Protecting your high yielding wheat

Kaitlyn Bissonnette

Assistant Extension Professor

University of Missouri

Disease Triangle

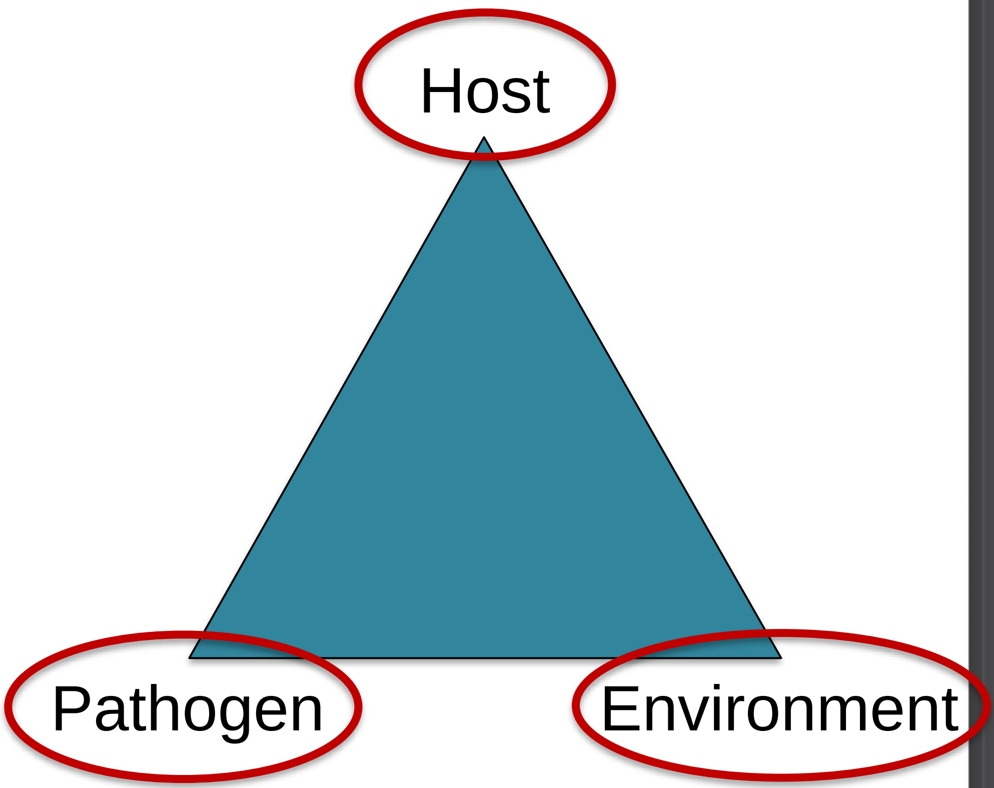
Host

Pathogen

Environment

Effective disease management

- Disrupts the disease triangle
- Integrated disease management
  - Varietal resistance
  - Cultural practices
  - Chemical control measures



Wheat Diseases

- Fusarium head blight
- Stripe rust
- Stagnospora leaf and glume blotch
- Barley Yellow Dwarf Virus

Fusarium head blight

- *Fusarium graminearum*
- Environment
  - Warm temperatures (75 – 85°F)
  - High relative humidity (>90%)
- Pathogen survival
  - On residues
  - Spores released in spring

Fusarium head blight

- Majority of infection at flowering
- Yield loss not just from kernel damage
  - Mycotoxins
    - DON (vomitoxin)
    - NIV
    - Zea

The 3ADON Population of *Fusarium graminearum* Found in North Dakota Is More Aggressive and Produces a Higher Level of DON than the Prevalent 15ADON Population in Spring Wheat

Krishna D. Puri and **Shaobin Zhong**

Department of Plant Pathology, North Dakota State University, Fargo 58108-6050.

2010

2010

A comparison of aggressiveness and deoxynivalenol production between Canadian *Fusarium graminearum* isolates with 3-acetyl and 15-acetyldeoxynivalenol chemotypes in field-grown spring wheat

Authors Authors and affiliations

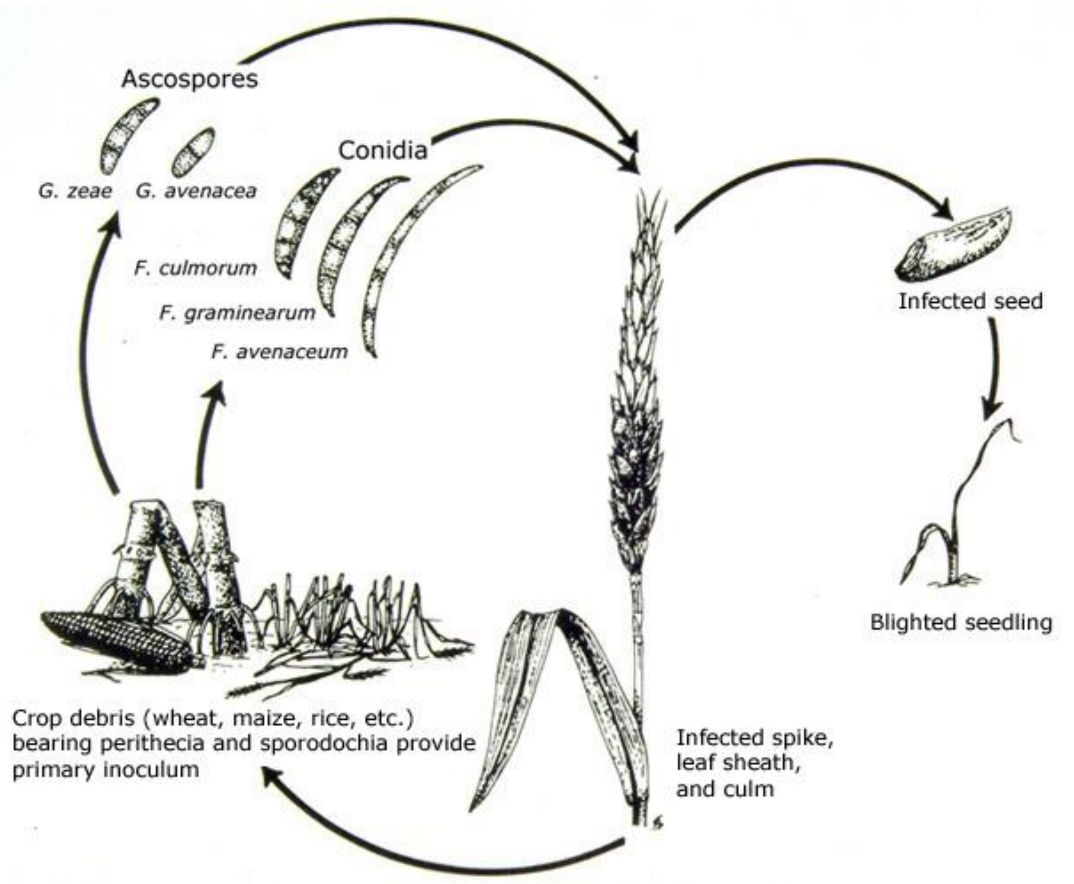
Christiane von der Ohe, Victoria Gauthier, Lily Tamburic-Ilincic, Anita Brule-Babel, W. G. Dilantha Fernando, Randy Clear,

