</td>
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<tr>
<td></td>
<td></td>
<td>oxathin-carboxamides</td>
<td>oxypyrazam</td>
<td>penfluifen</td>
<td>penthiopyrad</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>pyridine-carboxamides</td>
<td>bosalid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C2: complex II: succinate-dehydrogenase (SDHI (Succinate dehydrogenase inhibitors))

<table>
<thead>
<tr>
<th>GROUP NAME</th>
<th>CHEMICAL GROUP</th>
<th>COMMON NAME</th>
<th>COMMENTS</th>
<th>FRAC CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>methoxy-acrylates</td>
<td>azoxylostrobine</td>
<td>Resistance known for several fungal species in field populations and lab mutants. Target site mutations in sdh gene, e.g. H/Y (or H/L) at 257, 267, 272 or P225L, dependent on fungal species. Resistance management required. Medium to high risk. See FRAC SDHI Guidelines for resistance management.</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>methoxy-carbamates</td>
<td>pyraclostrobine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oximino acetates</td>
<td>kresoxim-methyltrifloxystrobine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oximino-acetamides</td>
<td>dimoxyostrobine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oxazolidine-diones</td>
<td>famoxadone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dihydro-dioxazines</td>
<td>fluoxastrobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imidazolinones</td>
<td>fenamidone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>benzyl-carbamates</td>
<td>pyribencarb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C3: complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)

<table>
<thead>
<tr>
<th>GROUP NAME</th>
<th>CHEMICAL GROUP</th>
<th>COMMON NAME</th>
<th>COMMENTS</th>
<th>FRAC CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>QoI-fungicides (Quinone outside Inhibitors)</td>
<td>methoxy-acrylates</td>
<td>azoxylostrobine</td>
<td>Resistance known in various fungal species. Target site mutations in cyt b gene (G143A, F128L) and additional mechanisms. Cross resistance shown between all members of the QoI group. High risk. See FRAC QoI Guidelines for resistance management.</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>methoxy-carbamates</td>
<td>pyraclostrobine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oximino acetates</td>
<td>kresoxim-methyltrifloxystrobine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oximino-acetamides</td>
<td>dimoxyostrobine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oxazolidine-diones</td>
<td>famoxadone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dihydro-dioxazines</td>
<td>fluoxastrobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imidazolinones</td>
<td>fenamidone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>benzyl-carbamates</td>
<td>pyribencarb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Group 3 Fungicide

SPECIMEN

Fungicide

For use in disease control in the following crops: barley, oats, rye, sugar beets, triticale and wheat

Active Ingredient:
metoconazole: 5-(4-chlorophenyl)methyl]-2,2-dimethyl-1-
(1H)-1,2,4-benzoxazol-1-yl)methyl)cyclopropand 8.6%
Other Ingredients: ........................................ 91.4%
Total*: ........................................ 100.0%

EPA Reg. No. 7069-246
EPA Est. No.

Fungicide
A co-pack of azoxystrbin and mefenoxam for broad-spectrum disease control in potatoes.

Active Ingredient:
Azoxystrbin: methyl(E)-2-[2-[6-(2-cyanophenoxo)pyrimidin-4-yl oxy]phenyl]-3-methoxyacrylate* . . . 22.9%
Inert Ingredients: 77.1%
Total: 100.0%
Contains 2.08 lbs. of active ingredient

Active Ingredients:
Mefenoxam*: 49.0%
Other Ingredients: 51.0%
Total: 100.0%
*CAS Nos. 70630-17-0 and 69516-34-3
Contains 4 lbs. active ingredient per gallon.
Risk of resistance development

- QoI’s *aka strobilurins* (eg. Quadris, Headline): **High** FRAC 11
- DMI’s *aka triazoles* (eg. Caramba, Tilt, Folicur, Proline, Domark): **Medium** FRAC 3
- Benzimidazoles (eg. Topsin M, Thiophanate methyl): **High** FRAC 1
- Carboxamides (eg. 1 ing. in Priaxor, Endura): **Medium** FRAC 7
Resistance Management

• Apply the recommended dose (cutting the dose is bad)
  – Minimizes selection of strains with intermediate fungicide sensitivity when resistance involves several genes

• At-risk fungicides should be used in alternation with other at-risk fungicides with different modes of action or different chemical groups, and they should be combined or alternated with fungicides that have a low resistance risk.

