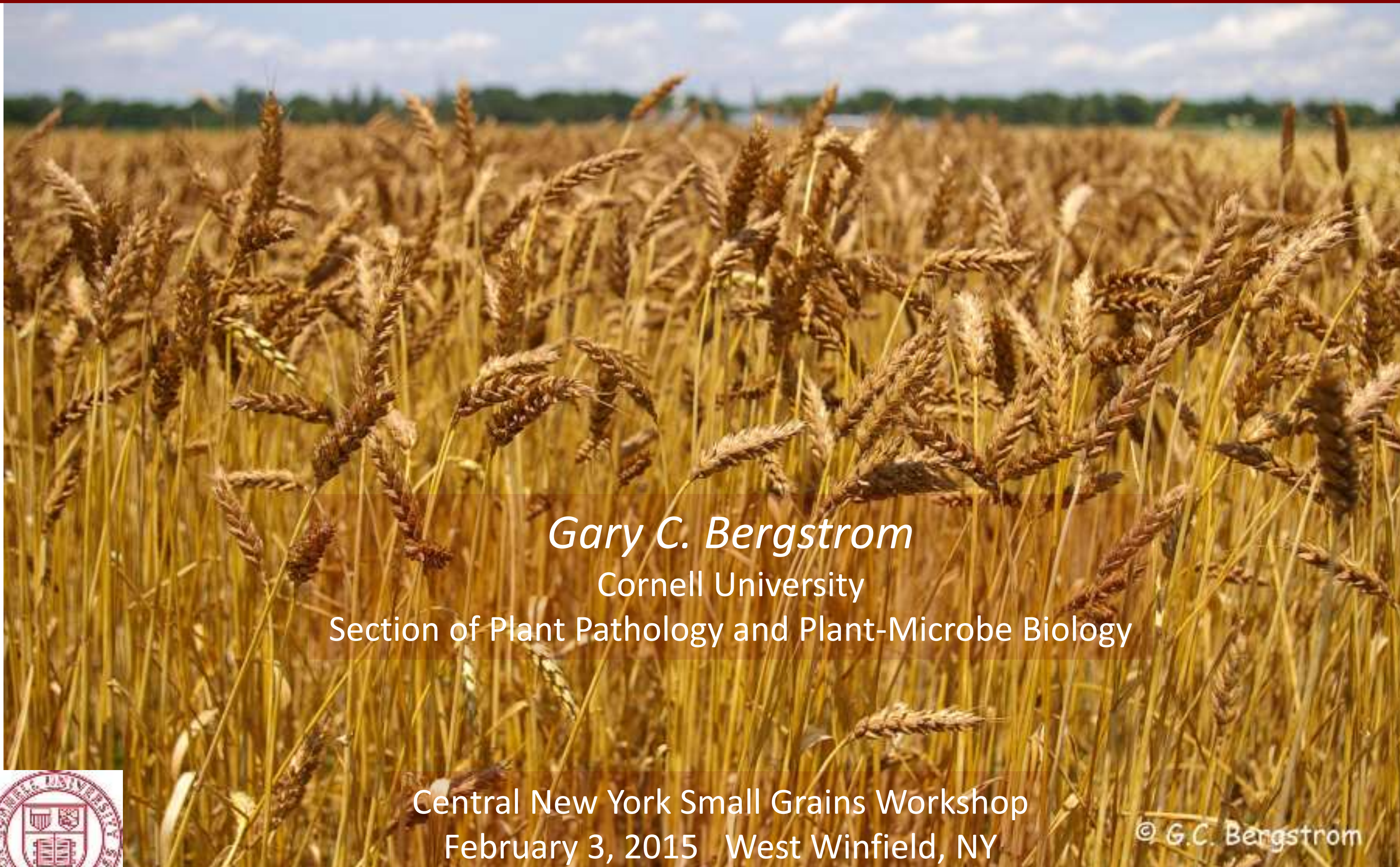
Common Diseases of Small Grains and Their Management



Gary C. Bergstrom
Cornell University
Section of Plant Pathology and Plant-Microbe Biology

Central New York Small Grains Workshop
February 3, 2015 West Winfield, NY

Plant Disease: A condition of a plant of abnormal growth or function

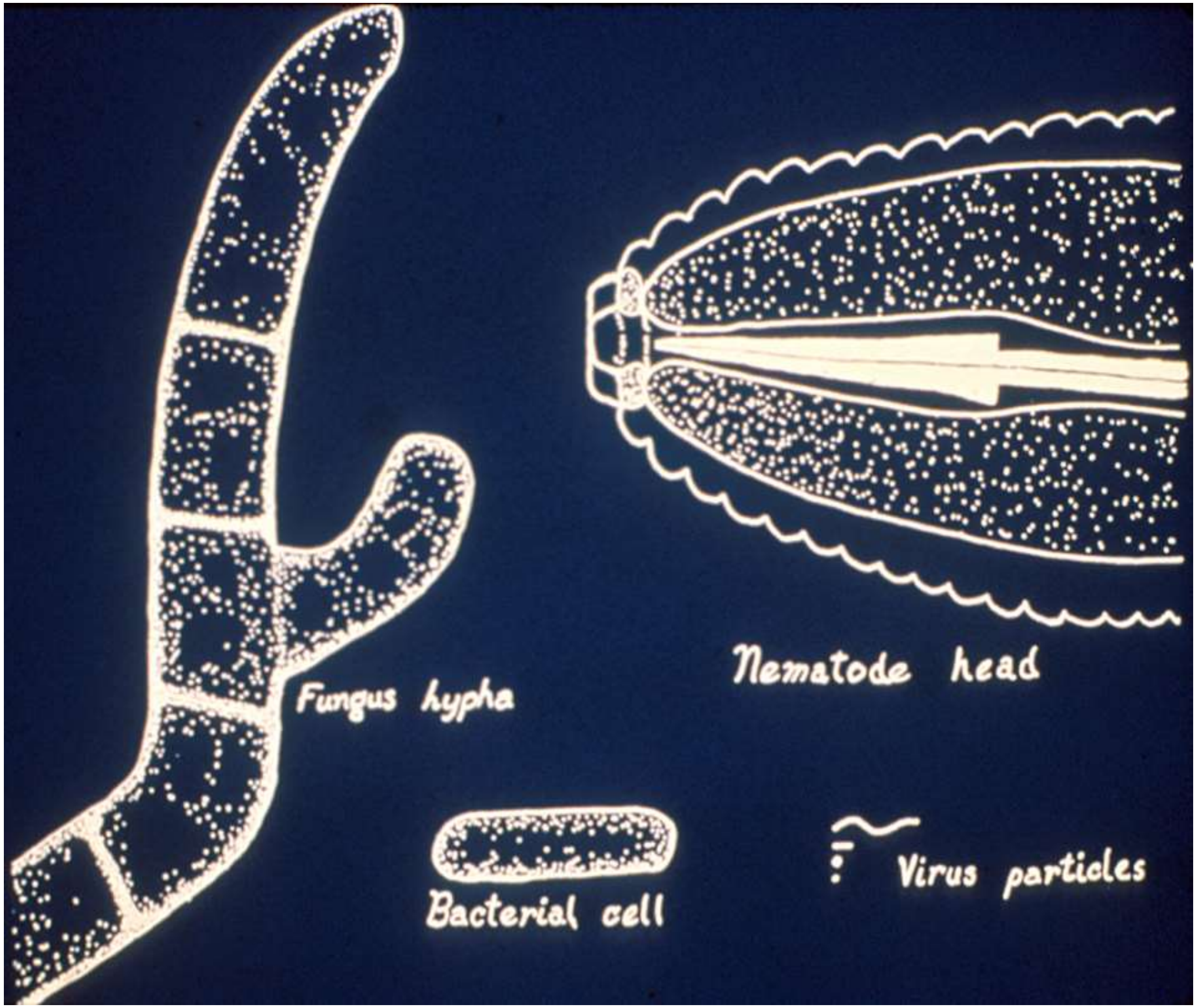
Plant Pathogen: A living organism that can incite plant disease