Greenhouse Studies Reveal Increased Aggressiveness of Emergent Canadian *Fusarium graminearum* Chemotypes in Wheat

N. A. Foroud, Agriculture and Agri-Food Canada, Lethbridge Research Centre, Alberta T1J 4B1; **S. P. McCormick**, Bacterial Foodborne Pathogens and Mycology Unit, National Center for Agricultural Utilization Research, USDA-ARS, Peoria, IL 61604; **T. MacMillan** and **A. Badea**, Agriculture and Agri-Food Canada, Lethbridge Research Centre, Alberta; **D. F. Kendra**, National Center for Agricultural Utilization Research, USDA-ARS, Peoria, IL; **B. E. Ellis**, Michael Smith Laboratories, University of British Columbia, Vancouver, British Columbia V6T 1Z4; **F. Eudes**, Agriculture and Agri-Food Canada, Lethbridge Research Centre, Alberta

2012

Fusarium head blight

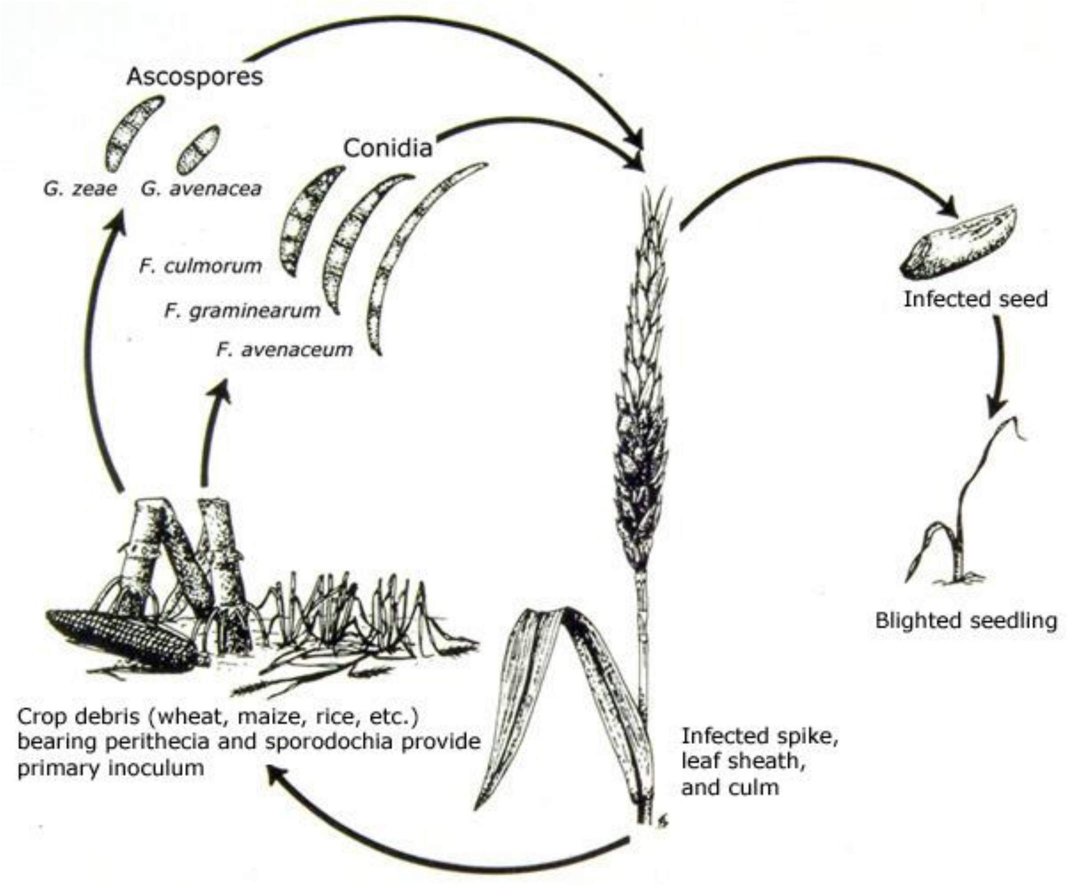


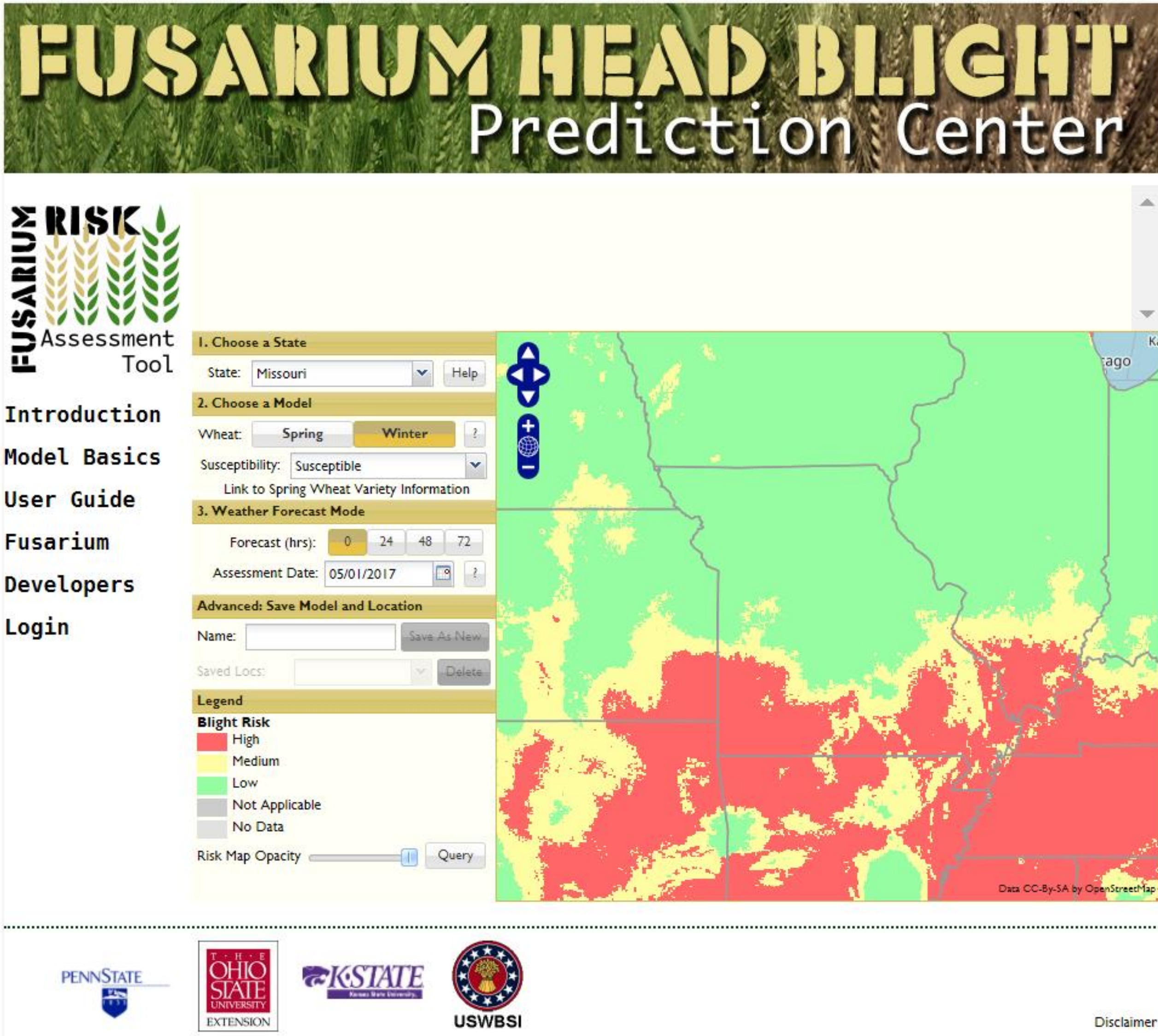
FHB Management

- Crop rotation

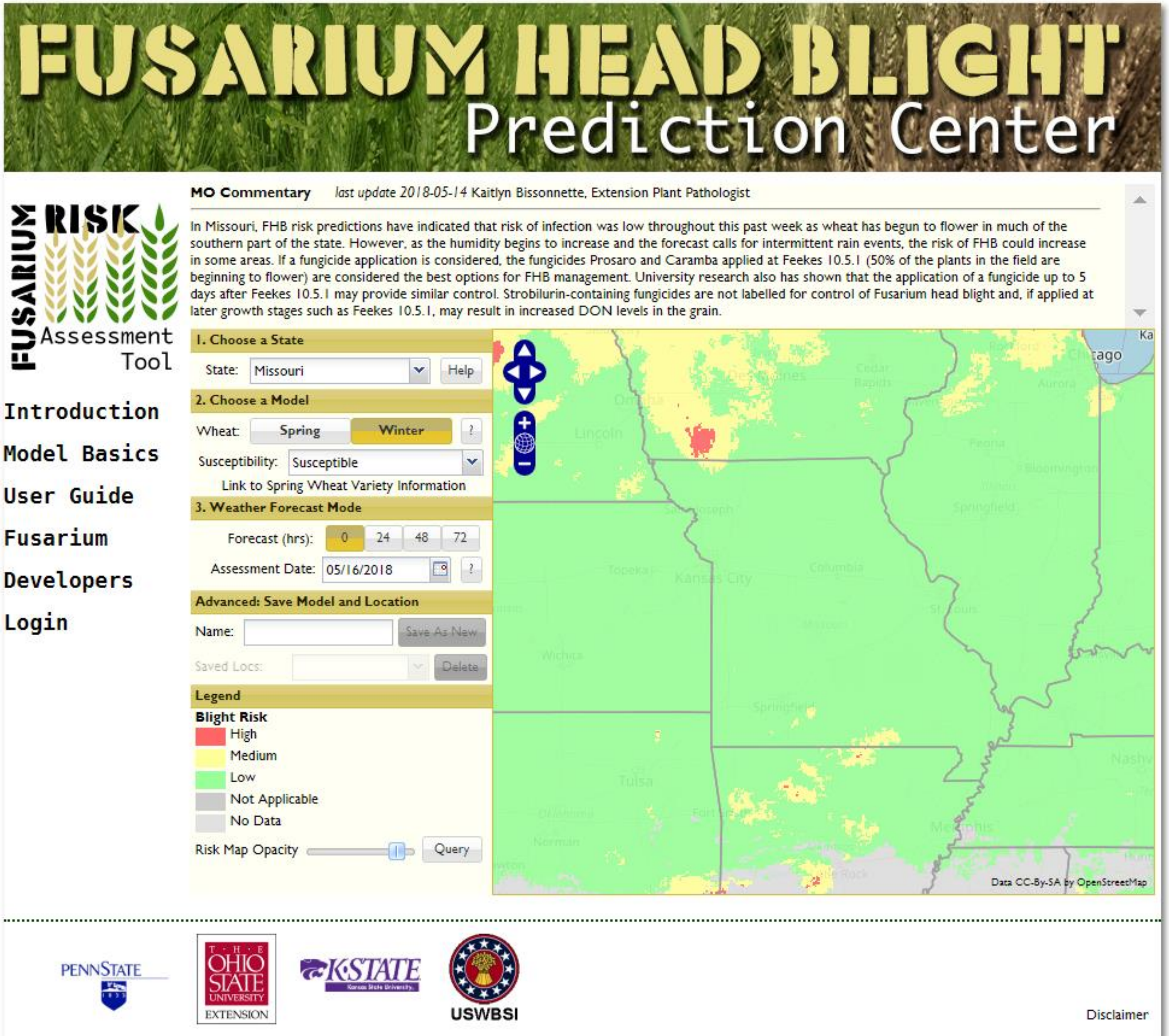
Limitations of crop rotation

- Abundant inoculum
- Corn diseases
  - Gibberella ear rot
  - Gibberella stalk rots
- Assumption that always present





www.wheatscab.psu.edu


FUSARIUM HEAD BLIGHT
Prediction Center
FUSARIUM RISK Assessment Tool
Introduction
Model Basics
User Guide
Fusarium
Developers
Login
MO Commentary
last update 2018-05-14 Kaitlyn Bissonnette, Extension Plant Pathologist
In Missouri, FHB risk predictions have indicated that risk of infection was low throughout this past week as wheat has begun to flower in much of the southern part of the state. However, as the humidity begins to increase and the forecast calls for intermittent rain events, the risk