• Get good coverage

• Use non-chemical control methods as much as possible
Factors for Fungicide Application

• Previous crop
  • Continuous cropping and no-till
• Yield potential for field
• Susceptibility of the variety
• Potential for disease spread (rainfall & humidity)
• Field location (extended dew period)
• Market price of crop
• Fungicide and Application Cost
Small Grains
Use of fungicides in small grains

• Fungicides can be effective in reducing some yield-limiting leaf diseases
• Fungicide use is one tool in the approach to reducing vomitoxin in the harvested product
Major Wheat Diseases

- Rusts
- Powdery mildew
- Leaf spots
- Head scab
Controls

• Resistant cultivars: know what cultivar is being grown and its purported level of resistance
• Fungicide: growers should be investigating the potential costs of fungicides in case they need to respond to emerging disease threats
Powdery Mildew

- Present almost every year
- Environmental conditions determine yield impact (likes cool weather, humidity, high N situations)
- Favored by wheat following wheat or barley, no till
- Some resistant varieties available
Head scab

- *F. graminearum* (also causes Gibberella ear rot of corn)
- Produces mycotoxins (Deoxynivalenol=vomitoxin)
- Favored by no-till, wheat following wheat, cool & wet weather
- Fungus infects through flowers
- Perfect conditions in 2011, not very much in 2012, pretty bad in 2013
Fusarium Head Blight (Scab)

• Infection happens when you have:
  – Susceptible varieties
  – Previous corn/wheat residue harboring fungus
  – Warm, humid conditions *during* flowering (fungus enters through flowers)
Vomitoxin prevention approach

• Select a resistant variety
• Track conditions to target fungicide applications
• Less important, but possibly helpful:
  - Plant following beans
  - Isolate from corn

Based on ND Combo trials 03-05
Management: FHB

- *Fusarium graminearum*
- U.S. Wheat and Barley Scab Initiative
- Prediction tool
- What happened in 2013?
Using a fungicide for Scab prevention

• Be prepared to spray when prediction tool forecasts “medium” to “high” risk for your area

• Fungicides applied before flowering do not provide control

• Wheat that is 5 days or more beyond initial flowering cannot be treated

• Do not use strobilurins (Headline, Quadris, Twinline, Quilt, Stratego) at or after heading (there is evidence that these chemicals can increase toxin levels)
Fungicide Response: Cornell

Contamination of Grain by DON (ppm)

- Control
- Caramba
- Folicur
- Prosaro

K.D. Waxman, G.C. Bergstrom, R. J. Richtmyer III, and R.R. Hahn,
Cornell University
Fungicide Response: Cornell

Adjusted Grain Yield (Bu/A)

- Control
- Caramba
- Folicur
- Prosaro

Yield (Bu/A)

- Pioneer 25R47
- Truman
- Jensen
- Richland

Environment 1

Environment 2

K.D. Waxman, G.C. Bergstrom, R. J. Richtmyer III, and R.R. Hahn, Cornell University
# Fungicide economics

<table>
<thead>
<tr>
<th>Grain price ($/bu)</th>
<th>$4</th>
<th>$5</th>
<th>$6</th>
<th>$7</th>
<th>$8</th>
<th>$9</th>
<th>$10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (bu/a) gain to recoup investment</td>
<td>7.5</td>
<td>6.0</td>
<td>5.0</td>
<td>4.3</td>
<td>3.8</td>
<td>3.3</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Assumes $30/acre based on cost of fungicides and application. Actual cost will vary.
Fungicides for Head Scab Management

• Even the most effective fungicides applied at the perfect time provide only 50-60% reduction in this disease

• Effective fungicides include:
  – Prosaro, Caramba
  – If these are unavailable, then Proline & Folicur may be tank mixed at 3 + 3 fl oz/A
Other leaf/head diseases

Stagonospora glume blotch (*Phaeosphaeria nodorum*)

Septoria leaf Blotch (*Septoria tritici*)
Wheat Fungicide Efficacy Guide

- Gives information for recommended chemistries, rates, timing and restrictions for major diseases
Management of Small Grain Diseases
Fungicide Efficacy for Control of Wheat Diseases (Revised 4-05-10)

The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed the following information on fungicide efficacy for control of certain foliar diseases of wheat for use by the grain production industry in the U.S. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy is based on proper application timing to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes most widely marketed products, and is not intended to be a list of all labeled products.

