

WE SUSTAIN LIFE

Integrated Management of Diseases and Mycotoxins in Soft Red Winter



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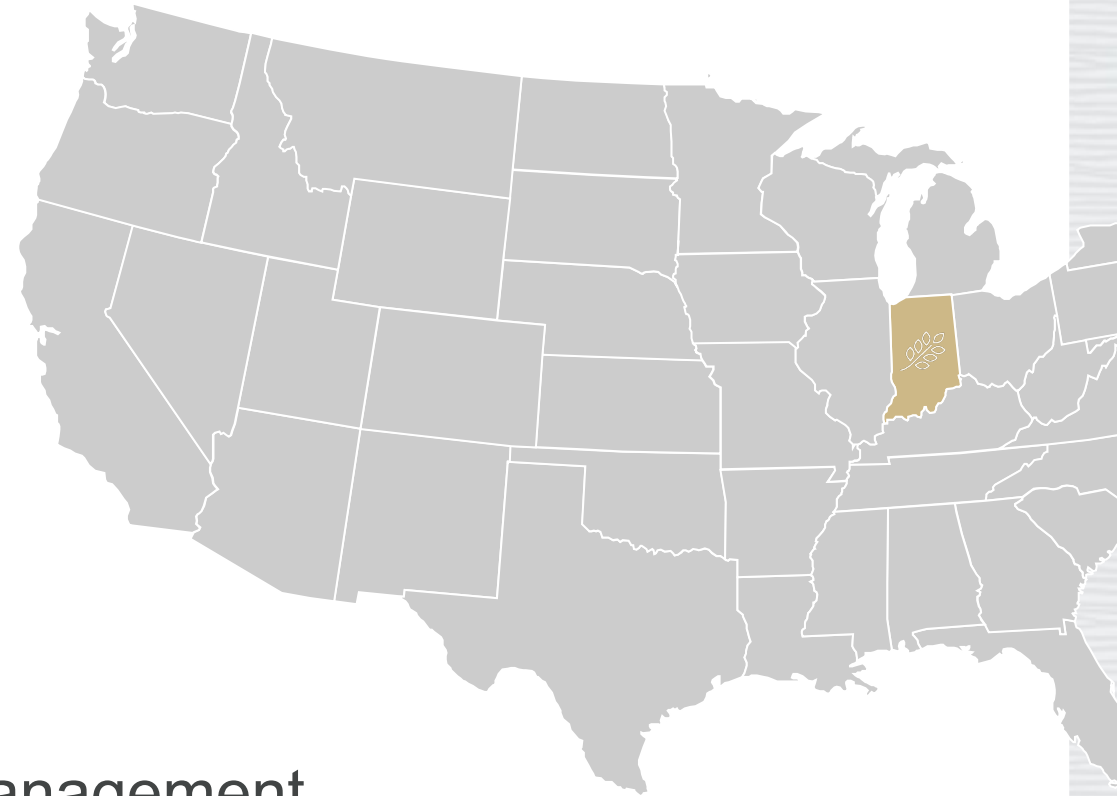


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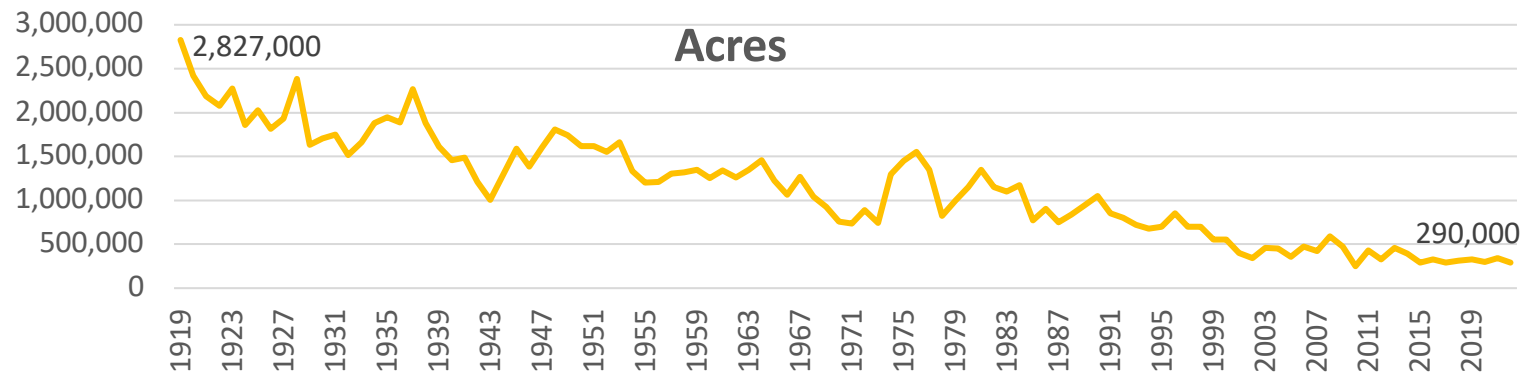
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

Agenda

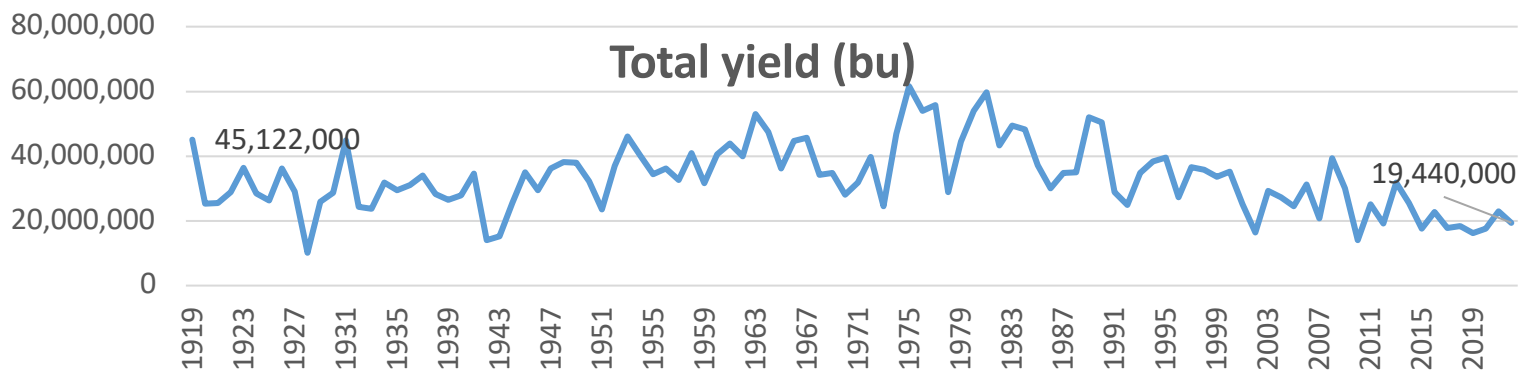
- 1 Importance of wheat in Indiana
- 2 Foliar diseases and management
- 3 Fusarium head blight and mycotoxin management
- 4 Concluding remarks