of FHB could increase in some areas. If a fungicide application is considered, the fungicides Prosaro and Caramba applied at Feekes 10.5.1 (50% of the plants in the field are beginning to flower) are considered the best options for FHB management. University research also has shown that the application of a fungicide up to 5 days after Feekes 10.5.1 may provide similar control. Strobilurin-containing fungicides are not labelled for control of Fusarium head blight and, if applied at later growth stages such as Feekes 10.5.1, may result in increased DON levels in the grain.
1. Choose a State
State: Missouri
Help
2. Choose a Model
Wheat: Spring Winter
Susceptibility: Susceptible
Link to Spring Wheat Variety Information
3. Weather Forecast Mode
Forecast (hrs): 0 24 48 72
Assessment Date: 05/16/2018
Advanced: Save Model and Location
Name:
Save As New
Saved Locs:
Delete
Legend
Blight Risk
High
Medium
Low
Not Applicable
No Data
Risk Map Opacity
Query
Lincoln
Kansas City
Columbia
St. Louis
Springfield
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FHB Management

- Crop rotation
- Resistant varieties

Defining resistance

- FHB index
  - 21 days after flowering
  - Incidence – percent plants in a plot infected
  - Severity – percent of infected head diseased
  - Fusarium damaged kernels (FDK)
- Resistance classes
  - Very susceptible (VS)
  - Susceptible (S)
  - Moderately susceptible (MS)
  - Moderately resistant (MR)

Cultivar trial

- Cultivar resistance
  - How does resistance class affect mycotoxin concentration?
  - Can FHB indices effectively estimate mycotoxin concentration by resistance class?