When a microbe feeds on a:	It is called a:
Living host	parasite
Non-living host	saprophyte

When a pathogen:	It is called a:
Gets its nutrients from living cells	biotroph
Kills host cells before acquiring nutrients	necrotroph

Causal agents (pathogens) of infectious plant diseases

- FUNGUS
- OOMYCETE
- BACTERIUM
- VIRUS
- NEMATODE



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Factors affecting disease epidemiology and management

- Pathogen dissemination potential
  - (long-distance, regional, local)
- Survival in debris
- Vector relationship
- Favorable environment

Methods of disease management

- Cultural (e.g., crop rotation)
- Resistance (e.g., resistant or tolerant varieties)
- Biological (e.g., biopesticides)
- Chemical (e.g., fungicide seed treatment)
- Regulatory (e.g., seed certification)

Yellow dwarf of cereals and grasses

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Yellow dwarf of cereals and grasses

- Pathogen: *Barley yellow dwarf luteovirus* and *Cereal yellow dwarf polerovirus* strains
- Host range: all grasses
- Symptoms: leaves yellow to red or purple; stunting
- Conditions: early planting; large aphid populations
- Survival: in infected aphids and grasses
- Spread: by aphids (short & long distance)
- Management: plant after Hessian fly free date, systemic seed insecticides

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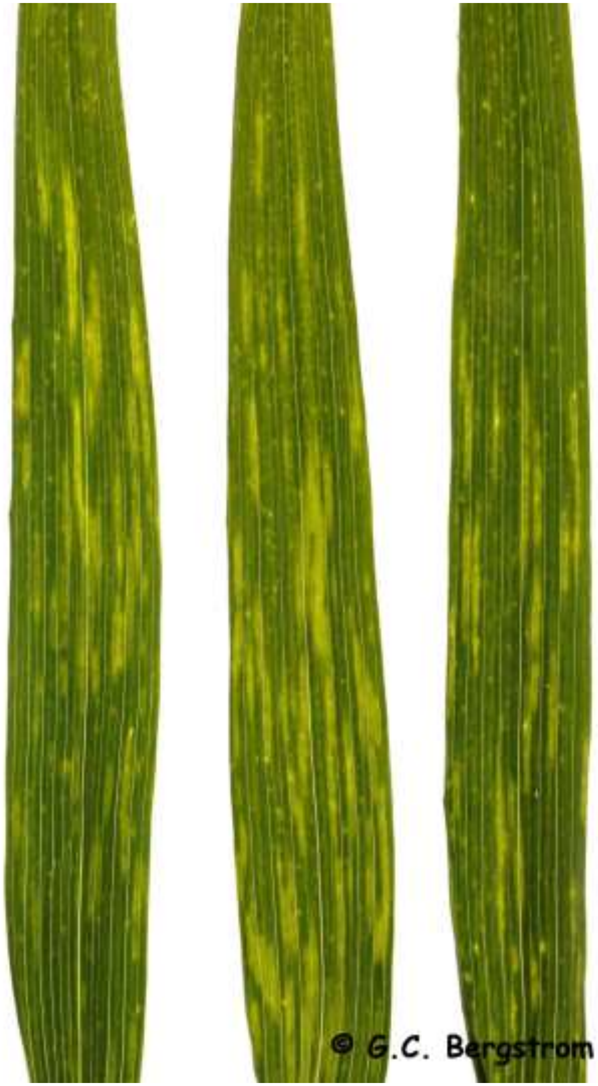
Soilborne viruses

Wheat spindle streak mosaic virus



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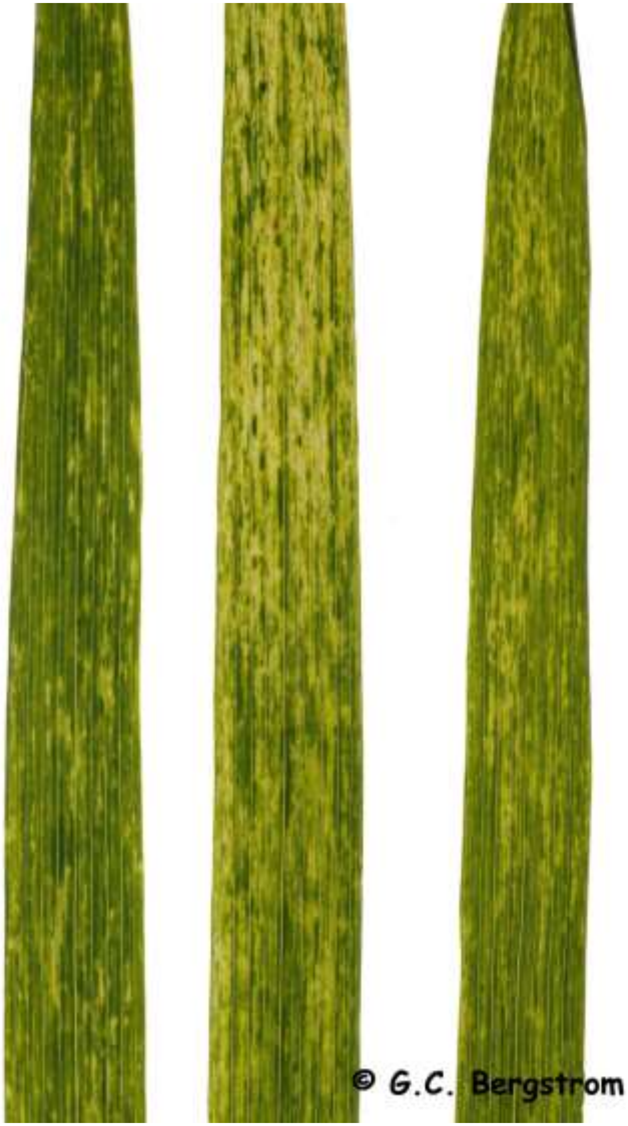
- Occurs in NY soils statewide
- Causes disease on wheat only
- Leaves with yellow vertical streaks tapered at ends (April/May)
- Favored by cool spring temperatures
- Choose adapted varieties with resistance
- Related to *Barley yellow mosaic virus* (not found in NY)

Soilborne wheat mosaic virus



- Currently confirmed in southern Finger Lakes area of New York
- Potential for spread in the Northeast
- Mosaic and stunting (April/May)
- Choose adapted varieties with resistance

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Powdery mildews:
Biotrophic pathogens of specific cereal species

Powdery mildew on winter wheat

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Powdery mildews: Biotrophic pathogens of specific cereal species

Powdery mildew on spring barley

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Powdery mildew (biotrophic fungi)

Pathogens: ***Blumeria graminis f. sp. tritici*** **(wheat)**
Blumeria graminis f. sp. hordei **(barley)**
Host range: **wheat**
Symptoms: **white powdery spores on leaves and stems; mature lesions with dark fruiting bodies**
Conditions: **humid, moderate temperatures, dense stands, high N fertility**
Survival: **infected wheat plants and debris**
Spread: **airborne spores (regional)**
Management: **resistant varieties, foliar fungicides**

Bunts and Smuts:
Biotrophic pathogens of specific cereal species

Wheat loose smut

Barley loose smut

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Loose smuts
Biotrophic fungal pathogens of specific cereal species

- Pathogen: *Ustilago tritici* (wheat)
  Ustilago nuda (barley)
- Host range: specific cereal species
- Symptoms: kernels replaced by mass of black teliospores
- Conditions: moisture at crop flowering
- Survival: in contaminated seed
- Spread: in seed (embryo)
- Management: certified seed, systemic seed fungicides

Certified seed and seed treatment

Certified seed

- Genetic uniformity
- Viability
- Germination
- Low tolerance for smut / weed seeds

Fungicidal seed treatments protect against:

- seedborne & soilborne pathogens
- seed rot/seedling blight
- smuts and bunts
- improve emergence & vigor

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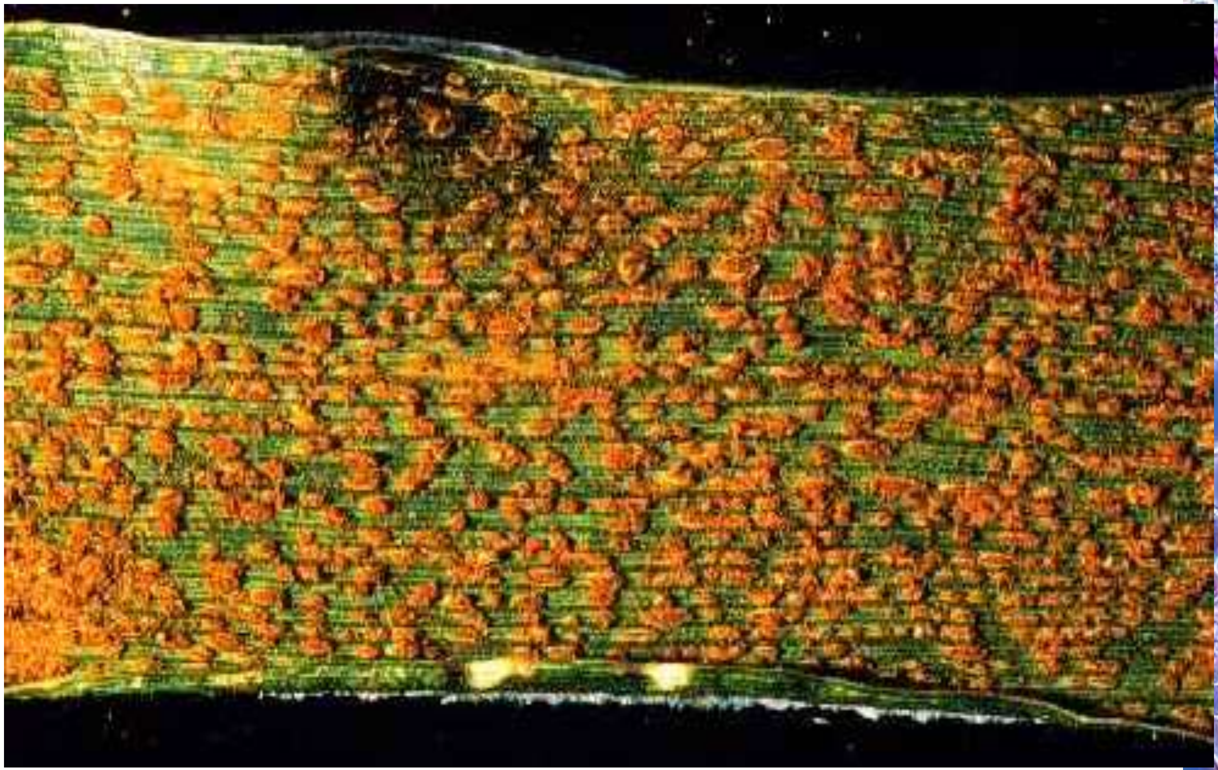
Leaf rusts
Biotrophic pathogens of specific grass species



Uredinial, orange rust stage

Telial, black rust stage

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Leaf rusts
Biotrophic pathogens of specific grass species

- Pathogen: *Puccinia recondita f. sp. tritici*
  Puccinia hordei
- Host range: species-specific
- Symptoms: orange-red urediospore pustules on leaves
- Conditions: warm, humid, June thunderstorms
- Survival: infected, live wheat plants in frost-free areas
- Spread: airborne spores (long distance)
- Management: timely planting, resistant varieties, foliar fungicides

Leaf rust of wheat

Stripe rust

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Crown rust of oat

Alternate host: Buckthorn

Rust aeciospores produced in May

Stem rust

Stem rust of barley

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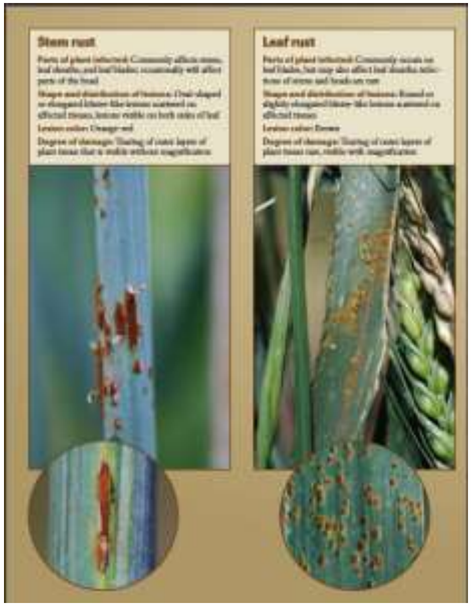
Identification guide for rust diseases of wheat and barley



Electronic versions (English and Spanish) available at http://fieldcrops.org

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Ergot of Cereals and Grasses

Ergot on winter rye

Ergot of Cereals and Grasses

Ergot on winter malting barley

Fungal leaf and glume blotches
Necrotrophic pathogens of cereals and grasses

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Stagonospora nodorum blotch

- Pathogen: *Parastagonospora nodorum*
- Host range: wheat (and perhaps some grasses)
- Symptoms: leaf and glume blotch
- Conditions: frequent rain, mild temperatures
- Survival: infected seed, wheat crop debris
- Spread: infected seed, splashing rain, possibly windborne spores
- Management: crop rotation, foliar fungicides, less susceptible varieties

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Net blotch of barley

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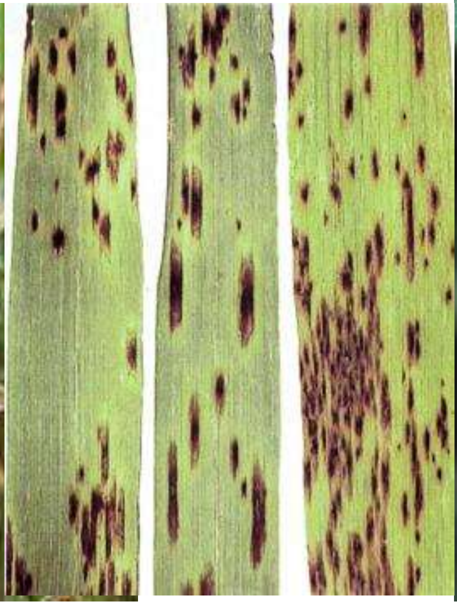
2014 Malting Barley Disease Survey

- 28 malting barley varieties, Spring and Winter
- 7 fields in 13 counties
- Field samples submitted for diagnosis
- Grain samples collected for mycotoxin analysis, and Fusarium content determination

2014 Malting Barley Disease Survey
12 diseases documented

- Halo spot, loose smut, bacterial blight, Fusarium root rot, net blotch, snow mold, scald, spot blotch, anthracnose, powdery mildew, Fusarium head blight, Rhizoctonia root rot,



Soilborne fungal diseases increase in short cereal rotations

Eyespot foot rot

Cephalosporium stripe

Lodging associated with wind and foot rot disease

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Disease targets of foliar fungicides

The primary targets of foliar fungicides are fungal foliar diseases …

Powdery mildew

Fungal leaf blotches

Leaf rust

… as well as Fusarium head blight and glume blotch.