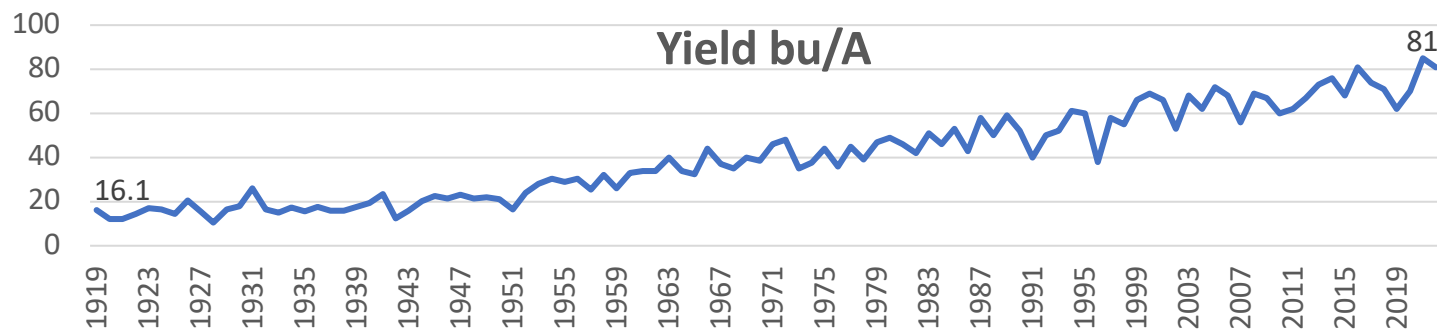
Wheat production in Indiana



1919: 2.8 MM A
2021: 290,000 A



1919: 45.1 MM bu
2021: 19.4 MM bu



1919: 16.1 bu/A
2021: 81.0 bu/A

Main foliar diseases



Stagonospora nodorum blotch

Parastagonospora nodorum



Septoria tritici blotch

Zymoseptoria tritici



Powdery mildew

Blumeria graminis

Other foliar diseases



Tan spot

Pyrenophora tritici-repentis



Leaf rust

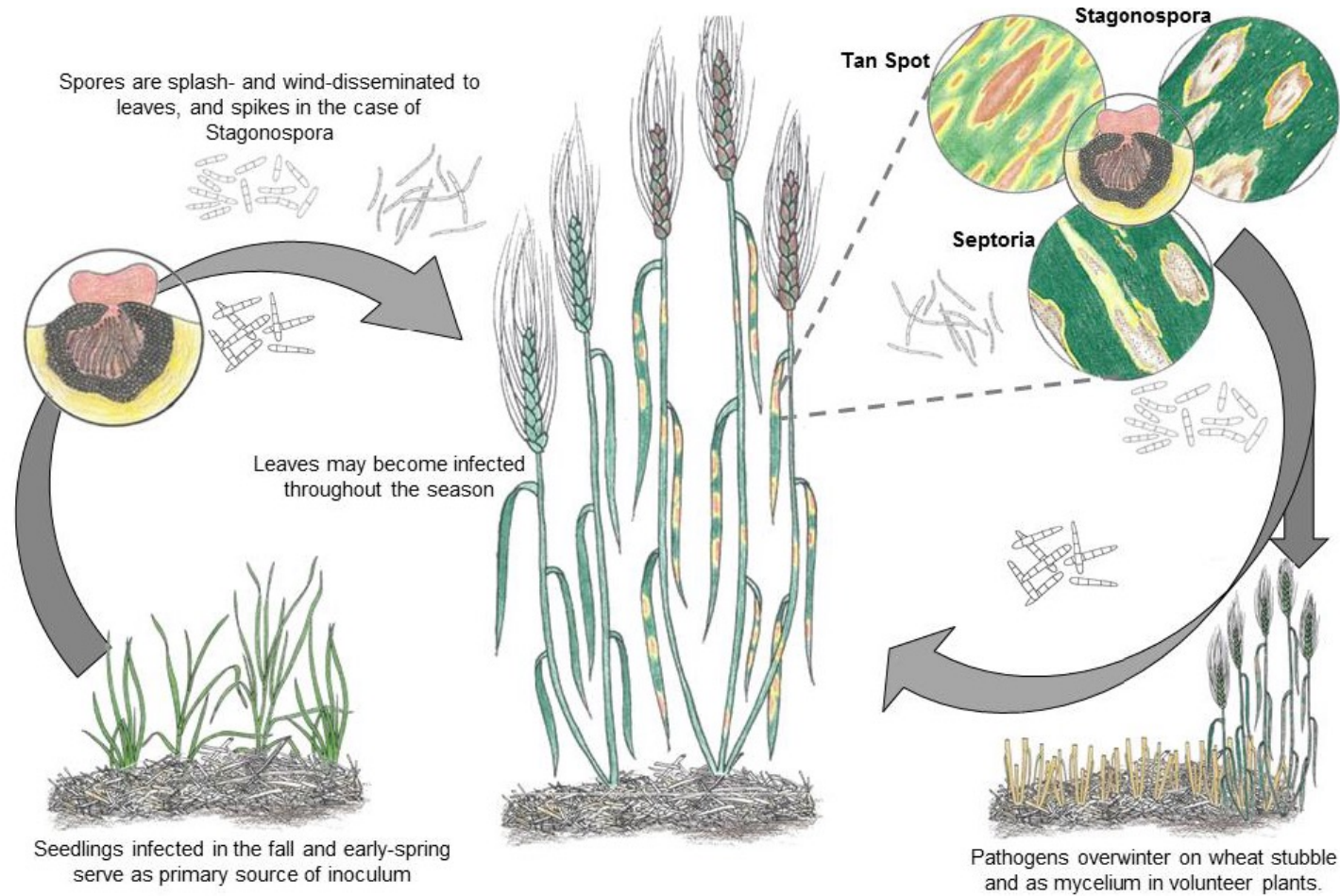
Puccinia triticina



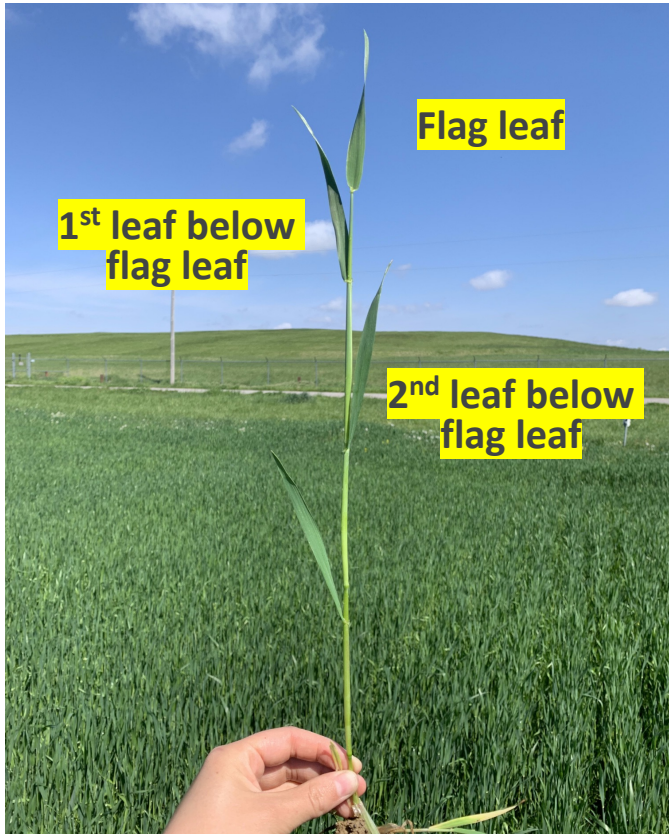
Stripe rust

Puccinia striiformis

Leaf blotch disease cycle



Scouting for foliar diseases

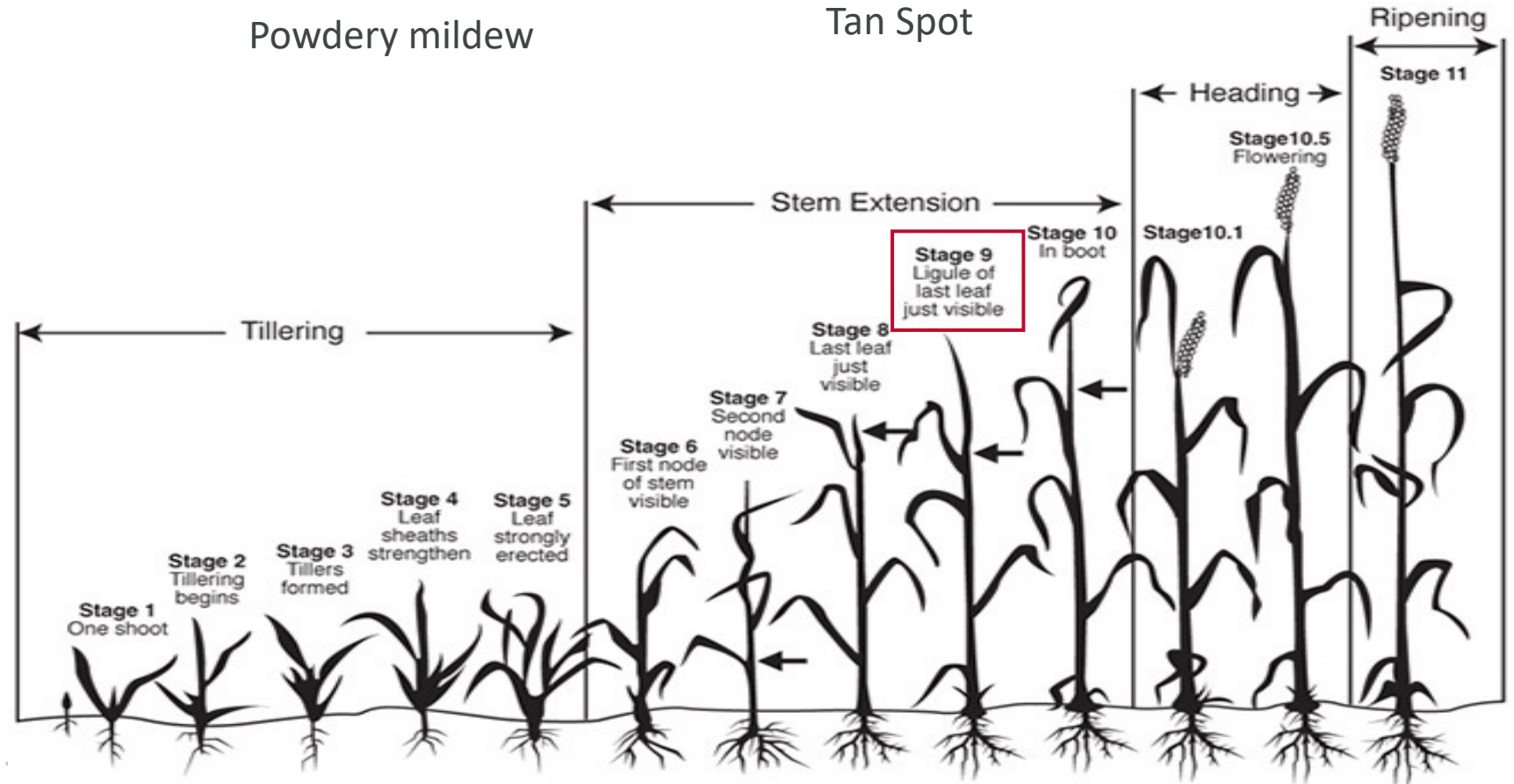


Septoria tritici blotch
Powdery mildew

Tan Spot

Stagonospora nodorum blotch

Rusts



How to manage foliar diseases?

- 1. Crop rotation:** wheat planted in only 1 of 3 years is recommended
- 2. Destroy volunteer wheat, rye, barley, and wild grasses** in the field before planting
- 3. Select varieties with moderate resistance** to foliar and kernel diseases where possible
- 4. Plant certified; disease-free seed** that has been treated with a recommended, seed-protectant fungicide
- 5. Planting Date:** sow winter wheat after the Hessian fly-safe date recommended for your county
- 6. Fertilize** wheat based on a soil test
- 7. Fungicide** application

Which products do we have?

CFAES



CROP PROTECTION NETWORK
A Product of Land Grant Universities



SMALL GRAIN DISEASE MANAGEMENT
CPN-3002-W

Fungicide Efficacy for Control of Wheat Diseases

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 United States.