	Cultivar Study
Design	RCBD
Locations	1 – irrigated
Years	2011, 2013, 2014
Plot Info	Single Row Plots
Cultivars	16-20
Treatments	Cultivar Resistance Class
Measured	DON (grain, straw), FHB Index

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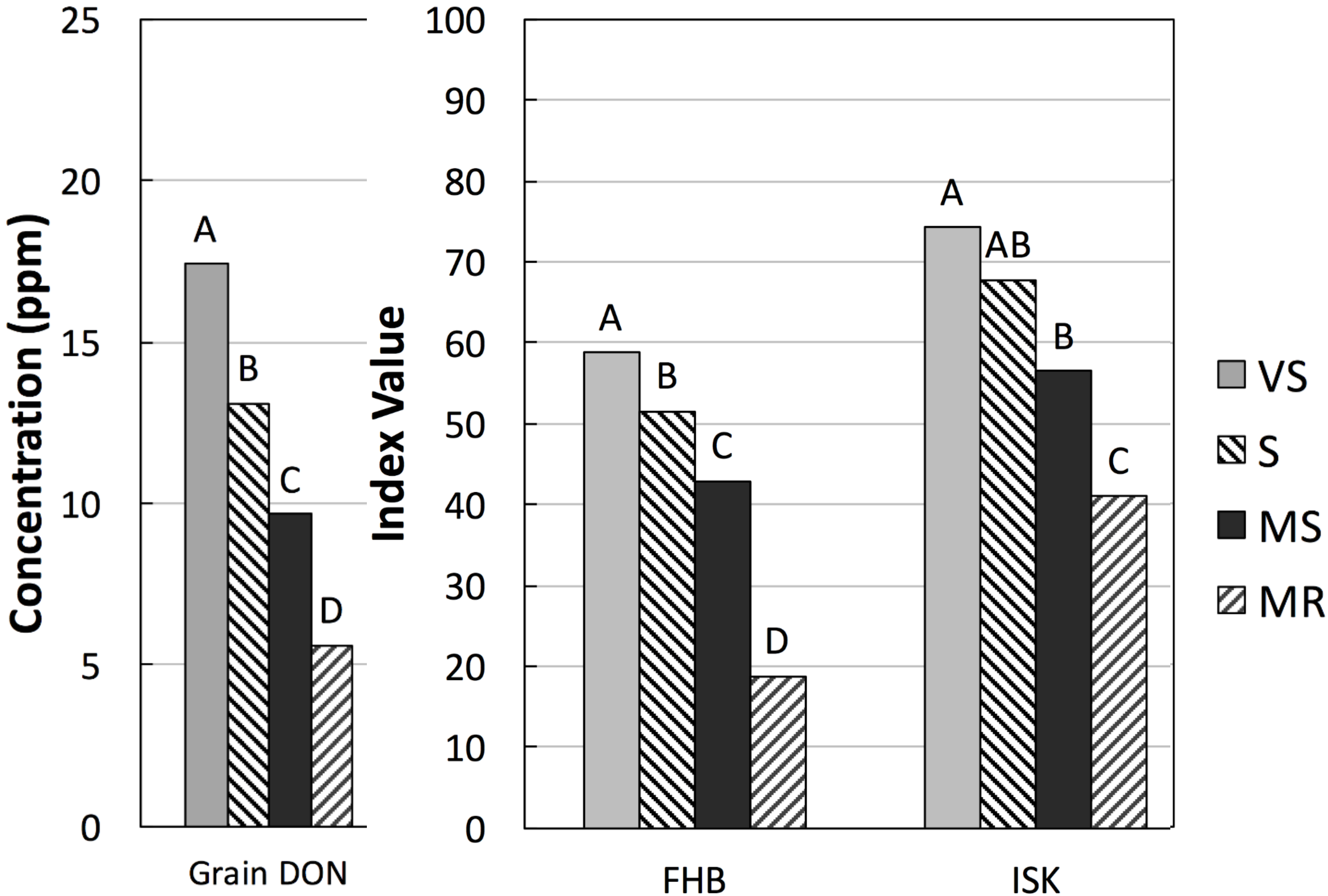
Management – R Varieties



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Conclusions – Cultivar

- How does resistance class affect mycotoxin concentration?
  - **Significantly lower mycotoxin concentrations were present in more resistant cultivars**
- Can FHB indices effectively estimate mycotoxin concentration by resistance class?
  - **FHB index and ISK could serve as potential indicators of mycotoxin concentration in the grain and straw**

FHB Management

- Crop rotation
- Resistant varieties
- Fungicide applications
  - Timing critical – 50% flowering
  - Avoid strobilurins

Fungicide trials

- Fungicide application
  - Do the concentrations of mycotoxins in grain and straw differ by fungicide class?
- Integrated disease management
  - Does the integration of cultivar resistance and a fungicide application significantly reduce mycotoxin concentration?

	Fungicide trial	Integrated disease management
Design	RCBD	Split-Block
Locations	4	4
Years	2011 - 2014	2011 - 2014
Plot Info	Planted into Corn Stubble	Planted into Corn Stubble
Cultivars	1, susceptible	2, MR and S
Treatments	4 Fungicides	Combination Cultivar + Fungicide

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Fungicide trials

Class	Trade Name	Active Ingredient	Application Time (FGS)	Year Applied
DMI	Caramba	Metconazole	10.5.1	2011 – 2014
	Folicur or Monsoon	Tebuconazole	10.5.1	2011 – 2014
	Prosaro	Tebuconazole + Prothioconazole	10.5.1	2011 – 2014
QoI	Headline	Pyraclostrobin	9.0	2011 – 2012
	Priaxor	Pyraclostrobin + Fluxapyroxad	9.0	2013
	Aproach	Picoxystrobin	9.0	2014