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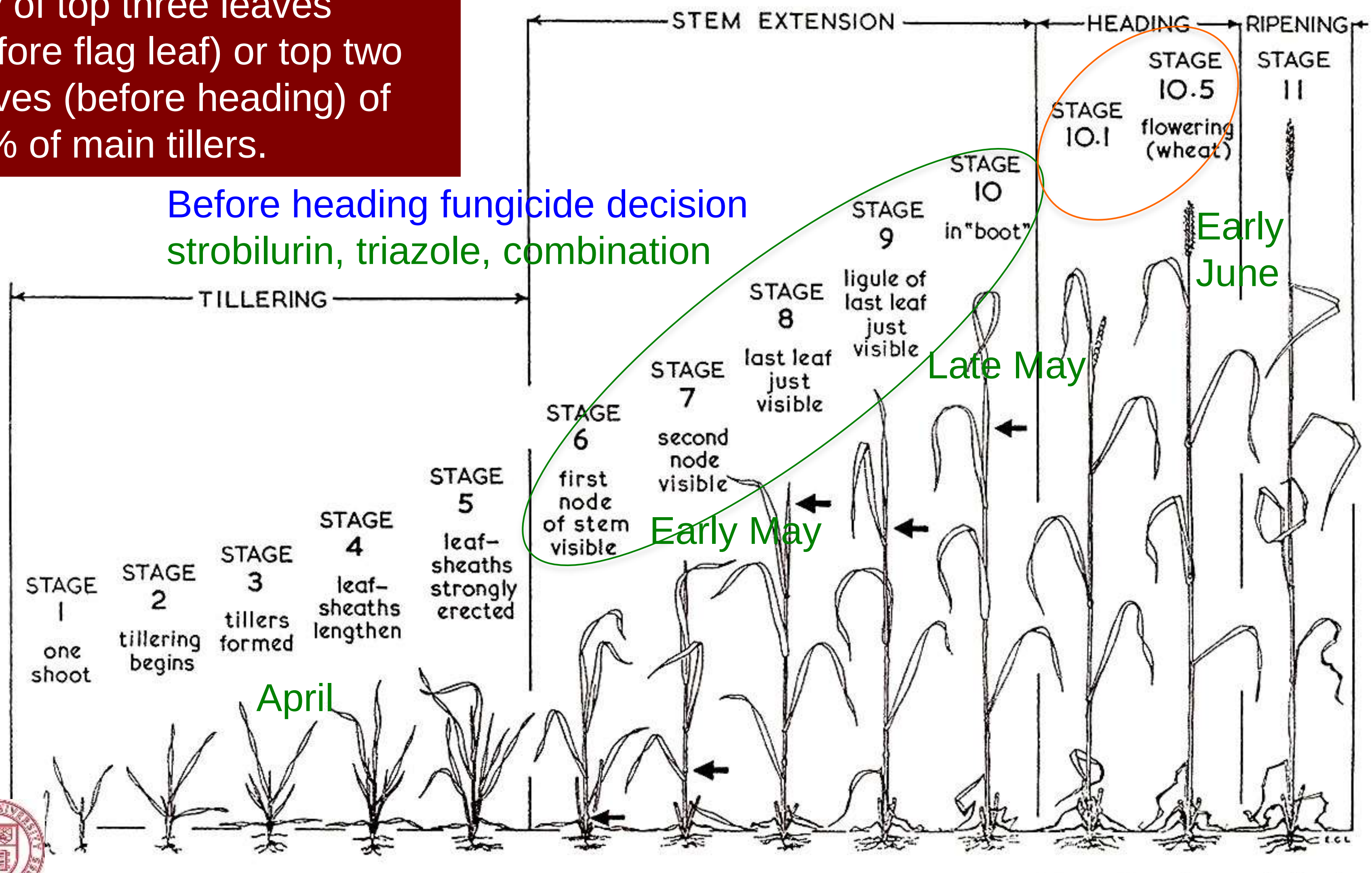
Fungicide application decisions from stem elongation to heading

Based on fungal disease on any of top three leaves (before flag leaf) or top two leaves (before heading) of 50% of main tillers.

Heading to flowering fungicide decision
triazole

Before heading fungicide decision
strobilurin, triazole, combination



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Foliar fungicides applied from jointing to heading

GROUP 11 FUNGICIDES

Solo strobilurin product:

Headline SC fungicide — pyraclostrobin (23.3%)

GROUP 3 | 11 FUNGICIDES

triazole & strobilurin combination products:

ABSOLUTE — tebuconazole (22.6%) & trifloxystrobin (22.6%)

Quilt Fungicide, Avaris — propiconazole (11.7%) & azoxystrobin (7.0%)

QuiltXcel Fungicide — propiconazole (11.7%) & azoxystrobin (13.5%)

STRATEGO YLD — prothioconazole (10.8%) & trifloxystrobin (32.3%)

TWINLINE FUNGICIDE — metconazole (7.4%) & pyraclostrobin (12%)

Broad spectrum foliar disease control prior to flag leaf emergence
Strobilurin may result in an increase in DON toxin if applied after spike emergence

Fusarium head blight (scab)

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Reduction of deoxynivalenol (DON) in grain

FDA guideline for
nonmilled grain is < 2 ppm

FDA guideline for
food products is < 1 ppm

Marketing of DON – contaminated grain

•Usually rejected for malt above 1 part per million

•Usually rejected for flour above 2 parts per million, especially if bran cereal market

•Usual rejection at pet food mills

•May be rejected at ethanol plants

•Beef cattle are tolerant; dairy cows and poultry are tolerant of moderate levels

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Viable *Fusarium* content before and after malting

Viable *Fusarium* content by variety and county

County	% Fusarium in Grain				
Montgomery	22.9	A			
Ontario	21.5	A	B		
Livingston	19.6	A	B	C	D
Dutchess	18.4	A	B	C	
Delaware	11.8		B	C	D	E
Otsego	11.8			C	D	E
Niagara	9.8			C	D	E
Orleans	9.2				D	E
Seneca	8.5					E
Steuben	7.9					E
Genesee	4.9					E
Yates	3.9					E
Monroe	2.0					E

Variety	% Fusarium in Grain			
Wintmalt	17.0	A		
Quest	14.0	A	B	
Conlon	12.0	A	B	C
Alba	11.8	A	B	C
Newdale	8.8	A	B	C
Legacy	7.8	A	B	C
Endeavor	3.9		B	C
Merideth	3.9			C

Not much differentiation among varieties

No significant difference between winter and spring

Pre-harvest assessment and harvest management

- Mycotoxin potential (pre-test)
- Grain moisture level for harvest
- Combine adjustment (high fan)
- Arrangements for grain drying and custom cleaning

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SCAB SMART
MANAGEMENT

www.scabsmart.org

Scab Smart provides information on key management information for each small grain class affected by this disease in the US. **Scab Smart** is intended as a **quick guide** to the integrated strategies that result in optimum reduction in Fusarium Head Blight (scab) and the primary assosciated mycotoxin (DON). Click on following links to learn about strategies for your grain class:

Variety Resistance: Hard Red Spring Wheat, Durum Wheat, Spring Barley, Hard Red Winter Wheat, Soft Red Winter Wheat – Northern Region, Soft Red Winter Wheat – Southern Region, Soft White Wheat, Hard White Wheat