The 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



Head scab
Image: Mimi Brieske



Which products do we have?

Efficacy of Fungicides for Wheat Disease Control Based on Appropriate Application Timing (03/2021)

	Active ingredient (%)	Product/Trade name	Rate/A (fl oz)	Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab ⁴	Harvest restriction
11	Picoxystrobin 22.5%	Aproach SC	6.0 – 12.0	G ¹	VG	VG ²	VG	E ³	VG	VG	NL	Feekes 10.5
	Pyraclostrobin 23.6%	Headline SC	6.0 – 9.0	G	VG	VG ²	E	E ³	E	G	NL	Feekes 10.5
	Azoxystrobin 22.9%	Quadris 2.08 SC	4.0 – 12.0	G	VG	VG	E	E	E	G	NL	Feekes 10.5.4
3	Metconazole 8.6%	Caramba 0.75 SL	10.0 – 17.0	VG	VG	--	VG	E	E	E	G	30 days
	Tebuconazole 38.7%	Folicur 3.6 F, multiple generics	4.0	NL	NL	NL	NL	E	E	E	F	30 days
	Prothioconazole 41.0%	Proline 480 SC	5.0 – 5.7	--	VG	VG	VG	VG	VG	VG	G	30 days
	Prothioconazole 19.0% Tebuconazole 19.0%	Prosaro 421 SC	6.5 – 8.2	G	VG	VG	VG	E	E	E	G	30 days
	Propiconazole 41.8%	Tilt 3.6 EC, multiple generics	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5.4
11	Trifloxystrobin 22.6%	Absolute Maxx SC	5.0	G	VG	VG	VG	VG	E	VG	NL	35 days
3	Tebuconazole 22.6%											
11	Picoxystrobin 17.9%	Aproach Prima SC	3.4 – 6.8	VG	VG	VG	VG	E	VG	--	NR	45 days
3	Cyproconazole 7.17%											
11	Trifloxystrobin 13.7%	Delaro 325 SC	8.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
3	Prothioconazole 16.0%											
7	Pydiflumetofen 13.7%	Miravis Ace SE	13.7	VG	VG	VG	VG	VG	VG	VG	G ⁵	Feekes 10.5.4
3	Propiconazole 11.4%											

SCAN ME



Fungicide efficacy trials

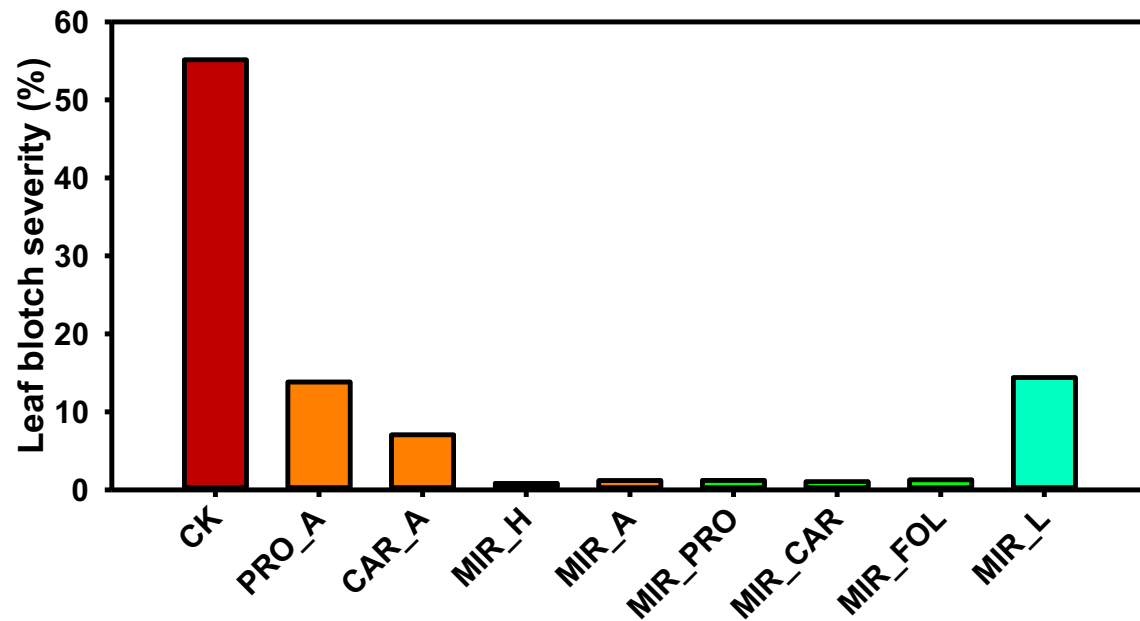
Code	Product	Rate (fl oz/A)	Timing
CK	Check (nontreated)	---	---
PRO_A	Prosaro	6.5	Feekes 10.5.1
CAR_A	Caramba	13.5	Feekes 10.5.1
MIR_H	Miravis Ace	13.7	Feekes 10.3
MIR_A	Miravis Ace	13.7	Feekes 10.5.1
MIR_PRO	Miravis Ace fb Prosaro	13.7 – 6.5	Feekes 10.5.1 / 4-6 DAA
MIR_CAR	Miravis Ace fb Caramba	13.7 – 13.5	Feekes 10.5.1 / 4-6 DAA
MIR_FOL	Miravis Ace fb Tebuconazole	13.6 – 4.0	Feekes 10.5.1 / 4-6 DAA
MIR_L	Miravis Ace	13.7 – 4.0	4-6 DAA

DAA = days after anthesis (Feekes 10.5.1)