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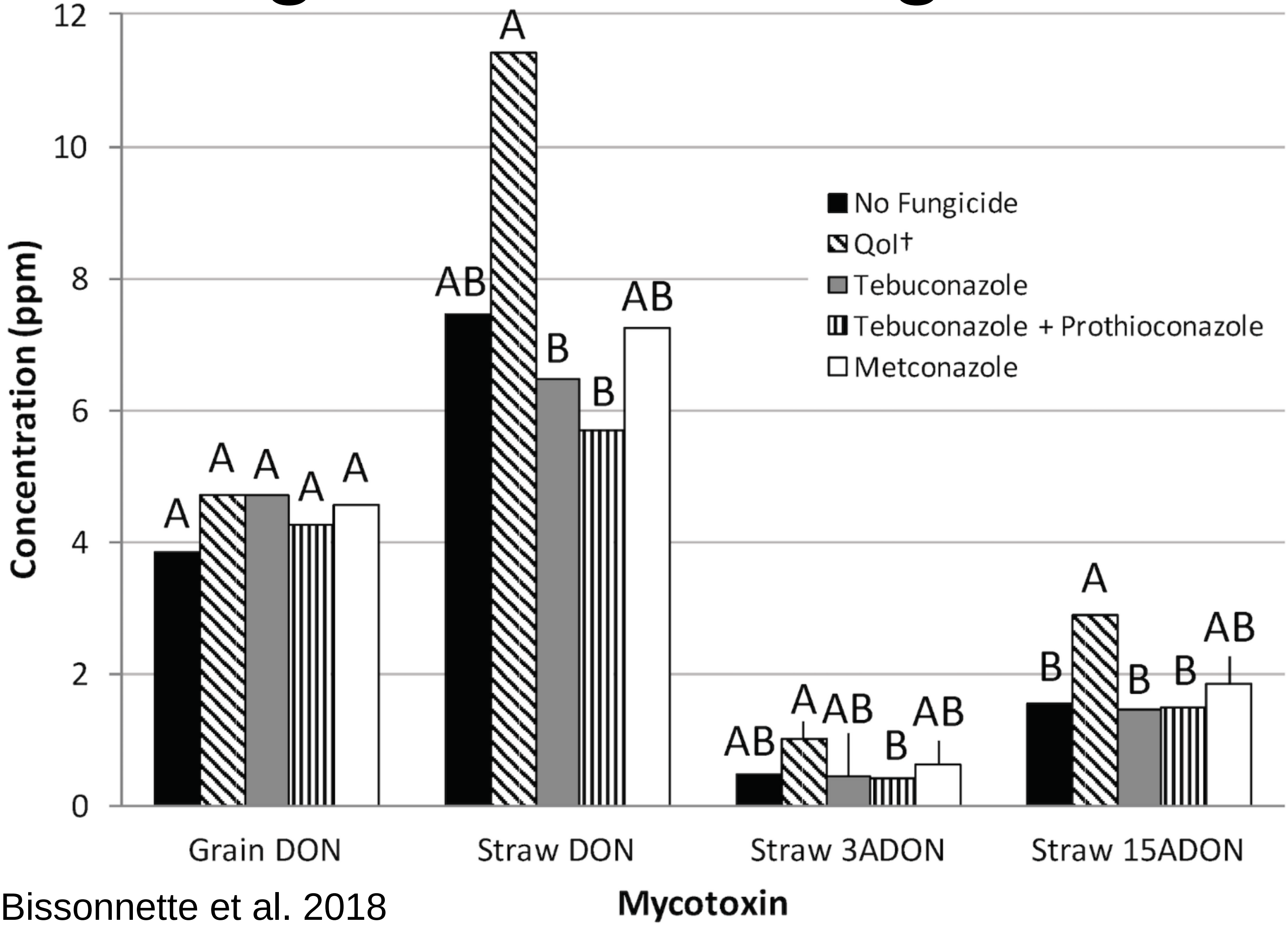
Management – Fungicides



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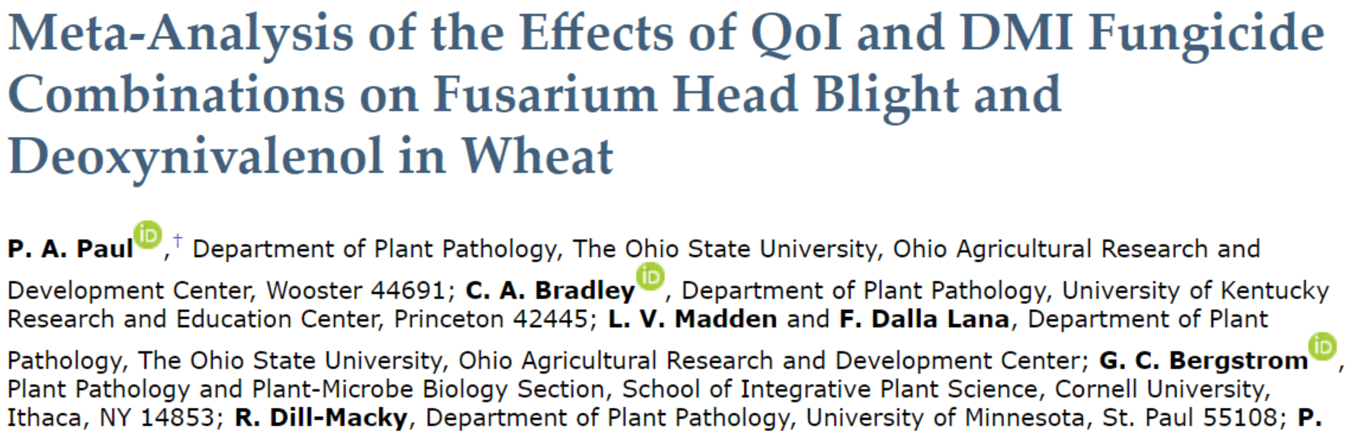
Conclusions – Fungicide Trial

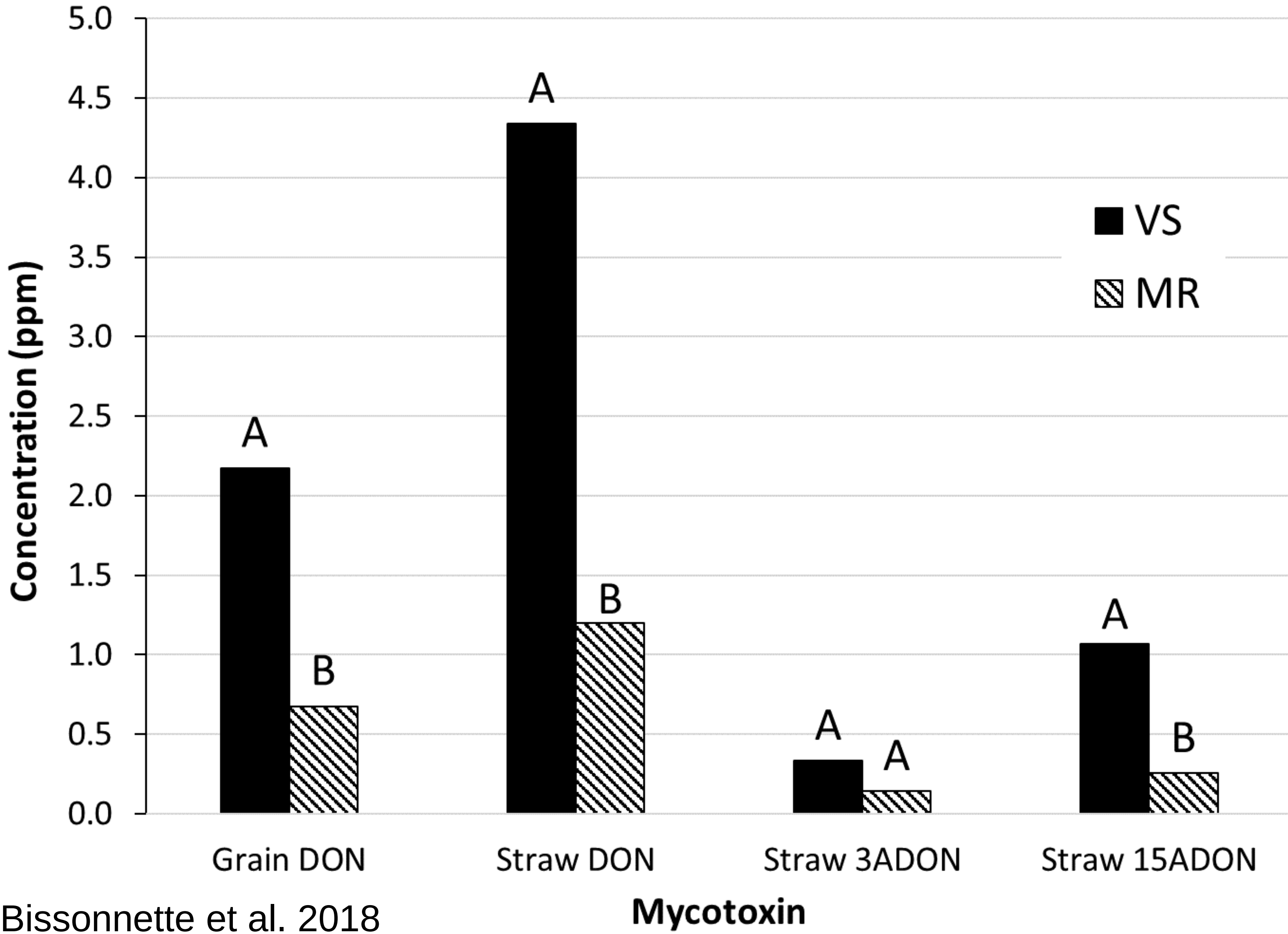
- Do the concentrations of mycotoxins in grain and straw differ by fungicide class?
  - **QoI fungicides resulted in higher DON accumulation over tebuconazole and tebuconazole + prothioconazole**