Efficacy of fungicides for wheat disease control based on appropriate application timing

<table>
<thead>
<tr>
<th>Class</th>
<th>Active Ingredient</th>
<th>Product</th>
<th>Rate/A (fl. oz)</th>
<th>Powdery mildew</th>
<th>Stagonospora leaf/glume blotch</th>
<th>Septoria leaf blotch</th>
<th>Tan spot</th>
<th>Stripe rust</th>
<th>Leaf rust</th>
<th>Stem rust</th>
<th>Head scab</th>
<th>Harvest Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strobilurin</td>
<td>Azoxyastrobin 22.9%</td>
<td>Quadris 2.08 SC</td>
<td>6.2 - 10.8</td>
<td>F(G)¹</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E²</td>
<td>E</td>
<td>VG</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>Pyraclostrobin 3.5%</td>
<td>Headline 2.05 EC</td>
<td>6.0 - 9.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E¹</td>
<td>E¹</td>
<td>E</td>
<td>G</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>Metconazole 8.6%</td>
<td>Caramba 0.75 SL</td>
<td>10.0 - 17.0</td>
<td>VG</td>
<td>VG</td>
<td>_3</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>NR</td>
</tr>
<tr>
<td>Triazole</td>
<td>Propiconazole 41.8%</td>
<td>Tilt 3.6 EC</td>
<td>4.0</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
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<td>VG</td>
<td>VG</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Prothioconazole 41%</td>
<td>Proline 480 SC</td>
<td>5.0 - 5.7</td>
<td>_3</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>G</td>
<td>30 days</td>
</tr>
<tr>
<td></td>
<td>Tebuconazole 38.7%</td>
<td>Folicur 3.6 F⁴</td>
<td>4.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>F</td>
<td>30 days</td>
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<tr>
<td></td>
<td>Prothioconazole 19%</td>
<td>Prosaro 421 SC</td>
<td>6.5 - 8.5</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>30 days</td>
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<tr>
<td></td>
<td>Tebuconazole 19%</td>
<td>TwinLine 1.75 EC</td>
<td>7.0 - 9.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>Propiconazole 11.7%</td>
<td>Quilt 200 SC</td>
<td>14.0</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>Azoxyastrobin 7.0%</td>
<td>Quilt Xcel 2.2 SE</td>
<td>14.0</td>
<td>_3</td>
<td>_3</td>
<td>_3</td>
<td>_3</td>
<td>VG</td>
<td>_3</td>
<td>_3</td>
<td>NR</td>
<td>Feekes 10.5</td>
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<tr>
<td></td>
<td>Propiconazole 11.7%</td>
<td>Trifloxystrobin 11.4%</td>
<td>14.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>NR</td>
<td>35 days</td>
</tr>
</tbody>
</table>

¹Efficacy categories: NR=Not Recommended; P=Poor; G=Good; VG=Very Good; E=Excellent. Efficacy designation with a second rating in parenthesis indicates greater efficacy at higher application rates.
²Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.
³Insufficient data to make statement about efficacy of this product.
⁴Multiple generic products containing tebuconazole may also be labeled. Some states, these products include: Muscle 3.6 F, Orlus 3.6 F, Tebucon 3.6 F, Tebustar 3.6 F, Tecouzol 3.6 F, Tegrol, & Toledo
⁵Estimates of fungicide efficacy against stem rust are based on a small number of observations, and may be less reliable than the ratings for other diseases.