Scab Forecasting

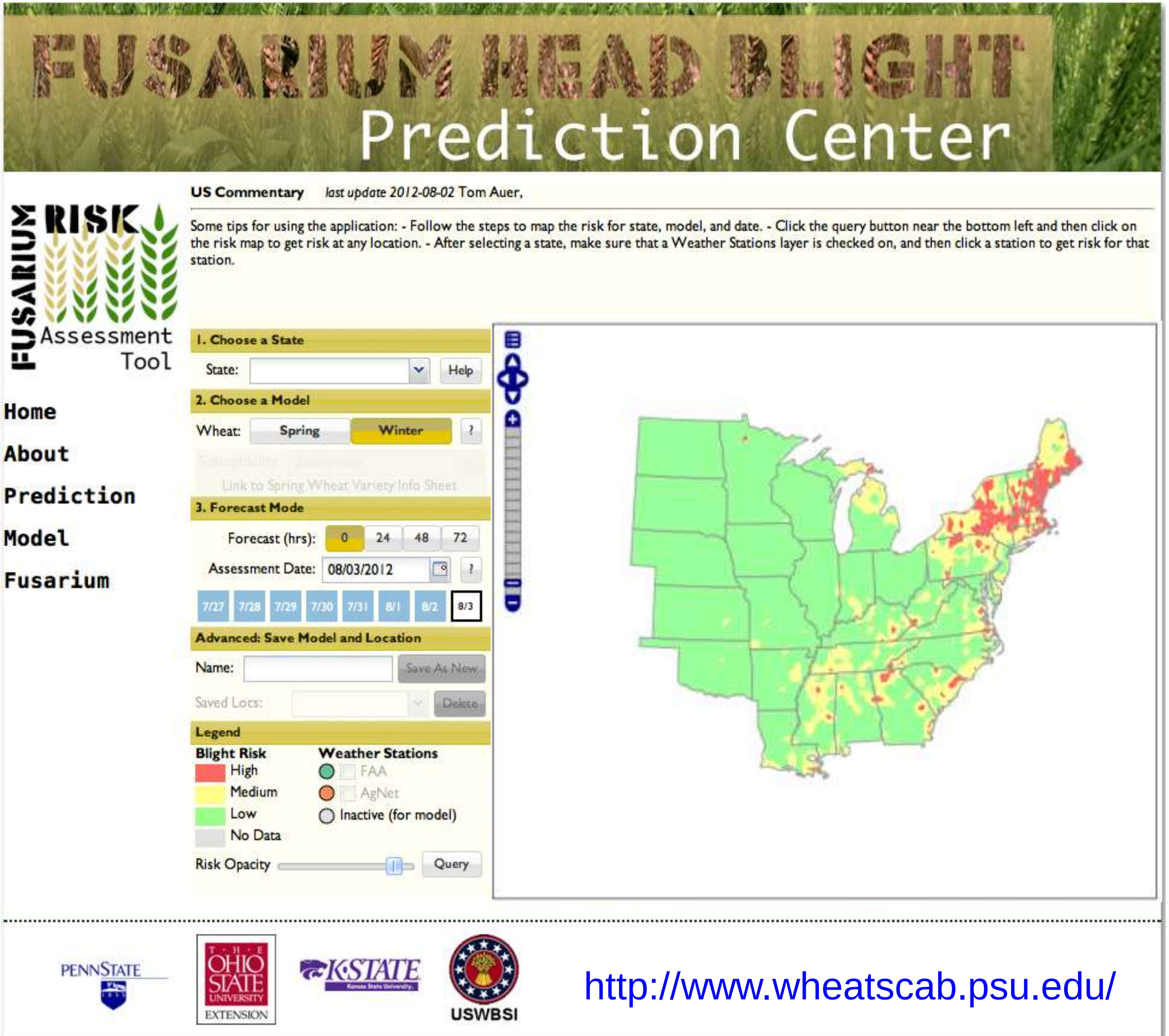
Fungicides

Crop Rotation

Other Management Strategies: Residue Management, Planting Date, Harvest Practices

All information provided is based on successful strategies identified by extensive research supported by the US Wheat and Barley Scab Initiative with funding provided by USDA-ARS.

USDA ARS



http://www.wheatscab.psu.edu/

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Subscribe to FHB Alerts by Cell Phone at:

http://www.scabusa.org/fhb_alert.php

Select Type of Alert

❑Text Messages and Email Alerts
❑Text Message Alerts
❑Email Alerts

Which FHB update alerts do you wish to subscribe to? (Select all that apply)

❑Southern Soft Winter Wheat (AL, AR, LA, MS)
❑Southern Atlantic Soft Winter Wheat (NC)
❑Central Great Plains Hard Winter Wheat (KS, NE, OK)
❑Mid West / Mid South Soft Winter Wheat (IA, IN, KY, OH)
❑Mid Atlantic Soft Winter Wheat (DE, MD, PA, VA)
☒Northern Soft Winter Wheat (MI, NY, WI, VT)
❑Northern Great Plains: Hard Spring Wheat, Durum, Hard Winter Wheat and Malting Barley (MN, ND, SD)
❑National
❑All

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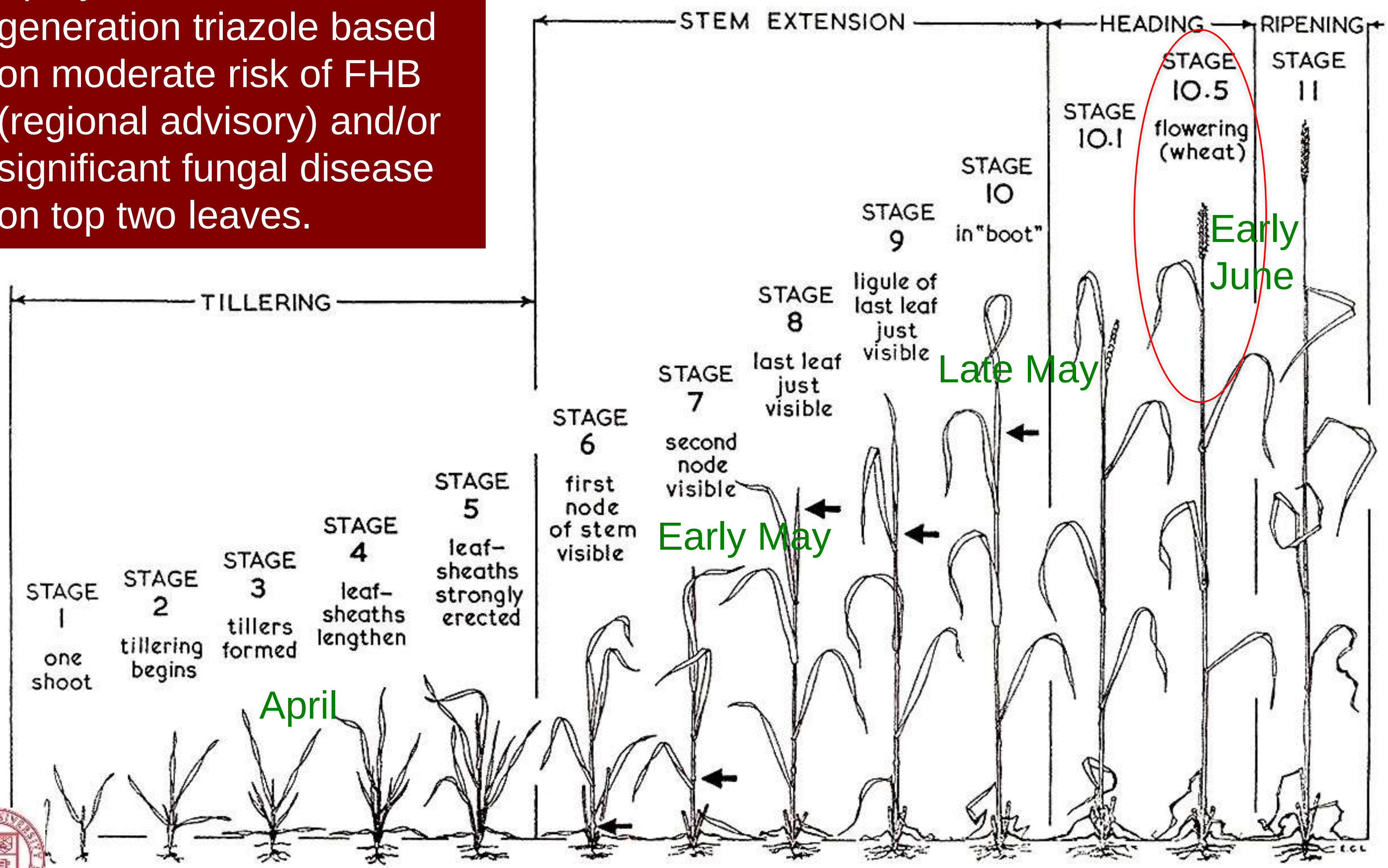
Triazole fungicide applied at initiation of flowering

Spray with a second generation triazole based on moderate risk of FHB (regional advisory) and/or significant fungal disease on top two leaves.