2018



• Combinations of QOI and DMI applications
  – 17 states
  – Anthesis applications of DMI
  – With or without QoI at flag leaf emergence
  – DMI following QoI helped to mitigate negative effects of QoI alone
  – Less efficacious than DMI-only at anthesis

Management – IPM



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Conclusions – IPM Trial

- Does the integration of cultivar resistance and fungicide application significantly reduce mycotoxin concentration?
  - **A fungicide application did not significant decrease mycotoxin accumulation**
  - **Much greater impact of cultivar resistance level**
  - **Significantly less DON accumulation in both the straw and in the grain in the moderately resistant cultivar**

The research…

- Across multiple environments, fungicides are variable
- Biggest factors to consider are genetics (host) and the environment

Crop Protection 30 (2011) 685–692

Contents lists available at ScienceDirect

Crop Protection

journal homepage:

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Tillage, Fungicide, and Cultivar Effects on Frogeye Leaf Spot Severity and Yield in Soybean

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winter w

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[b] Department of A

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Stoneville, MS 38776-0350;

cultivar effects on frogeye leaf

Ecology and Epidemiology

Meta-Analysis of Yield Response of Hybrid Field Corn to Foliar Fungicides in the U.S. Corn Belt

P. A. Paul, L. V. Madden, C. A. Bradley, A. E. Robertson, G. P. Munkvold, G. Shaner, K. A. Wise, D. K. Malvick, T. W. Allen, A. Grybauskas, P. Vincelli, and P. Esker

First and second authors: Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster 44691; third author: Department of Crop Sciences, University of Illinois, Urbana 61801; fourth and fifth authors: Department of Plant Pathology, Iowa State University, Ames 50011; sixth and seventh authors: Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907; eighth author: Department of Plant Pathology, University of Minnesota, St. Paul 55108; ninth author: Mississippi State University, Delta Research and Extension Center, Stoneville 38776; tenth author: Department of Plant Science and Landscape Architecture, University of Maryland, College Park 20742; eleventh author: Department of Plant Pathology, University of Kentucky, Lexington 40546; and twelfth author: Department of Plant Pathology, University of Wisconsin, Madison 53706.

Accepted for publication 29 April 2011.

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Volume 2013, Article ID 561370
http://dx.doi.org/10.1155/2013/5

e-Xtra*

ABSTRACT

Paul, P. A., Madden, L. V., Bradley, C. A., Robertson, A. E., Munkvold, G. P., Shaner, G., Wise, K. A., Malvick, D. K., Allen, T. W., Grybauskas, A., Vincelli, P., and Esker, P. 2011. Meta-analysis of yield response of hybrid field corn to foliar fungicides in the U.S. Corn Belt. Phytopathology 101:1122-1132.

plots) had a significant effect on yield for propiconazole + azoxystrobin ($P < 0.05$), whereas baseline foliar disease severity (mean severity in the nontreated plots) significantly affected the yield response to pyraclostrobin, propiconazole + trifloxystrobin, and propiconazole + azoxystrobin but not to azoxystrobin. Mean yield difference was generally

Research Artic

Soybean (Gly... the Absence of Disease Pressure

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heat

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Received 11 April 2013; Revised 29 May 2013; Accepted 31 Ma

Randy Weisz, Christina Cowger, Gaylon Ambrose, and Andrew Gardner

First author: Crop Science Department, North Carolina State University, Raleigh 27695; second author: United States Department of Agriculture–Agricultural Research Service, Department of Plant Pathology, Raleigh; and third and fourth authors: North Carolina Cooperative Extension, North Carolina State University and North Carolina A&T State University, Raleigh.

Accepted for publication 27 October 2010.

ABSTRACT

Weisz, R., Cowger, C., Ambrose, G., and Gardner, A. 2011. Multiple mid-Atlantic field experiments show no economic benefit to fungicide application when fungal disease is absent in winter wheat. Phytopathology 101:323-333.

increase needed to pay for a fungicide application at each combination of cost and price was calculated, and the cumulative probability function for the fungicide yield-response data was modeled. The model was used to predict the probability of achieving a break-even yield, and the probabilities were graphed against each cost-price combination. Tests were

2019

Integrated Effects of Genetic Resistance and Prothioconazole + Tebuconazole Application Timing on Fusarium Head Blight in Wheat

P. A. Paul† and **J. D. Salgado**, Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH 44691; **G. Bergstrom**, Plant Pathology and Plant-Microbe Biology Section, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853; **C. A. Bradley**, Department of Plant Pathology, University of Kentucky Research and Education Center, Princeton, KY 42445; **E. Byamukama**, South Dakota State University, Department of Agronomy, Horticulture, and Plant Sciences,

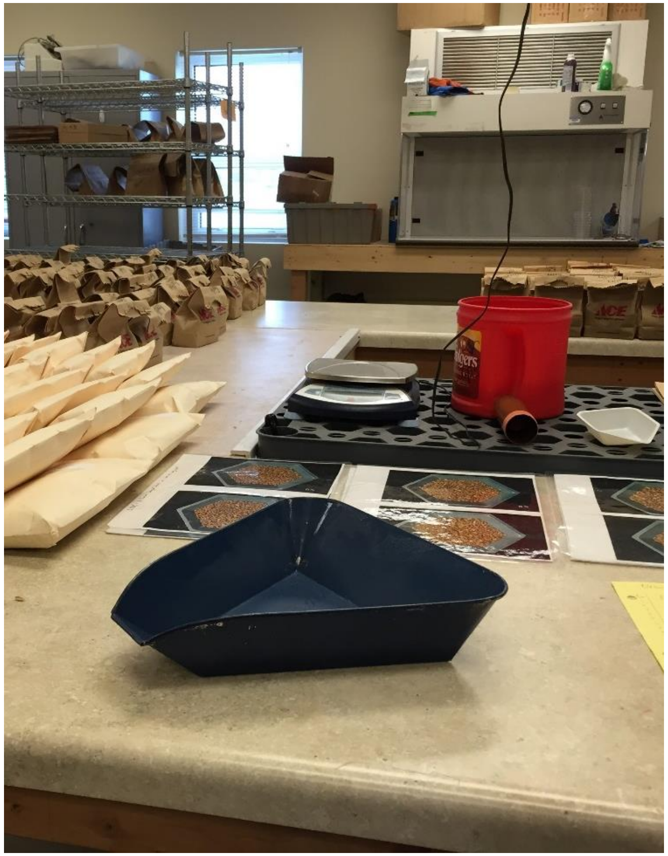
- Integrated disease management – 11 states
  - S, MS, and MR varieties and fungicide application
  - Greatest reduction in Index and DON starts with MR variety selection
  - MS or MR variety plus fungicide applied at or after 50% anthesis controlled FHB Index, FDK, DON by 50-75%
  - More efficacious (and economical) within a few days of anthesis than before anthesis