This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. No endorsement is intended for products listed, nor is criticism meant for products not listed. Members or participants in the NCERA-184 committee assume no liability resulting from the use of these products.
Corn
Use of fungicides in corn

• Not appropriate in all situations (mixed results when applied for “plant health” or in the absence of disease)

• Early-season applications not yet proven effective

• Greatest impact found when fungicides are applied at tassel (VT)
Gray Leaf Spot (GLS)

- Typically gray rectangular lesions restricted by veins
- Immature lesions brown/yellow
- Favored by moderate to high temperatures and relatively high humidity
- More severe in fields near streams, rivers, and foggy areas (extended dew period)
- **Fungus survives on crop residue**
Northern Corn Leaf Blight

- Large cigar shaped necrotic lesions
  - 1-6” long x 0.5-1.5” wide
  - Tan in color
  - Older lesions dark gray

- Disease favored by temperatures between 65 and 78F and high relative humidity

- *Fungus survives in crop residue*
Management: Corn Leaf Diseases

- Rotate to non-grass crop
- Select resistant hybrids
- Consider tillage
- Fungicides at proper threshold

Photo: J. Dillon
University trials indicate fungicides are most profitable in corn when a combination of factors are present:

• Hybrids susceptible to foliar disease
• Continuous corn
• No-till or reduced tillage systems
• Late-planted corn
• Irrigation
• Weather conditions are favorable for disease development
• Disease develops
Disease Observations

– **Susceptible or Moderate Susceptible Hybrids**
  • Consider fungicide if disease is present on 3rd leaf below ear or higher on 50% of the plants prior to tasseling

– **Intermediate hybrids**
  • Consider fungicide if field has history of disease, previous crop was corn with at least 35% residue, disease is present on 3rd leaf below ear or higher on 50% of plants prior to tasseling warm and humid weather thru July and August

– **Moderate Resistant or Resistant hybrids:**
  • Fungicide is generally not recommended, but field scouting is still important

• Apply at tasseling to brown silk
• Use a strobilurin or strobilurin-triazole premix
Leaves from one of the Farm Journal Test Plots demonstrate the importance of selecting disease-resistant hybrids and applying the right fungicides, whether preventive or curative, at the right time.
Management of Corn Diseases
Fungicide Efficacy for Control of Corn Diseases—May 2013

The Corn Disease Working Group (CDWG) has developed the following information on fungicide efficacy for control of major corn diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product, and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products. Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL=Not Labeled for use against this disease; -- = Insufficient data to make statement about efficacy of this product for this disease.