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Foliar fungicides applied at initiation of flowering

GROUP 3 FUNGICIDE — Triazoles

CARAMBA™ FUNGICIDE — metconazole (8.6%)

PROSARO® — prothioconazole (19%) & tebuconazole (19%)

PROLINE™ ENHANCED PERFORMANCE — prothioconazole (41%)

Very good foliar disease control, and good FHB suppression
Materials of choice for head emergence to flowering application

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Fungicidal suppression of FHB & DON – meta-analysis of 100 U.S. test environments*

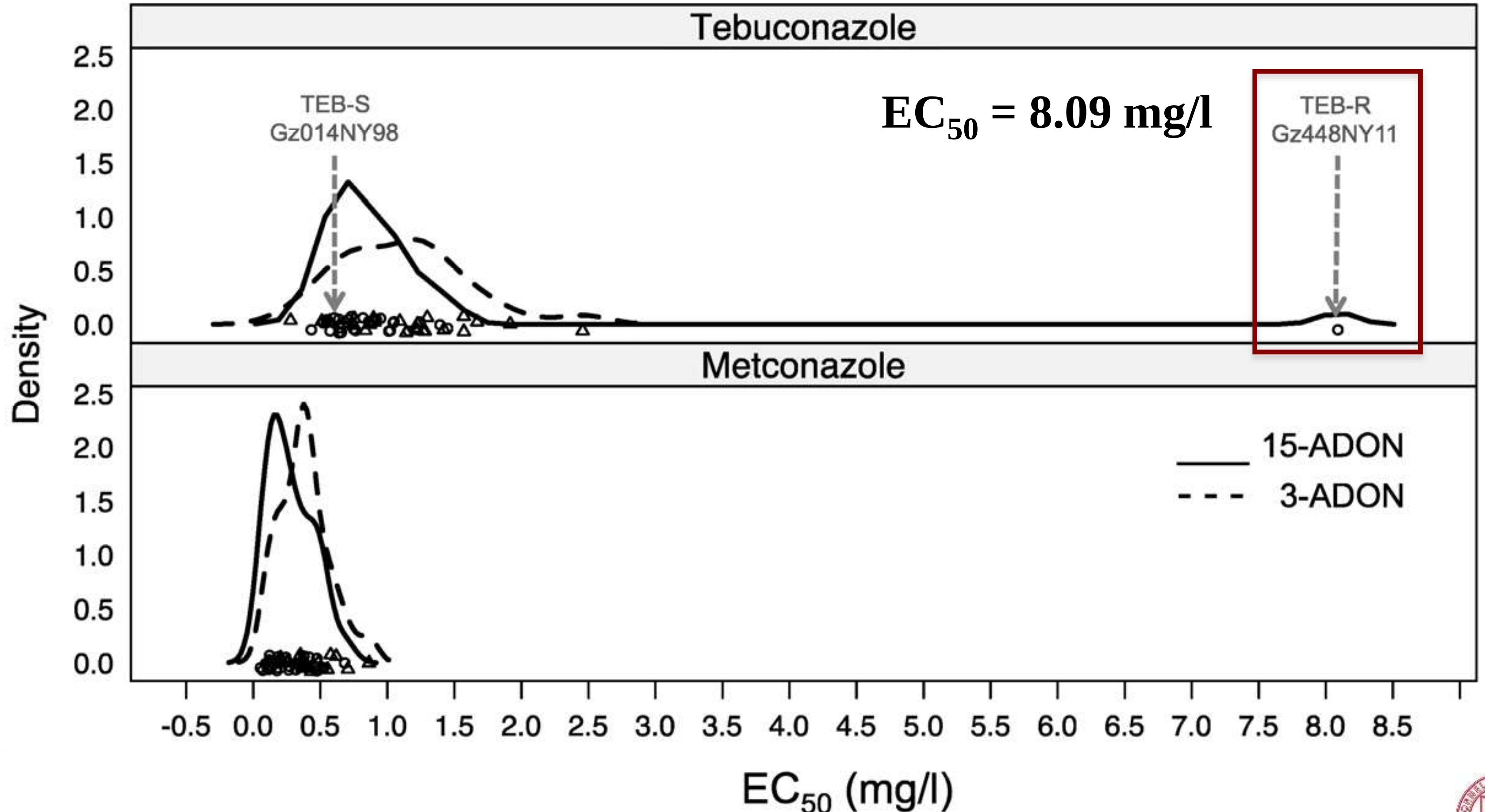
	% Suppression compared to non-treated	
Triazole fungicide:	Fusarium head blight disease	DON toxin
metconazole 86%	50	45
prothioconazole 41%	48	43
prothioconazole 19% & tebuconazole 19%	52	42
propiconazole 41.8%	32	12

*Paul et al. 2008. Phytopathology 98:999-1011

Fungicide sensitivity: Effective concentration of tebuconazole and metconazole that reduces mycelial growth by 50% (EC_{50})

plant disease

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



Is tebuconazole less effective in head blight and DON suppression against the tebuconazole-resistant isolate ?

YES!

				Trichothecene (ppm) in wheat kernels[a]		
Treatment, inoculum	**AUDPC[b]**	**TKW[c]**	**FDK[d]**	**DON**	**15-ADON**	**3-ADON**
Nonsprayed						
TEB-S	595.41	10.40	100.00	143.3	5.13	2.73
TEB-R	596.85	9.95	100.00	202.8	3.60	2.40
TEB-S + TEB-R	599.37	10.05	100.00	132.2	2.50	2.25
LSD[e]	53.34	2.14	0.00	77.79	2.61	0.92
Tebuconazole-sprayed						
TEB-S	196.03	18.63	70.25	23.73	0.60	0.22
TEB-R	488.21	12.53	92.00	123.35	1.40	0.92
TEB-S + TEB-R	368.31	16.55	78.00	83.90	1.31	0.77
LSD[e]	59.87	3.73	10.48	21.32	0.61	0.32

Is the tebuconazole-resistant variety less competitive in the absence of tebuconazole application?

NO

Is the tebuconazole-resistant isolate sensitive to metconazole, and are FHB and DON suppressed?

YES!

				Trichothecene (ppm) in wheat kernels[a]		
Treatment/inoculum	**AUDPC[b]**	**TKW[c]**	**FDK[d]**	**DON**	**15-ADON**	**3-ADON**
Nonsprayed						
TEB-S	547.18	10.21	94.25	195.70	28.78	2.35
TEB-R	550.38	9.43	93.75	266.73	38.78	3.48
TEB-S + TEB-R	526.10	10.12	94.50	141.98	25.43	2.40
LSD[e]	102.63	2.21	7.80	93.42	10.49	1.18
Metconazole-sprayed						
TEB-S	13.70	18.85	2.00	0.46	0.18	<0.05
TEB-R	19.15	18.35	2.25	0.86	0.97	<0.05
TEB-S + TEB-R	16.70	17.35	1.75	1.75	0.30	<0.05
LSD[e]	9.43	2.81	2.42	1.57	0.80	0.00

Is the tebuconazole-resistant isolate sensitive to prothioconazole?

YES, based on personal communication of Anna Noveroske and Kiersten Wise at Purdue University

Plants NOT sprayed with tebuconazole: No difference in FHB between tebuconazole-sensitive (NY 014) and resistant isolate (NY 448) or mixture

Plants sprayed with tebuconazole:
FHB more severe in plants inoculated with the tebuconazole-resistant isolate (NY 448) than the sensitive isolate (NY 014).

What is the risk of a fungicidal control failure with triazoles against FHB?

Low, but not zero!

Reservoir of fungus on several hosts, saprophytic phase.

Fungicide targeted at small portion of fungal life cycle.

No control failure has been documented, but a partial reduction in control may be difficult to discern.