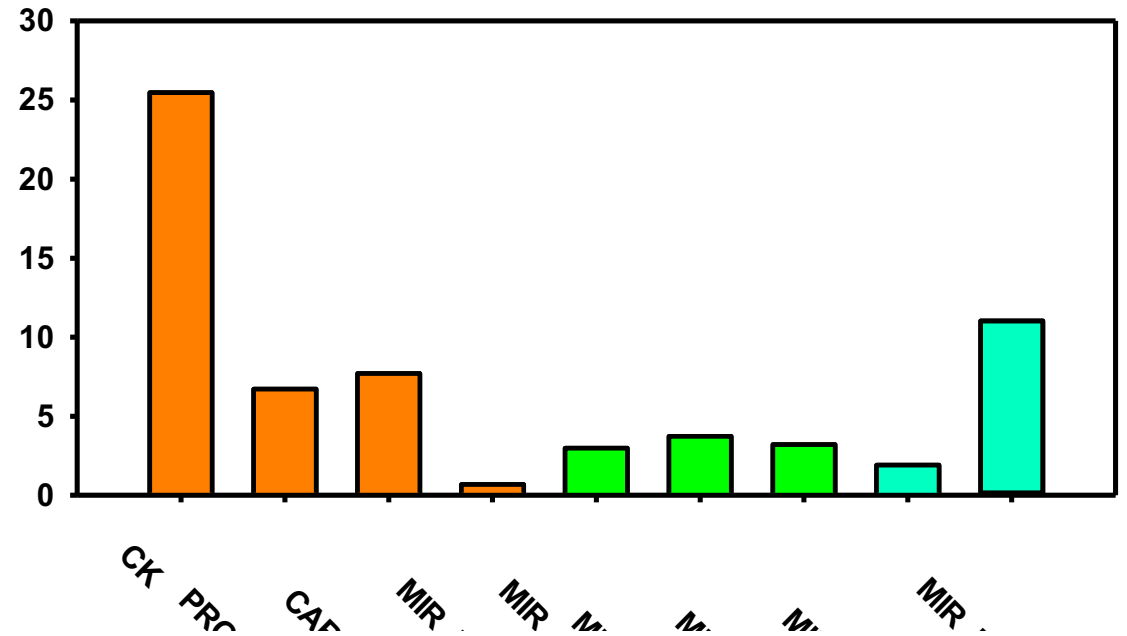
Fungicide efficacy trials

Leaf blotch diseases severity (%)- Flag Leaf

Wooster, OH - 2019



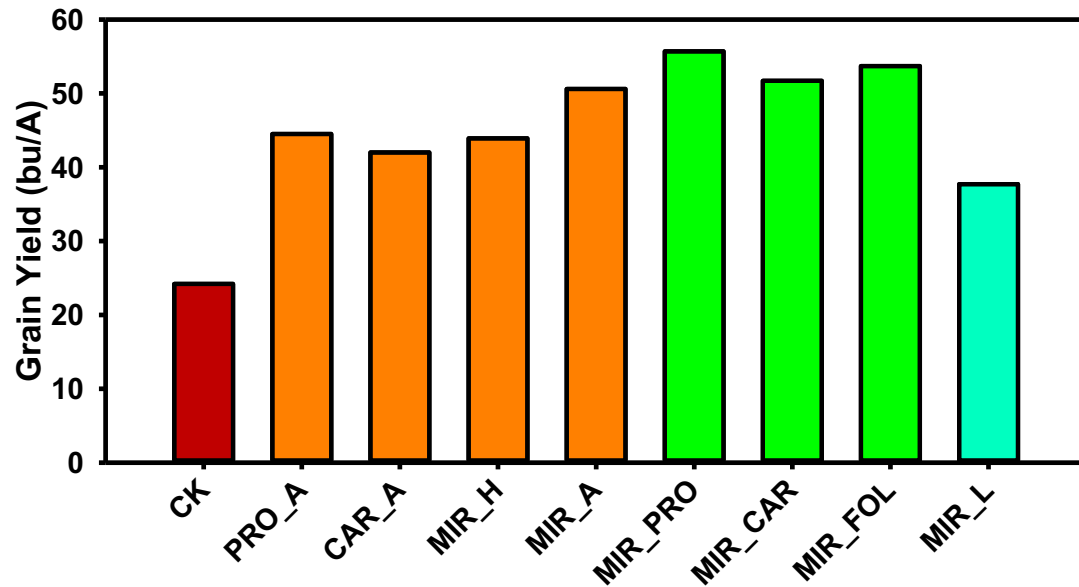
Wooster, OH - 2020



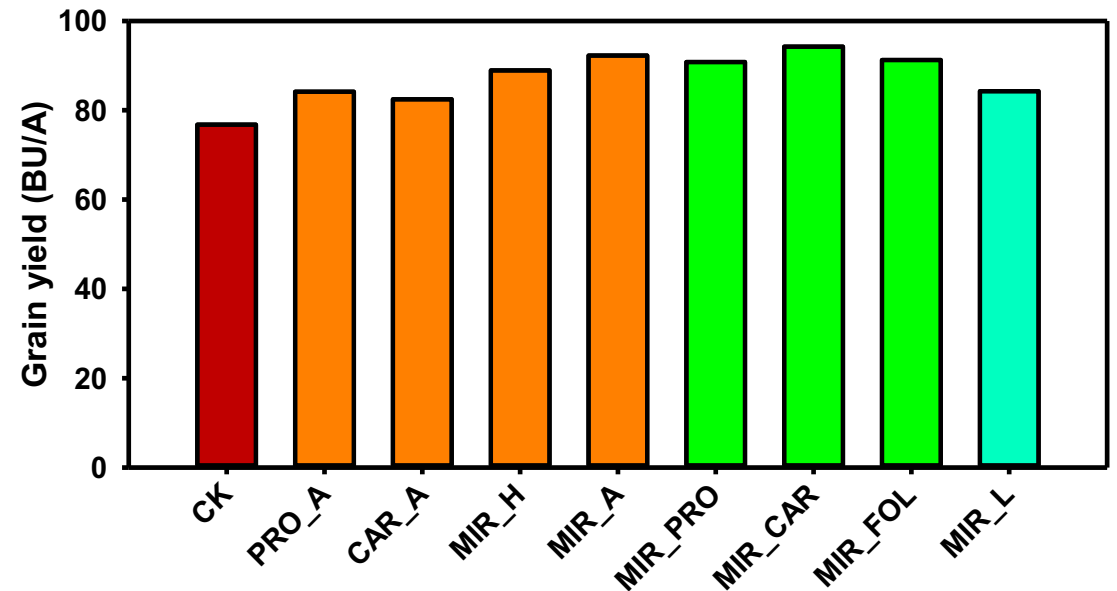
Fungicide efficacy trials

Grain Yield

Wooster, OH - 2019

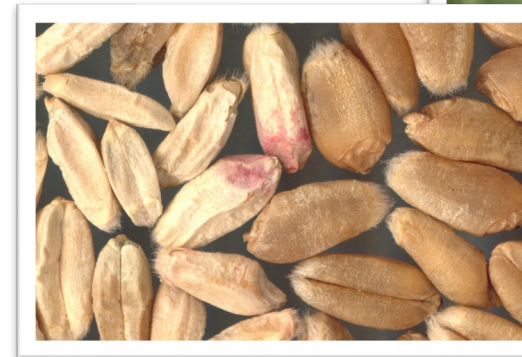


Wooster, OH - 2020



— Fusarium head blight (aka Scab, FHB)

- Caused by the fungal pathogen *Fusarium graminearum*
- Infects wheat spikes during anthesis
- FHB can reduce both **grain yield and quality**
- Survives in the residue: wheat, corn
- Mycotoxin production
 - ✓ **Deoxynivalenol (DON) aka “Vomitoxin”**
- Contaminated grain is rejected or priced down



How do we manage FHB?

PRE-PLANTING DECISIONS

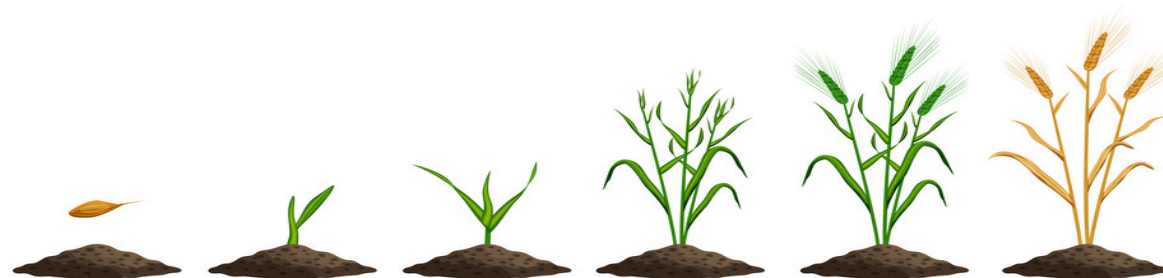
- ✓ Crop rotation
- ✓ Tillage
- ✓ High quality seed
- ✓ Variety selection
 - **Moderately resistant** may reduce FHB and DON by up to 50%

WITHIN-SEASON DECISIONS

- ✓ Fungicide applications
 - Timing is critical!!!**
- ✓ FHB risk tool - website

HARVEST DECISIONS

- ✓ Harvest timing
- ✓ Proper grain storage



What fungicide products do we use?

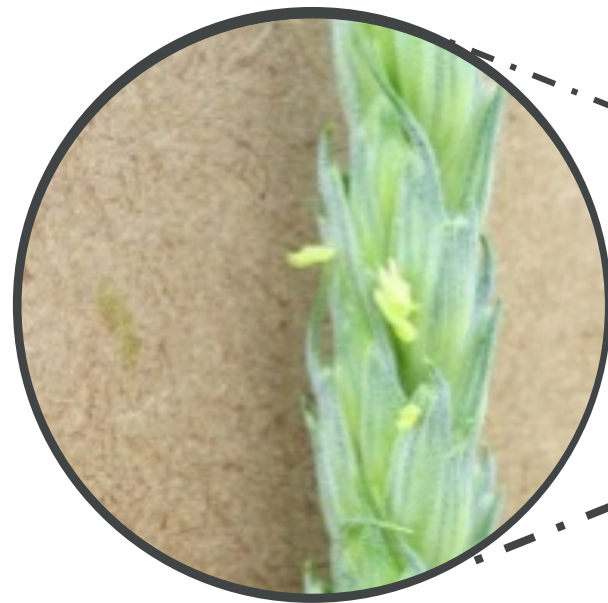
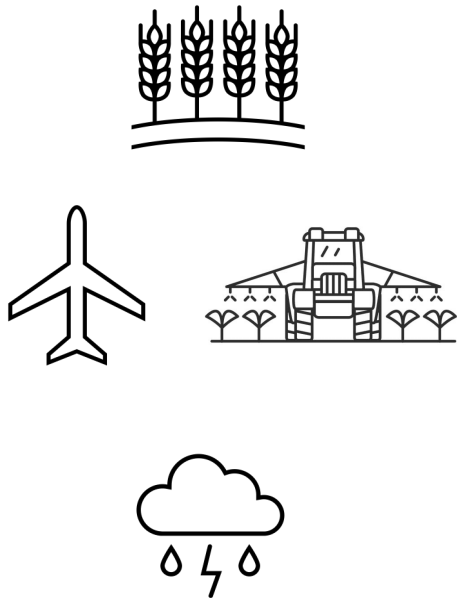
QoI	DMI	SDHI
Quinone outside inhibitors	Demethylation inhibitors	Succinate dehydrogenase inhibitors
FRAC CODE 11	FRAC CODE 3	FRAC CODE 7
Example: azoxystrobin	Example: tebuconazole	Example: fluopyram

Key products for FHB management

Product	Rate (fl oz/A)	Pre-harvest interval	Group name	FRAC CODE
Prosaro	6.5 – 8.2	30 days	DMI	FRAC 3
Proline	5 – 5.7	30 days	DMI	FRAC 3
Caramba	10 - 17	30 days	DMI	FRAC 3
Miravis Ace	13.7	Feekes 10.5.4	DMI + SDHI	FRAC 3 + FRAC 7
Sphaerex	7.3	30 days	DMI	FRAC 3
Prosaro Pro	10.3	30 days	DMI + SDHI	FRAC 3 + FRAC 7

Fungicide application time

CHALLENGES:



10.5.1

Early



Feekes 10.5.1

Mid



Feekes 10.5.2

Late



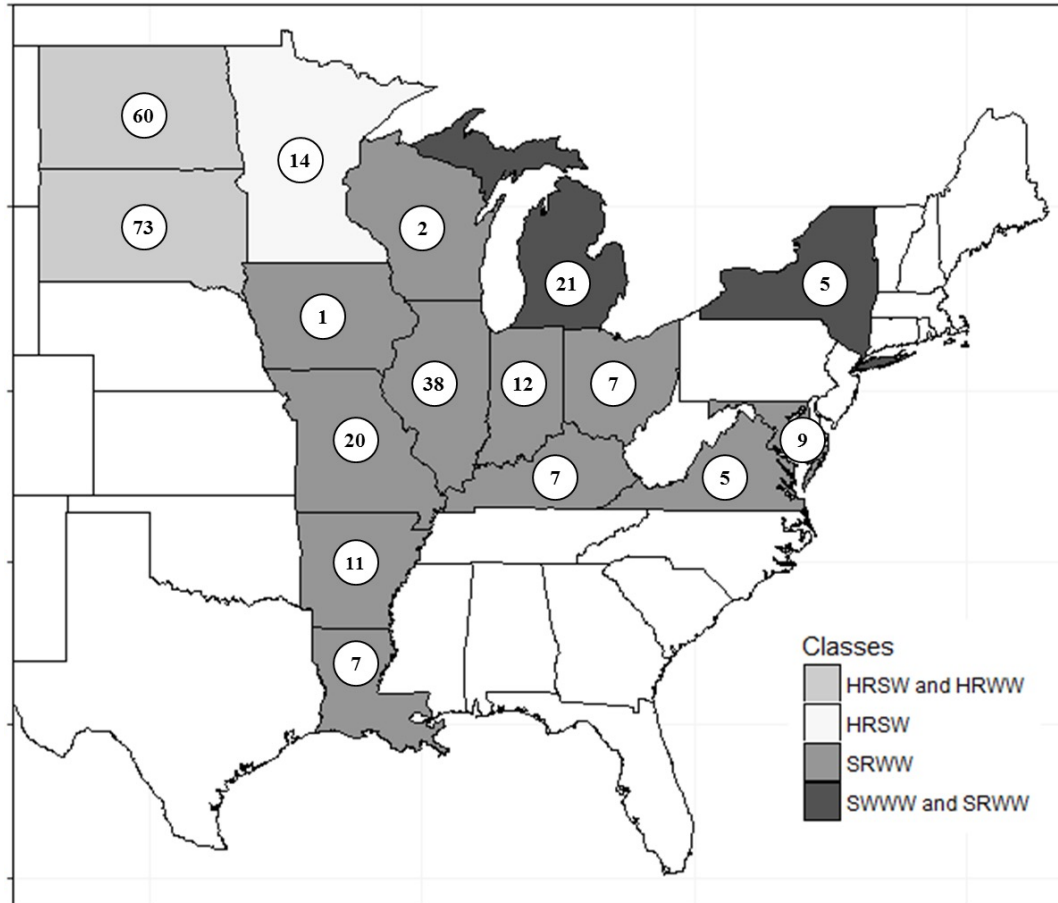
Feekes 10.5.3

Questions to answer

- ✓ What's the best time for a fungicide application to manage FHB and DON?
- ✓ What's the efficacy of fungicides applied before anthesis?
- ✓ What's the efficacy of New Products vs. Industry Standards?
- ✓ What's the effect of the integration of Fungicide + Genetic Resistance?

Fungicide application time

16 states over 19 years (1995 to 2013)



TREATMENTS

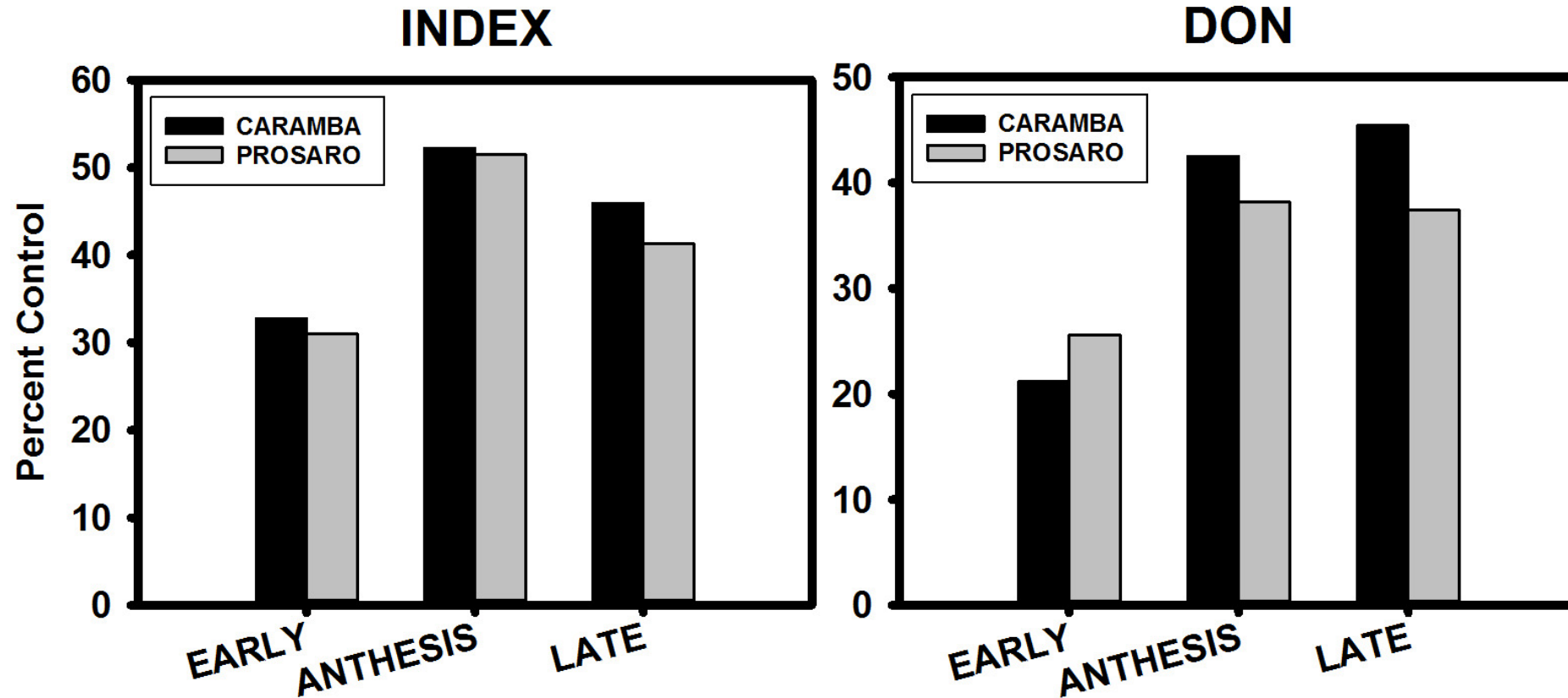
1. Nontreated check (CK)
2. Caramba early (CE)
3. Caramba at anthesis (CA)
4. Caramba late (CL)
5. Prosaro early (PE)
6. Prosaro at anthesis (PA)
7. Prosaro late (PL)

META-ANALYSIS

- ✓ Percent control (C)

$$\bar{C} = [1 - \exp(\bar{L})] \times 100$$


Fungicide application time



Fungicide application time: Revisited

PROPICONAZOLE GROUP 3 FUNGICIDE
 PYDIFLUMETOFEN GROUP 7 FUNGICIDE

PULL HERE TO OPEN ▶



Miravis[®] Ace

syngenta.

Fungicide

Active Ingredients:

Pydiflumetofen*:	13.7%
Propiconazole**:	11.4%
Other Ingredients:	74.9%
Total:	100.0%

*CAS No. 1228284-64-7
**CAS No. 60207-90-1

Miravis[®] Ace is a suspoemulsion (SE) formulation and contains 1.254 lb of active ingredient pydiflumetofen and 1.047 lb ai active ingredient propiconazole per gallon.

**KEEP OUT OF REACH OF CHILDREN.
CAUTION**

See additional Precautionary Statements and Directions for Use inside booklet.

EPA Reg. No. 100-1645
EPA Est. 100-NE-001

SCP 1645A-L1 0219
4104399

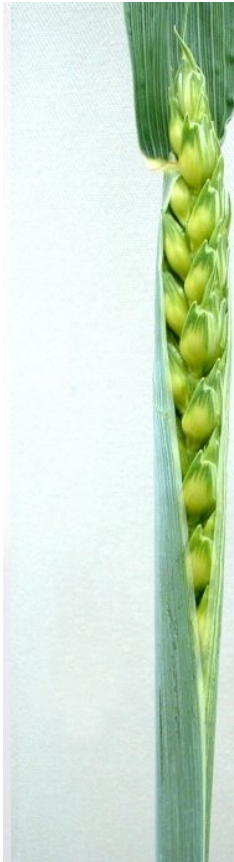
2.5 Gallons
Net Contents

DMI – Propiconazole
+
SDHI - Pydiflumetofen

Target Disease	Rate (fl oz/A)	Application Timing
Fusarium head blight (<i>Fusarium</i> spp.)	13.7*	Apply between Feekes growth stage 10.3 (Zadoks 55) and Feekes 10.5.2 (Zadoks 65). (See growth stage descriptions below.)

— Fungicide application time: Revisited

10.3



10.4



10.5



10.5.1



10.5.2



— Fungicide application time: Revisited

Fungicide programs

Code	Product	Rate (fl oz/A)	Timing
CK	Check - Nontreated	---	---
PRO_A	Prosaro	6.5	Feekes 10.5.1
MIR_H	Miravis Ace	13.7	Feekes 10.3
MIR_A	Miravis Ace	13.7	Feekes 10.5.1
MIR_FOL	Miravis Ace fb Tebuconazole	13.6 - 4.0	Feekes 10.5.1 / 4-6 DAA

DAA = days after anthesis (Feekes 10.5.1)