The research…

- Across multiple environments, fungicides are variable
- Biggest factor to consider are genetics (host) and the environment
- ROI dependent on:
  - Cost of application
  - Disease severity
  - Commodity value

Challenges to FHB

- Tombstone kernels
  - Mycotoxins
  - Can be in sound kernels
- Timing of application
  - Equipment availability
  - Weather conditions



2018

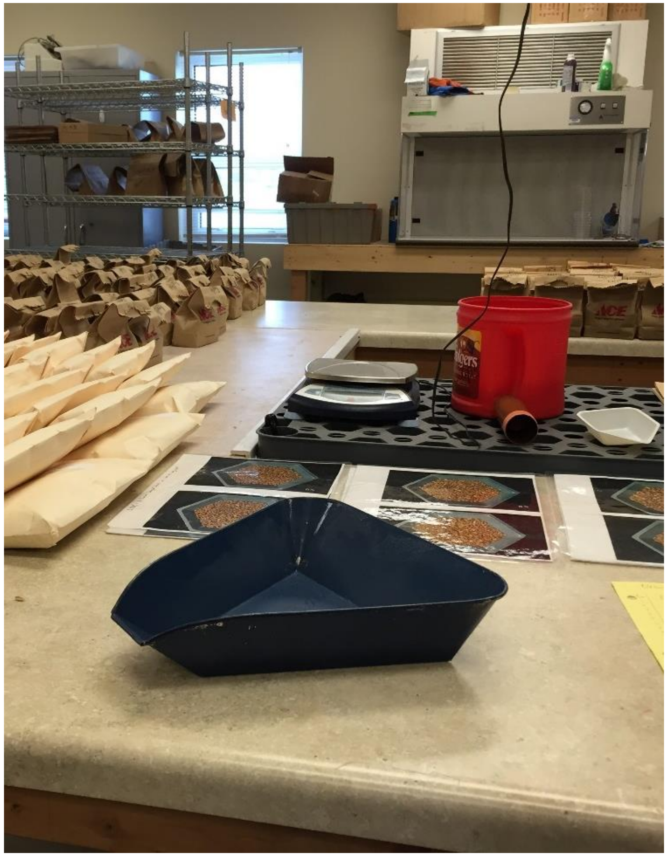
Effects of Pre- and Postanthesis Applications of Demethylation Inhibitor Fungicides on Fusarium Head Blight and Deoxynivalenol in Spring and Winter Wheat

Pierce A. Paul,† Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, 44691; **Carl A. Bradley**, Department of Plant Pathology, University of Kentucky Research and Education Center, Princeton, 42445; **Laurence V. Madden** and **Felipe Dalla Lana**, Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center,

- Looking at effect of application timing
  - 19 site years of data – Prosaro, Caramba
  - Pre-anthesis (heading), anthesis, post-anthesis (5-7 days after)
  - Efficacy highest at anthesis (>50%)
    - Followed by post (41-45%)
    - Followed by pre (<33%)

Challenges to FHB

- Tombstone kernels
  - Mycotoxins
  - Can be in sound kernels
- Timing of application
  - Equipment availability
  - Weather conditions
- Fungicide resistance



Fungicide resistance

Triazole Sensitivity in a Contemporary Population of *Fusarium graminearum* from New York Wheat and Competitiveness of a Tebuconazole-Resistant Isolate

2014

Pierri Spolti, Department of Plant Pathology and Plant-Microbe Biology, Cornell University, Ithaca NY 14853-5904, and Departamento de Fitossanidade, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS 91540000, Brazil; **Emerson M. Del Ponte**, Departamento de Fitossanidade, Universidade Federal do Rio Grande do Sul; **Yanhong Dong**, Department of Plant Pathology, University of Minnesota, St. Paul 55108; and **Jaime A. Cummings** and **Gary C. Bergstrom**, Department of Plant Pathology and Plant-Microbe Biology, Cornell University

Fungicide efficacy trials

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

Fungicide(s)				Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab[4]	Harvest Restriction
Class	Active ingredient	Product	Rate/A (fl. oz)									
Strobilurin	Picoxystrobin 22.5%	Aproach SC	6.0 – 12.0	G[1]	VG	VG[2]	VG	E[3]	VG	VG	NL	Feekes 10.5
	Fluoxastrobin 40.3%	Evito 480 SC	2.0 – 4.0	G	--	--	VG	--	VG	--	NL	Feekes 10.5 and 40 days
	Pyraclostrobin 23.6%	Headline SC	6.0 - 9.0	G	VG	VG[2]	E	E[3]	E	G	NL	Feekes 10.5
Triazole	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[5]	4.0	NL	NL	NL	NL	E	E	E	F	30 days
	Prothioconazole 41%	Proline 480 SC	5.0 - 5.7	--	VG	VG	VG	VG	VG	VG	G	30 days
	Prothioconazole19% Tebuconazole 19%	Prosaro 421 SC	6.5 - 8.2	G	VG	VG	VG	E	E	E	G	30 days
	Propiconazole 41.8%	Tilt 3.6 EC[45]	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5.4
Mixed modes of action[5]	Tebuconazole 22.6% Trifloxystrobin 22.6%	Absolute Maxx SC	5.0	G	VG	VG	VG	VG	E	VG	NL	35 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	Aproach Prima SC	3.4-6.8	VG	VG	VG	VG	E	VG	--	NR	45 days
	Fluoxastrobin 14.8% Flutriafol 19.3%	Fortix	4.0 - 6.0	--	--	VG	VG	E	VG	--	NL	Feekes 10.5 and 40 days
	Fluapyroxad 2.8% Pyraclostrobin 18.7% Propiconazole 11.7%	Nexicor EC	7.0 - 13.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
	Fluxapyroxad 14.3% Pyraclostrobin 28.6%	Priaxor	4.0 - 8.0	G	VG	VG	E	VG	VG	G	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 13.5%	Quilt Xcel 2.2 SE[5]	10.5 - 14.0	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4
	Prothioconazole 10.8% Trifloxystrobin 32.3%	Stratego YLD	4.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
	Benzovindiflupyr 2.9% Propiconazole 11.9% Azoxystrobin 10.5%	Trivapro SE	9.4 - 13.7	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4 14 days
	Metconazole 7.4% Pyraclostrobin 12%	TwinLine 1.75 EC	7.0 – 9.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5

Stripe rust

- *Puccinia striiformis* f. sp. *tritici*
- Environment
  - Moderate temperatures (50 – 64°F) with 6 hours of dew
  - Development slows at or above 90°F
- Pathogen survival
  - Volunteer wheat, fall-infected plants
  - Southern states