<table>
<thead>
<tr>
<th>Fungicide(s)</th>
<th>Class</th>
<th>Active ingredient (%)</th>
<th>Product/Trade name</th>
<th>Rate/A (fl oz)</th>
<th>Anthracnose leaf blight</th>
<th>Common rust</th>
<th>Eyespot</th>
<th>Gray leaf spot</th>
<th>Northern leaf blight</th>
<th>Southern rust</th>
<th>Harvest Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>QoI Strobilurins Group 11</td>
<td>Azoxystrobin 22.9%</td>
<td>Quadris 2.08 SC</td>
<td>6.0 - 15.5</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>Fluoxastrobin 40.3%</td>
<td>Evito 480 SC</td>
<td>2.0 - 5.7</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>R4 (dough)</td>
<td></td>
</tr>
<tr>
<td>Pyraclostrobin 23.6%</td>
<td>Headline 2.09 EC/SC</td>
<td>6.0 - 12.0</td>
<td>--</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>E</td>
<td>G</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>Picoxystrobin</td>
<td>Aproach 2.08 SC</td>
<td>3.0 - 12.0</td>
<td>--</td>
<td>--</td>
<td>VG</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>DMI Triazoles Group 3</td>
<td>Propiconazole 41.8%</td>
<td>Tilt 3.6 EC Multiple Generics</td>
<td>2.0 - 4.0</td>
<td>NL</td>
<td>VG</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>30 days</td>
<td></td>
</tr>
<tr>
<td>Prothioconazole 41.0%</td>
<td>Proline 480 SC</td>
<td>5.7</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>VG</td>
<td>G</td>
<td>14 days</td>
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</tr>
<tr>
<td>Tebuconazole 38.7%</td>
<td>Folicur 3.6 F Multiple Generics</td>
<td>4.0 - 6.0</td>
<td>NL</td>
<td>--</td>
<td>NL</td>
<td>--</td>
<td>VG</td>
<td>--</td>
<td>--</td>
<td>36 days</td>
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<tr>
<td>Tetraconazole 20.5%</td>
<td>Domark 230 ME</td>
<td>4.0 - 6.0</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>G</td>
<td>R3 (milk)</td>
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<tr>
<td>Mixed mode of action</td>
<td>Azoxystrobin 7.0% Propiconazole 11.7%</td>
<td>Quilt 200 SC</td>
<td>7.0 - 14.0</td>
<td>NL</td>
<td>VG-E</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>VG</td>
<td>30 days</td>
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<tr>
<td>Azoxystrobin 13.5% Propiconazole 11.7%</td>
<td>Quilt Xcel 2.2 SE</td>
<td>10.5 - 14.0</td>
<td>VG</td>
<td>VG-E</td>
<td>VG-E</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>VG</td>
<td>30 days</td>
<td></td>
</tr>
<tr>
<td>Pyraclostrobin 13.6% Metconazole 5.1%</td>
<td>Headline AMP 1.68 SC</td>
<td>10.0 - 14.4</td>
<td>--</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>20 days</td>
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<tr>
<td>Pyraclostrobin 28.58% Fluxapyroxad 14.33%</td>
<td>Priaxor 4.17 SC</td>
<td>4.0 - 8.0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>G</td>
<td>21 days</td>
<td></td>
</tr>
<tr>
<td>Trifloxystrobin 11.4% Propiconazole 11.4%</td>
<td>Stratego 250 EC</td>
<td>10.0 - 12.0</td>
<td>--</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>G</td>
<td>G</td>
<td>14 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trifloxystrobin 32.3% Prothioconazole 10.8%</td>
<td>Stratego YLD 4.18 SC</td>
<td>4.0 - 5.0</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>VG</td>
<td>30 days</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Soybeans
Use of fungicides in beans

• The soybean diseases that can be controlled with fungicides include:
  – Soybean rust
  – Brown Spot
  – Frogeye leaf spot

• Depends on when they show up and how bad it is

• No yield response from fungicides applied after R3
Septoria Brown Spot

- *Septoria glycines*
- Came in mid season this year, on lower leaves first (different from bacterial spot)
- Present every year
Cercospora Blight & Frogeye Leaf Spot

- Leaf spots, purple seed stain (various species of cercospora)
- Can impact yield, quality
- Scout at R1/R2, if present, consider strobilurin ingredient at R3
- Fungicide resistant populations in midwest!
Are fungicides necessary for soybeans?

• Diseases have not traditionally been yield limiting
  (Seed producers may have issues with seed quality)

• Most major fungicides are labeled for foliar and stem diseases

• Can be efficacious at reducing disease...but yield?
Management of Soybean Diseases
Fungicide Efficacy for Control of Foliar Soybean Diseases—April 2013

The North Central Regional Committee on Soybean Diseases and the Regional Committee for Soybean Rust Pathology (NCERA-212 and NCERA-208) have developed the following information on foliar fungicide efficacy for control of major foliar soybean diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by field-testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product, and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table, unless otherwise noted. Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products. Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL = Not Labeled for use against this disease.