All treatments applied with a non-ionic surfactant @ 0.125% V/V

— Fungicide application time: **Revisited**

Anthesis

Prosaro vs Miravis Ace



Wooster, OHIO 2019

— Fungicide application time: **Revisited**

Early Heading to Anthesis

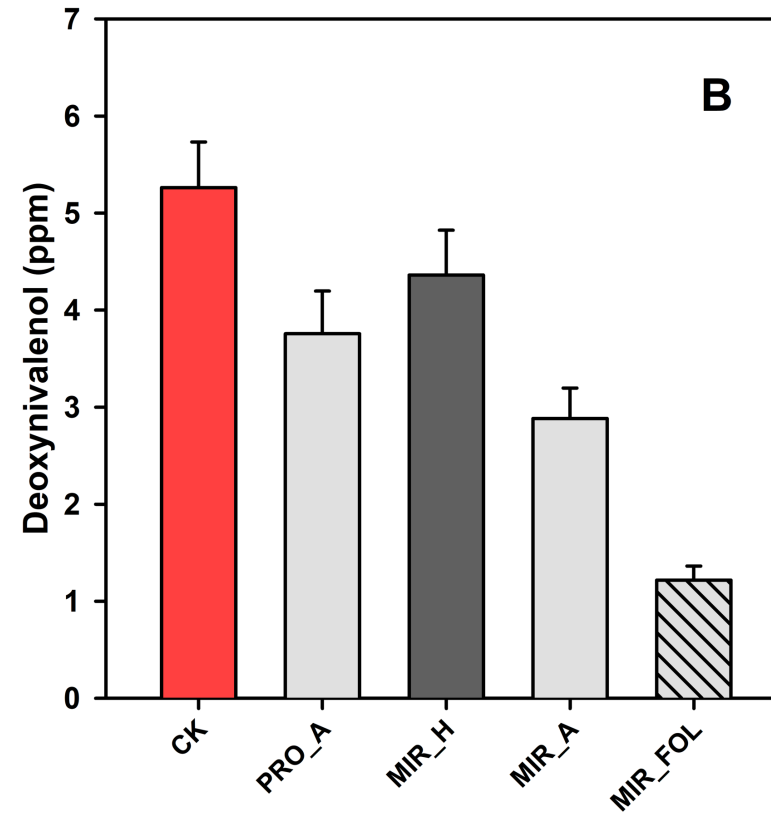
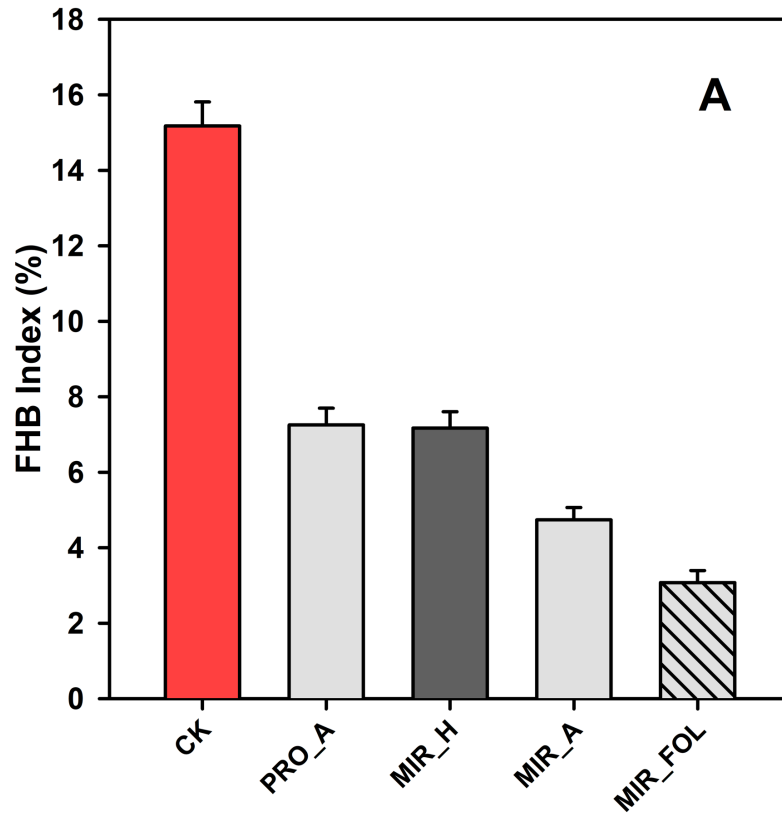
Miravis Ace



Wooster, OHIO 2019

Fungicide application time: Revisited

Treatment Means



New Products vs Industry Standards

CFAES

Miravis[®] Ace
syngenta.

Fungicide

Active Ingredients:	
Pydiflumetofen*	13.7%
Propiconazole**	11.4%
Other Ingredients:	74.9%
Total:	100.0%

DMI – Propiconazole
+
SDHI - Pydiflumetofen

BAYER

PROSARO[®] PRO 400 SC Fungicide

Net Contents:
2.5 Gallons

PROTHIOCONAZOLE	GROUP 3	FUNGICIDE
TEBUCONAZOLE	GROUP 3	FUNGICIDE
FLUOPYRAM	GROUP 7	FUNGICIDE

DMI – Prothioconazol
+
DMI – Tebuconazole
+
SDHI – Fluopyram

BASF
We create chemistry

Metconazole	Group 3	Fungicide
Prothioconazole	Group 3	Fungicide

Sphaerex[™]
Fungicide

For disease control in wheat

Active Ingredients*:	
metconazole: 5-[[4-(chlorophenyl)methyl]-2,2-dimethyl-1-(1H-1,2,4-triazol-1-ylmethyl)cyclopentanol]	10.91%
prothioconazole: 2-[2-(1-chlorocyclopropyl)-3-(2-Chlorophenyl)-2-hydroxypropyl]-1,2-dihydro-3H-1,2,4-triazole-3-thione	18.19%
Other Ingredients:	70.90%
Total:	100.00%

* Sphaerex[™] fungicide contains 0.939 lb metconazole and 1.565 lbs prothioconazole per gallon.
EPA Reg. No. 7969-473 EPA Est. No.

DMI – Metconazole
+
DMI – Prothioconazole

New Products vs Industry Standards

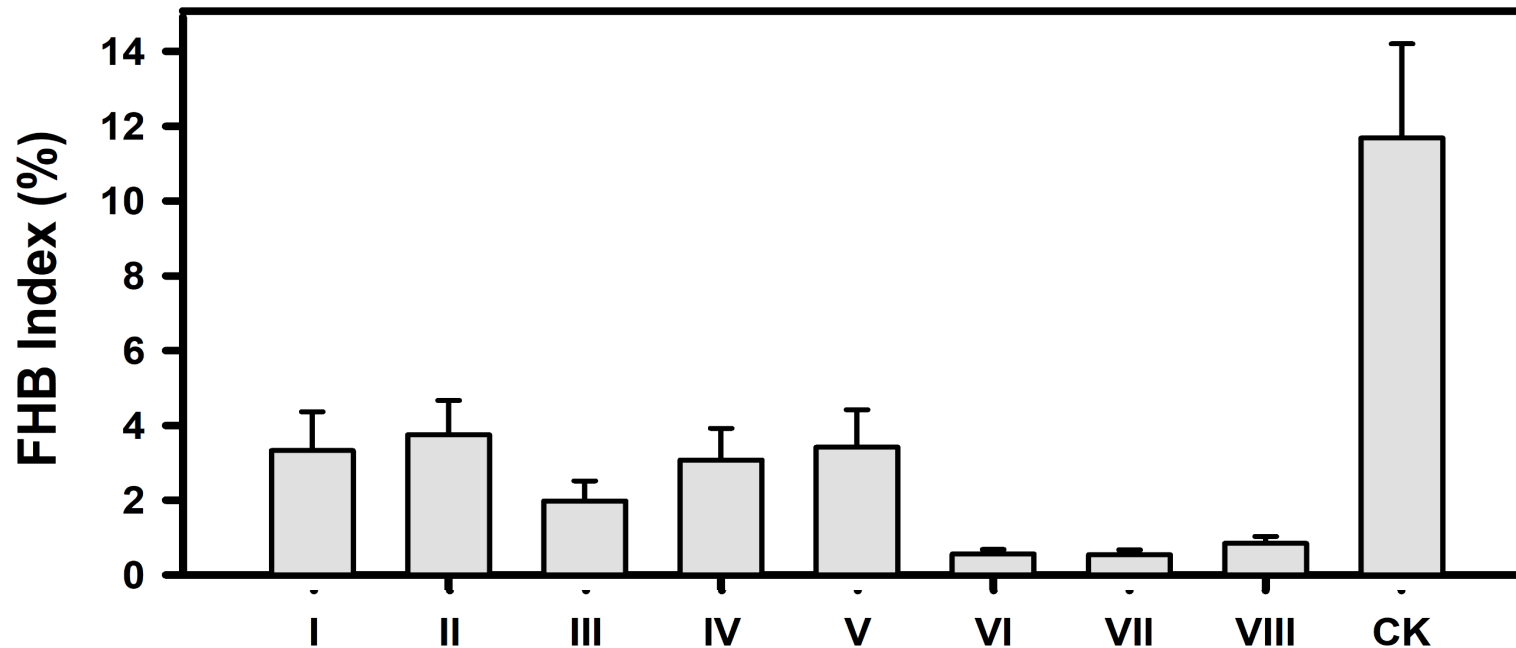
Code	Product	Rate (fl oz/A)	Timing
CK	Check (nontreated)	---	---
I	Prosaro	6.5	Feekes 10.5.1
II	Caramba	13.5	Feekes 10.5.1
III	Miravis Ace	13.7	Feekes 10.5.1
IV	Prosaro Pro	10.3	Feekes 10.5.1
V	Sphaerex	7.3	Feekes 10.5.1
VI	Miravis Ace fb Prosaro Pro	13.7 – 10.3	Feekes 10.5.1 / 4-6 DAA
VII	Miravis Ace fb Sphaerex	13.7 – 7.3	Feekes 10.5.1 / 4-6 DAA
VIII	Miravis Ace fb Tebuconazole	13.6 – 4.0	Feekes 10.5.1 / 4-6 DAA

DAA = days after anthesis (Feekes 10.5.1)