Control can be reduced by many factors including timing of application and weather conditions.

What should occur as a consequence of these findings?

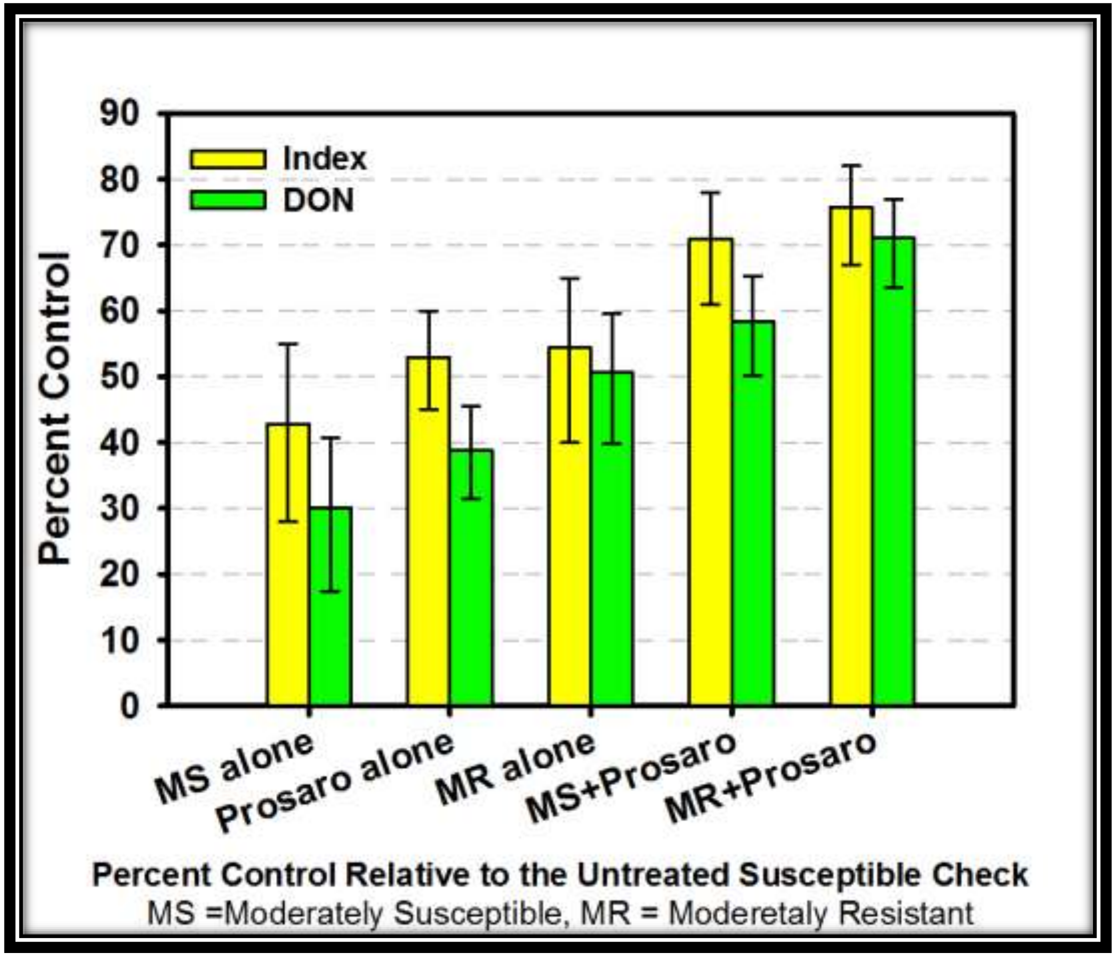
Use proactive management strategies that reduce risk of selection for resistance in pathogen populations.

- Integrated disease management (cultural, varietal, fungicidal methods).

- Alternate or combine triazole active ingredients at flowering; use other fungicide (mode of action) at earlier growth stages.

- Avoid unnecessary sprays – especially at early growth stages or those that target cereal debris

The overall mean percent control of FHB (index) and DON from 15 states



U.S. Wheat & Barley Scab Initiative

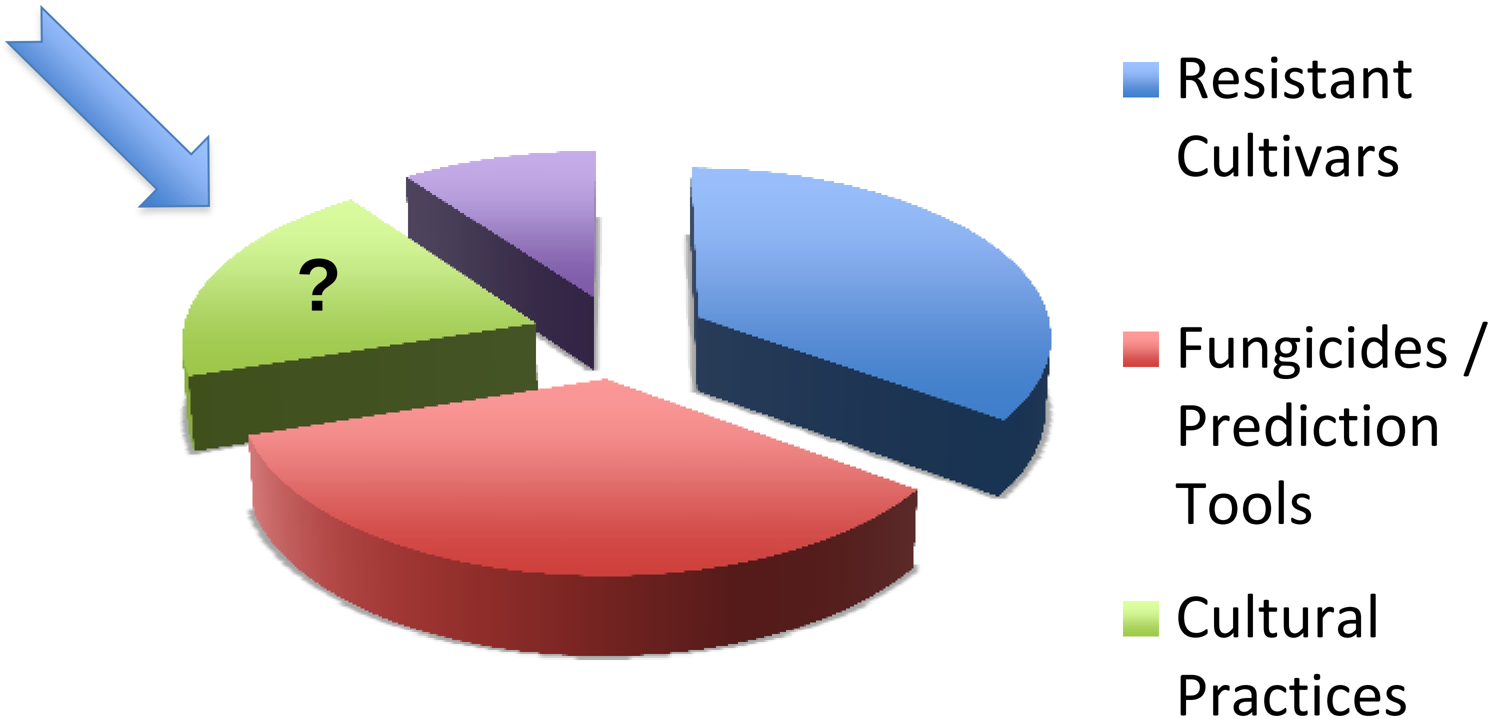
"This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0790-4-112. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture."

THE OHIO STATE UNIVERSITY OARDC EXTENSION

K. T. Willyerd et al. Plant Disease. 2012. Volume 96:957-967.

What is the contribution of cultural control to integrated management of FHB/DON?

No single answer for all environments and cropping systems.



For wheat within corn-growing regions in the north central and northeastern U.S., generally less than 30% contribution to DON reduction.