<table>
<thead>
<tr>
<th>Fungicide(s)</th>
<th>Class</th>
<th>Active ingredient (%)</th>
<th>Product/Trade name</th>
<th>Rate/ A (fl oz)</th>
<th>Aerial web blight</th>
<th>Anthracnose</th>
<th>Brown spot</th>
<th>Cercospora leaf blight</th>
<th>Frogeye leaf spot</th>
<th>Phomopsis/ Diaporthe (Pod and stem blight)</th>
<th>Soybean rust</th>
<th>White mold</th>
<th>Harvest restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azoxyystrobin</td>
<td>QoI Str biurns Group 11</td>
<td>22.9%</td>
<td>Quadris 2.08 SC</td>
<td>6.0 - 15.5</td>
<td>VG</td>
<td>VG</td>
<td>G</td>
<td>F</td>
<td>VG</td>
<td>-</td>
<td>G-VG</td>
<td>P</td>
<td>14 days</td>
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<tr>
<td>Fluoxastrobin</td>
<td>QoI Str biurns Group 11</td>
<td>40.3%</td>
<td>Aftershock 480 SC Evito 480 SC</td>
<td>2.0 - 5.7</td>
<td>VG</td>
<td>G</td>
<td>G</td>
<td>-</td>
<td>VG</td>
<td>-</td>
<td>-</td>
<td>NL</td>
<td>R5 (beginning seed) 30 days</td>
</tr>
<tr>
<td>Picoxistrobin</td>
<td>QoI Str biurns Group 11</td>
<td>23.6%</td>
<td>Aproach 2.08 SC</td>
<td>6.0 - 12.0</td>
<td>VG</td>
<td>G</td>
<td>G</td>
<td>-</td>
<td>VG</td>
<td>-</td>
<td>-</td>
<td>G</td>
<td>-</td>
</tr>
<tr>
<td>Pyraclostrobin</td>
<td>QoI Str biurns Group 11</td>
<td>23.6%</td>
<td>Headline 2.09 EC/SC</td>
<td>6.0 - 12.0</td>
<td>VG</td>
<td>VG</td>
<td>G</td>
<td>F</td>
<td>VG</td>
<td>-</td>
<td>G-VG</td>
<td>NL</td>
<td>21 days</td>
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<tr>
<td>Cyproconazole</td>
<td>DMI Triazoles Group 3</td>
<td>8.9%</td>
<td>Alto 100SL</td>
<td>2.75 - 5.5</td>
<td>-</td>
<td>-</td>
<td>VG</td>
<td>-</td>
<td>F</td>
<td>-</td>
<td>VG</td>
<td>NL</td>
<td>30 days</td>
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<tr>
<td>Flutriafol</td>
<td>DMI Triazoles Group 3</td>
<td>11.8%</td>
<td>Topguard 1.04 SC</td>
<td>7.0 - 14.0</td>
<td>-</td>
<td>VG</td>
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<td>F</td>
<td>VG</td>
<td>-</td>
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<tr>
<td>Propiconazole</td>
<td>DMI Triazoles Group 3</td>
<td>41.8%</td>
<td>Tilt 3.6 EC Multiple Generics</td>
<td>2.0 - 4.0</td>
<td>P</td>
<td>VG</td>
<td>G</td>
<td>NL</td>
<td>F</td>
<td>NL</td>
<td>VG</td>
<td>NL</td>
<td>R5 (beginning seed)</td>
</tr>
<tr>
<td>Prothioconazole</td>
<td>DMI Triazoles Group 3</td>
<td>41.0%</td>
<td>Proline 480 SC</td>
<td>2.5 - 4.3</td>
<td>NL</td>
<td>NL</td>
<td>NL</td>
<td>NL</td>
<td>VG</td>
<td>NL</td>
<td>VG</td>
<td>G</td>
<td>21 days</td>
</tr>
<tr>
<td>Tetraconazole</td>
<td>DMI Triazoles Group 3</td>
<td>20.5%</td>
<td>Domark 230 ME</td>
<td>4.0 - 5.0</td>
<td>NL</td>
<td>VG</td>
<td>VG</td>
<td>-</td>
<td>VG-E</td>
<td>-</td>
<td>G-VG</td>
<td>R5 (beginning seed)</td>
<td></td>
</tr>
<tr>
<td>Thiophanatemethyl</td>
<td>MBC Thiophanates Group 1</td>
<td>10.0 - 20.0</td>
<td>Topsin-M Multiple Generics</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>F</td>
<td>VG</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>21 days</td>
<td></td>
</tr>
</tbody>
</table>
Manage for resistance!

• The best fungicides are prone to resistance (strobilurins, triazoles)
• Every application gets us closer to resistance
• Common diseases in both corn and soybean are related (Gray leaf spot, frogeye leaf spot and Cercospora leaf spot: all *Cercospora* spp.)
Manage for resistance!

• Don’t treat crops in absence of disease
  – Applying for “plant health” benefits is a dangerous game
  – Doesn’t mean to wait until field is half-dead

• Don’t use the same chemistry over and over again
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