All treatments applied with a non-ionic surfactant @ 0.125% V/V

New Products vs Industry Standards

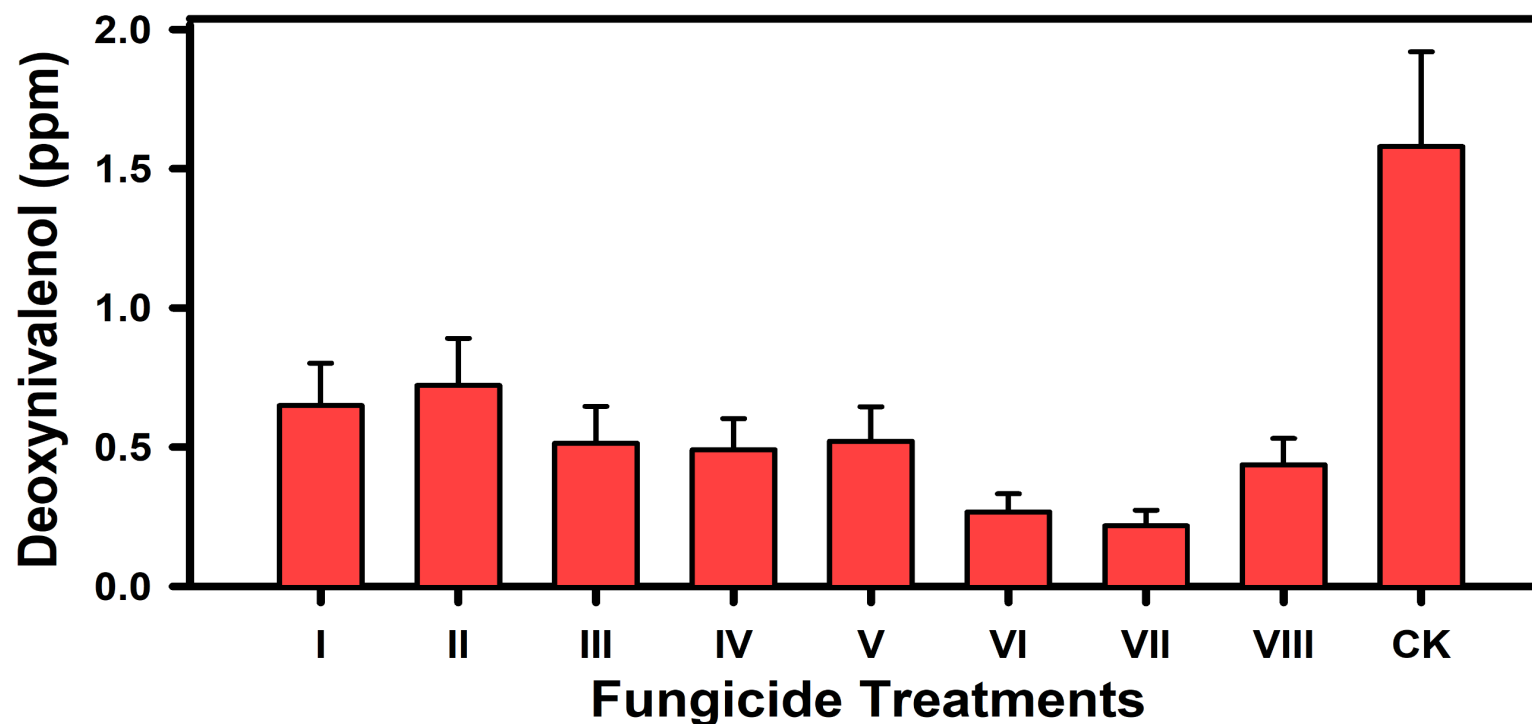
FHB index (%)



Fungicide treatment programs: non-treated check (CK), or an application of Prosaro (I), Caramba (II), Miravis Ace (III), Prosaro Pro (IV), or Sphaerex (V) at anthesis, or Miravis Ace at anthesis followed by an application of Prosaro Pro (VI), Sphaerex (VII), or Tebuconazole (VIII) at 4-6 days after anthesis.

New Products vs Industry Standards

Vomitoxin (DON)



Fungicide treatment programs: non-treated check (CK), or an application of Prosaro (I), Caramba (II), Miravis Ace (III), Prosaro Pro (IV), or Sphaerex (V) at anthesis, or Miravis Ace at anthesis followed by an application of Prosaro Pro (VI), Sphaerex (VII), or Tebuconazole (VIII) at 4-6 days after anthesis.

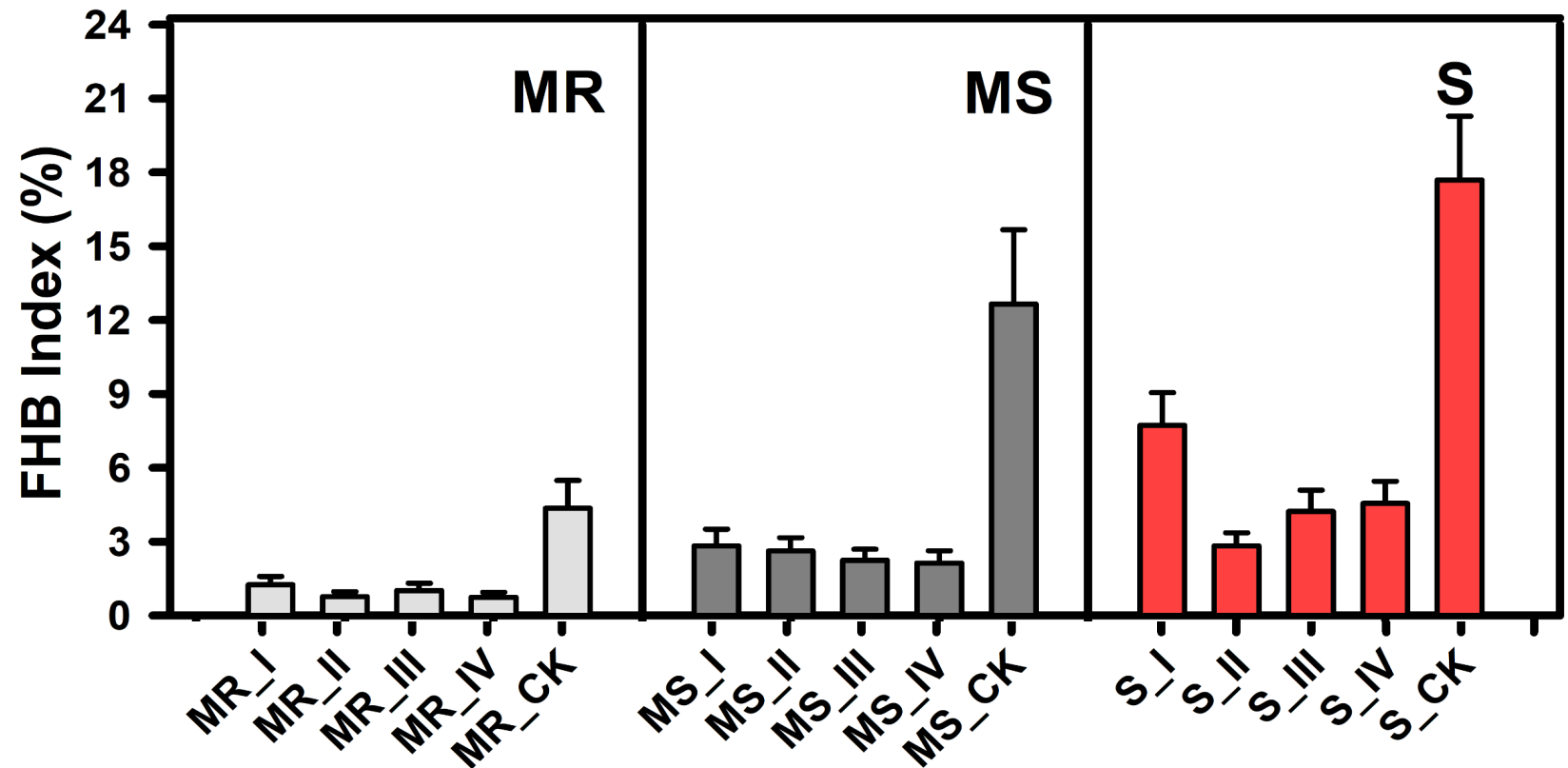
Fungicide + Variety Resistance

Fungicide x Resistance – FHB index (%)