Stripe rust

- Resurgence in MW since 2000
- Pathogen races
  - Differences amongst varieties
  - Sexual recombination
  - Continue to develop with deployment of R genes

Stripe rust – Host resistance

- All-stage resistance
  - Race specific
- Adult plant resistance (APR)
  - Jointing stage
- High-temperature adult plant resistance (HTAP)
  - Jointing and warm temperatures

Stripe rust management

- Resistant varieties
  - Rust diseases can typically overcome host resistance
  - HTAP resistance race non-specific, most durable
  - Multiple resistance types in a variety, less vulnerable to pathogen changes

Combination of all-stage and high-temperature adult-plant resistance QTL confers high-level, durable resistance to stripe rust in winter wheat cultivar Madsen

Authors   Authors and affiliations

L. Liu, M. N. Wang, J. Y. Feng, D. R. See, S. M. Chao, X. M. Chen

2018

2015

Race-Specific Adult-Plant Resistance in Winter Wheat to Stripe Rust and Characterization of Pathogen Virulence Patterns

Eugene A. Milus (retired), **David E. Moon**, **Kevin D. Lee**, and **R. Esten Mason**

First, second, and third authors: Department of Plant Pathology, University of Arkansas,

Characterizing and Validating Stripe Rust Resistance Loci in US Pacific Northwest Winter Wheat Accessions (*Triticum aestivum* L.) by Genome-wide Association and Linkage Mapping

Weizhen Liu, Yukiko Naruoka, Kaitlin Miller, Kimberly A. Garland-Campbell, and Arron H. Carter*

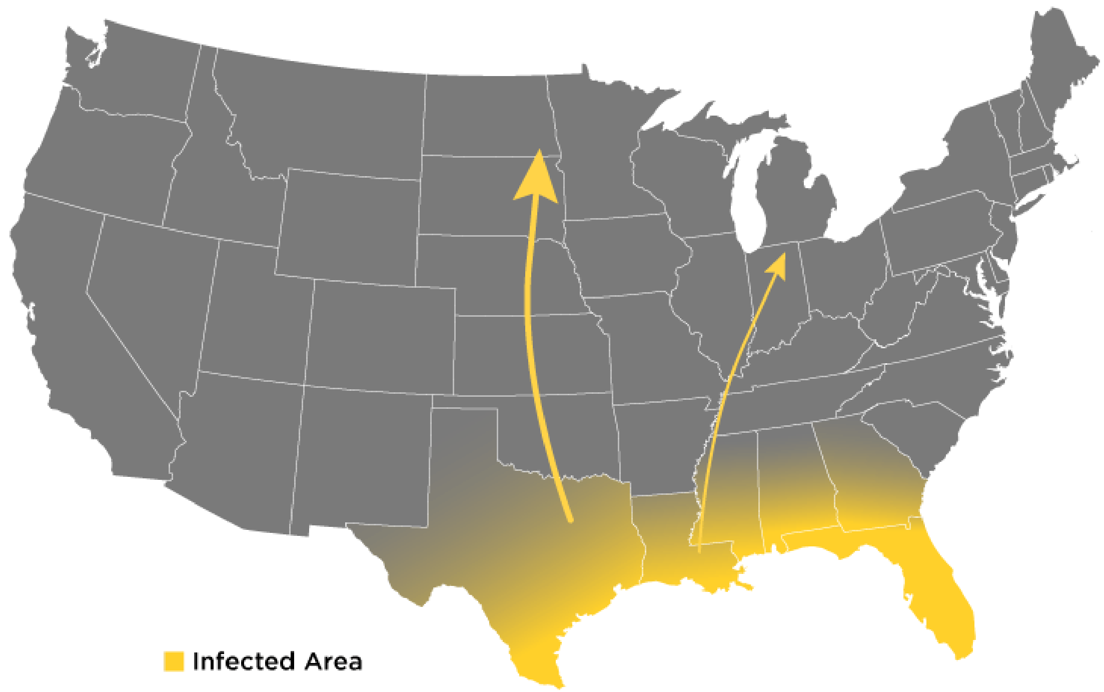
2018

Stripe rust management

- Resistant varieties
  - Rust diseases can typically overcome host resistance
  - HTAP resistance race non-specific, most durable
  - Multiple resistance types in a variety less vulnerable to pathogen changes
- Regular scouting and managing volunteers

Stripe rust scouting

- Begin scouting early in the spring
- Snow pack can insulate spores in pustules
- Generally specific to wheat, but can infect other grasses



Stripe rust management

- Resistant varieties
  - Rust diseases can typically overcome host resistance
  - HTAP resistance race non-specific, most durable
  - Multiple resistance types in a variety less vulnerable to pathogen changes
- Regular scouting and managing volunteers
- Fungicides
  - Timing is key – regular scouting
  - Strobilurins most effective – preventative

Fungicides

- Especially when growing susceptible or moderately susceptible varieties
  - In PNW, if 2-5% rust on susceptible variety, fungicide application is generally warranted
- In epidemic years, up to 40% yield loss

Integrated disease management

Integration of cultivar resistance and fungicide application for control of wheat stripe rust

X.M. Chen

Pages 311-326 | Accepted 10 May 2014, Accepted author version posted online: 14 May 2014, Published online: 06 Jun 2014

- Cultivar resistance most effective
- Fungicides warranted more often in MS and S cultivars
- Low pressure years, cultivar resistance can be enough

Fungicide efficacy trials

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

Fungicide(s)													
Class	Active ingredient	Product	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
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	Propiconazole 41.8%	Tilt 3.6 EC[45]	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5.4
Mixed modes of action[5]	Tebuconazole 22.6% Trifloxystrobin 22.6%	Absolute Maxx SC	5.0	G	VG	VG	VG	VG	E	VG	NL	35 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	Aproach Prima SC	3.4-6.8	VG	VG	VG	VG	E	VG	--	NR	45 days
	Fluoxastrobin 14.8% Flutriafol 19.3%	Fortix	4.0 - 6.0	--	--	VG	VG	E	VG	--	NL	Feekes 10.5 and 40 days
	Fluapyroxad 2.8% Pyraclostrobin 18.7% Propiconazole 11.7%	Nexicor EC	7.0 - 13.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
	Fluxapyroxad 14.3% Pyraclostrobin 28.6%	Priaxor	4.0 - 8.0	G	VG	VG	E	VG	VG	G	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 13.5%	Quilt Xcel 2.2 SE[5]	10.5 - 14.0	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4
	Prothioconazole 10.8% Trifloxystrobin 32.3%	Stratego YLD	4.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
	Benzovindiflupyr 2.9% Propiconazole 11.9% Azoxystrobin 10.5%	Trivapro SE	9.4 - 13.7	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4 14 days
	Metconazole 7.4% Pyraclostrobin 12%	TwinLine 1.75 EC	7.0 – 9.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5

Wheat management

- Think disease triangle
  - Hybrid/Variety/Cultivar susceptibility
  - Weather conditions
  - Pathogen present? Scout!
- Use IPM strategies
  - Scout!, assess, apply (or not)
  - First line of defense is host resistance
  - Fungicides are a tool, not a cure

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U.S. Wheat & Barley
Scab Initiative