Treatments

MR = Moderately Resistant
MS = Moderately Susceptible
S = Susceptible

CK – Non-treated
I – Prosaro
II – Miravis Ace
III – Prosaro Pro
IV – Sphaerex



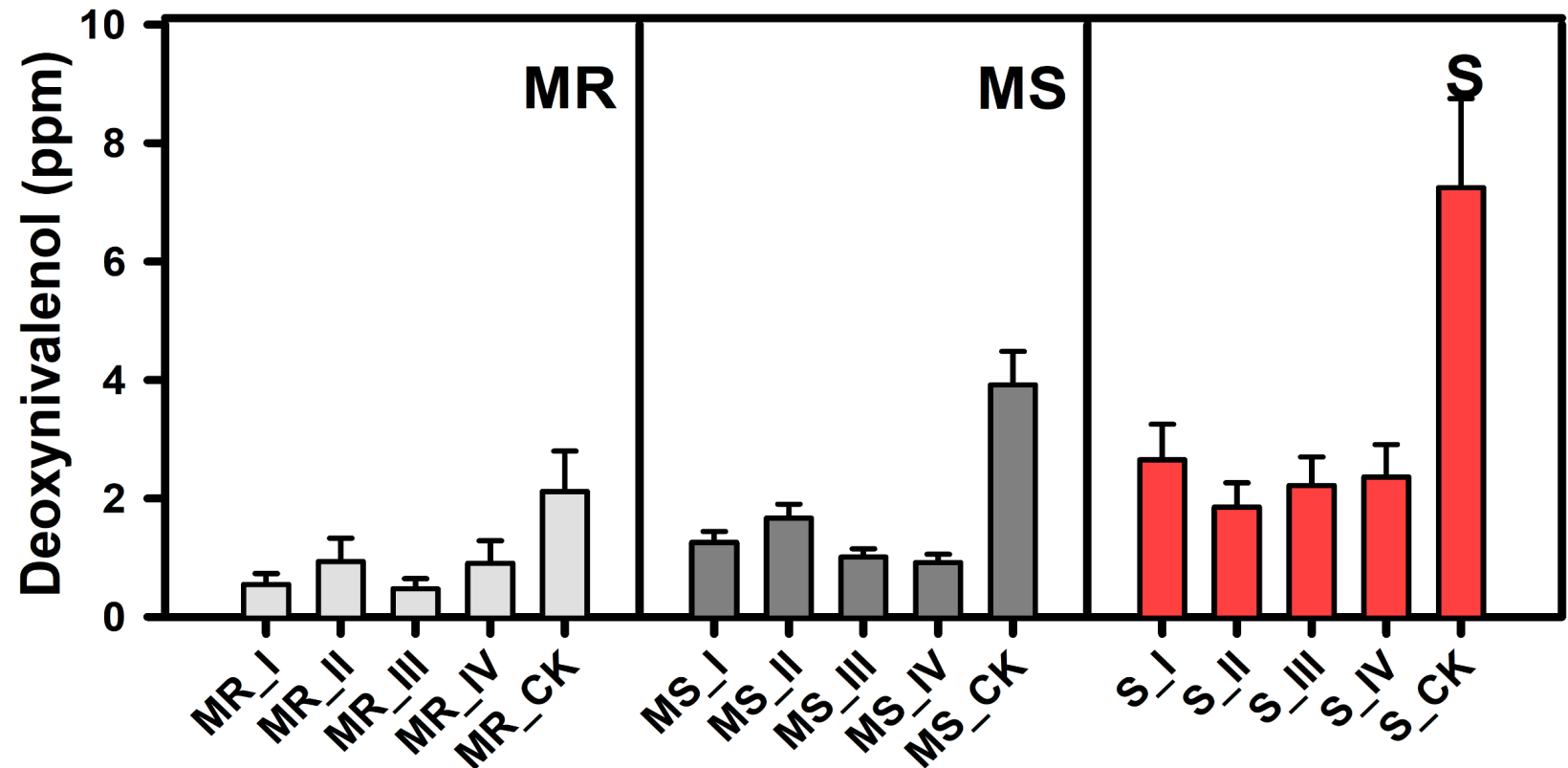
Fungicide + Variety Resistance

Fungicide x Resistance – DON

Treatments

MR = Moderately Resistant
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S = Susceptible

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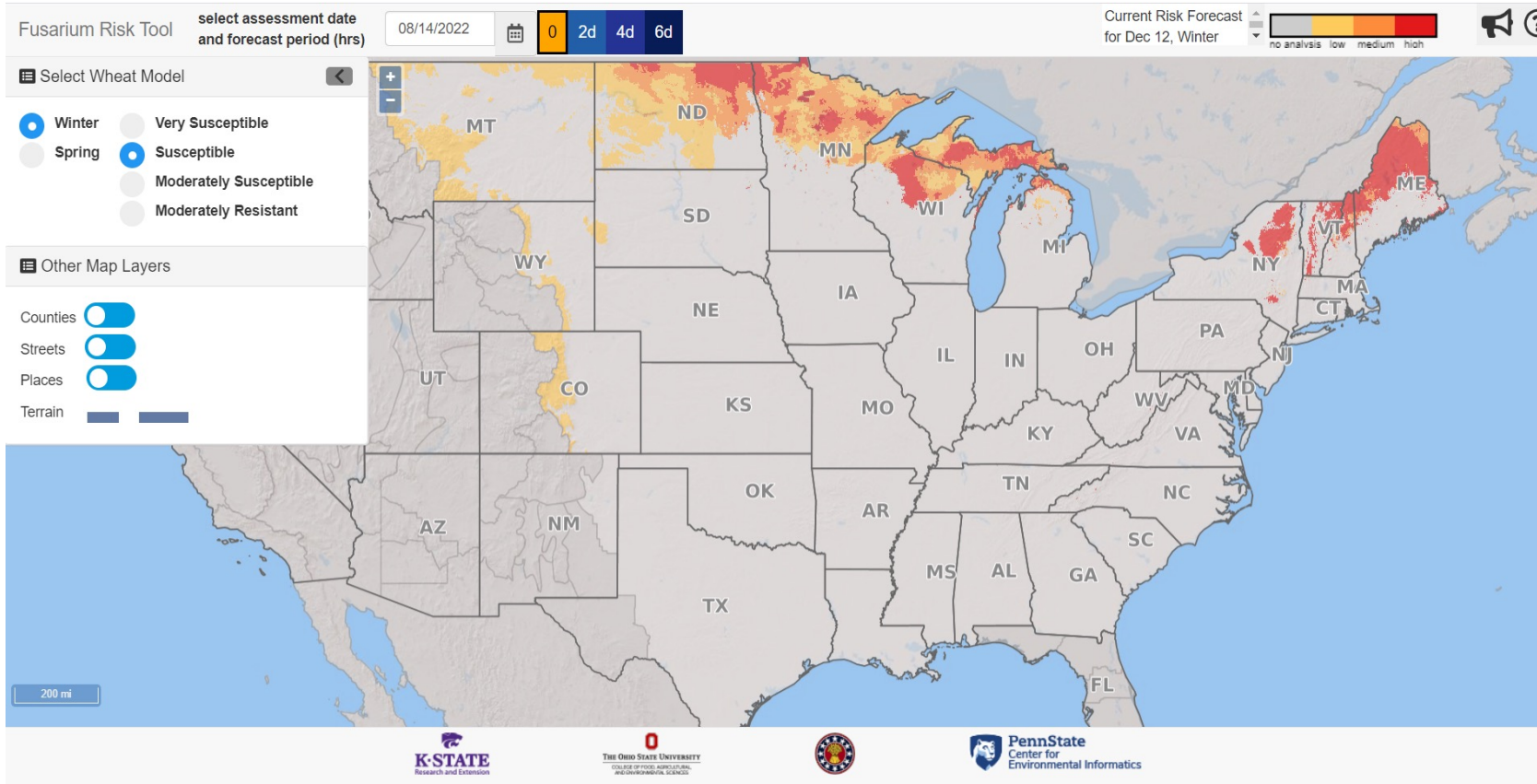


Concluding remarks

- ✓ What's the best time for a fungicide application to manage FHB and DON?
- ✓ What's the efficacy of fungicides applied before anthesis?
- ✓ What's the efficacy of New Products vs. Industry Standards?
- ✓ What's the effect of the integration of Fungicide + Genetic Resistance?

Scab weather-based risk

CFAES



SCAN ME



Acknowledgements



Dr. Darcy Telenko



Dr. Pierce Paul



Dr. Pierce Paul's Lab



U.S. Wheat & Barley
Scab Initiative



CFAES

EST. 1870

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Thank you!

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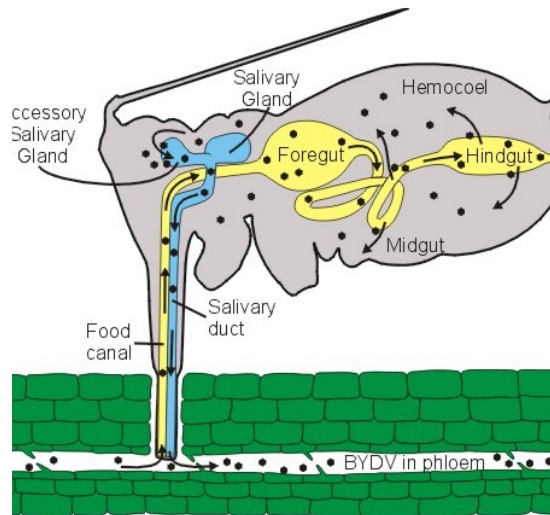
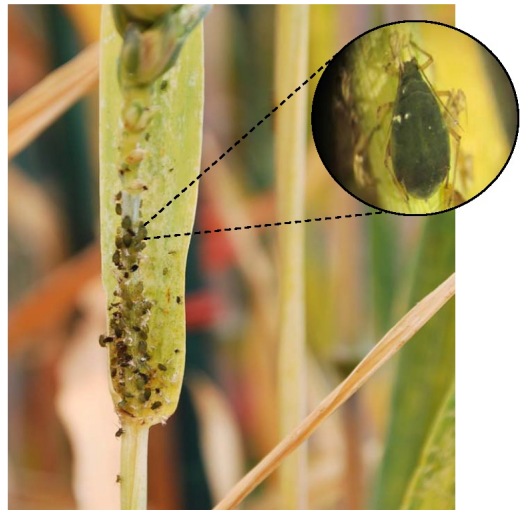
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Barley Yellow Dwarf

- Most widely distributed and economically most important virus disease of wheat
- Yield losses up to 20%
- Caused by at least eight viral species in the *Luteoviridae* virus family
- Transmitted by over 20 species of aphids
- Early symptoms resemble mineral deficiencies, low temperature damage, root rots, herbicide injury, or other problems



Wegulo and Hein, 2013



D'Arcy and Domier, 2000

Management

1. Plant BYD resistant or tolerant varieties
2. Delay fall seeding of wheat until aphid populations decline
3. Proper fertilization is necessary for good crop growth
4. Control volunteer wheat, barley, oats and grassy weeds
5. Use insecticides to control aphids

Laboratories testing for BYD:

- Agdia, Inc., <http://www.agdia.com/testing-services/>
- Purdue Plant and Pest Diagnostic Lab, <http://www.ppdl.purdue.edu/ppdl/samples.html>