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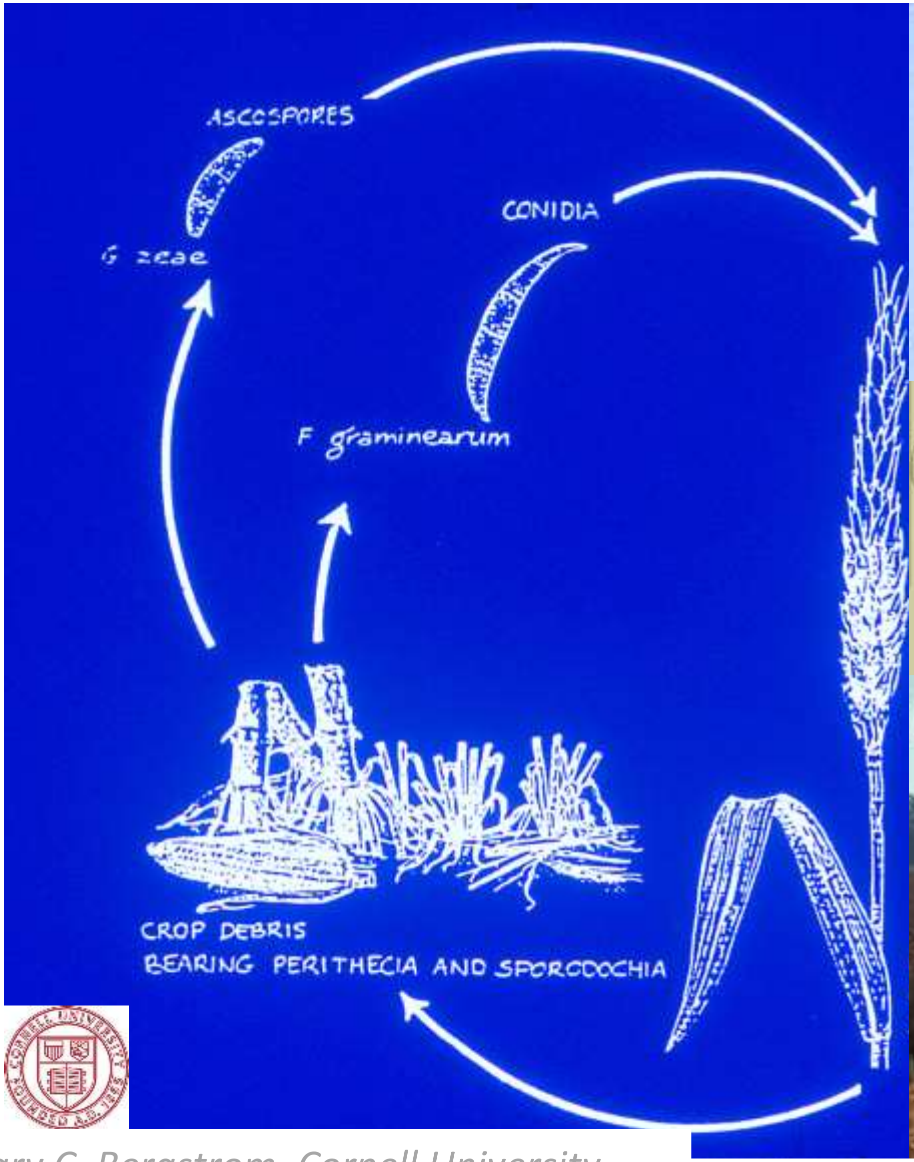
Cereal residues: principal source of spores for FHB



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Management of overwintered cereal residues: Regional impact and benefits in individual cereal fields

Gary C. Bergstrom, Cornell University

Debris management strategies for FHB

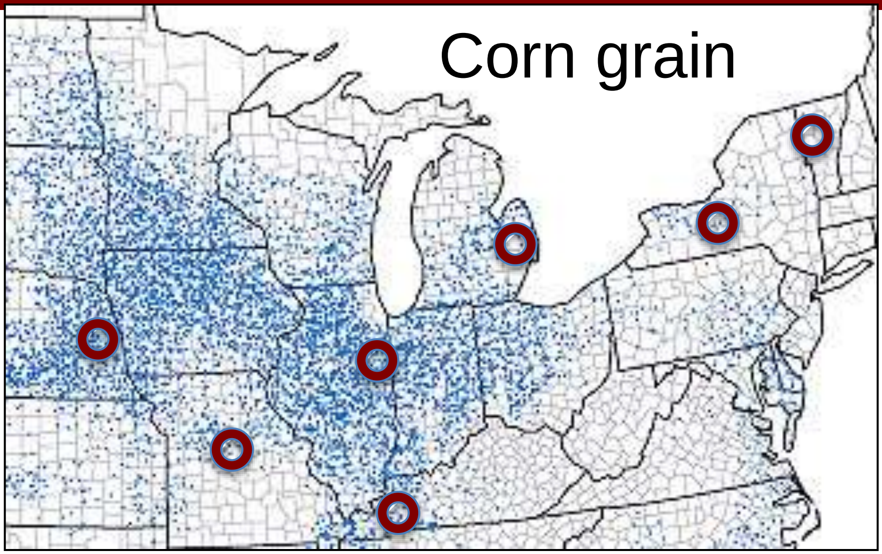
- Avoid growing wheat and barley in proximity to cereal debris
  - Crop Rotation: follow non-host crops
  - Underseeded crops as splash barrier

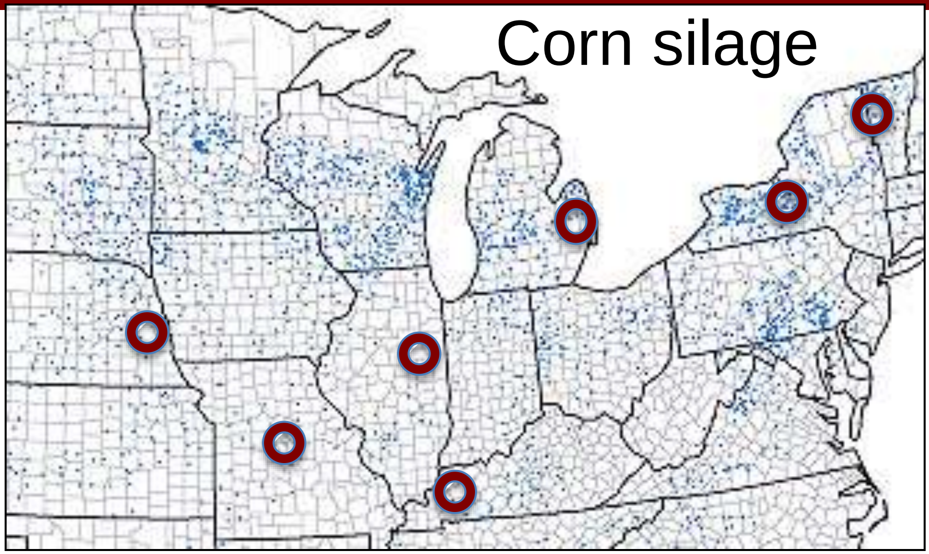
- Remove or destroy cereal debris
  - Tillage: bury debris by moldboard (nearly complete) or chisel (partial or reduced) plowing
  - Burning of residue
  - Chopping, splitting, or other size reduction

- Treat debris to reduce *Fusarium* survival/sporulation
  - Green manures, organic acids, C/N sources, soil, clay, lime, microbial inoculants

- Reduce *Fusarium* content in debris of resistant cereals

Environments typical of north-central and northeast regions where wheat is grown in proximity to / rotation with corn





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Effects of Local Corn Debris Management on FHB and DON Levels in Seventeen U.S. Wheat Environments in 2011 to 2013

Co-authors:
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Laura E. Sweets (Univ. of Missouri)

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Commercial-scale wheat after corn strip trials (no-till vs moldboard-plowed) experimental design

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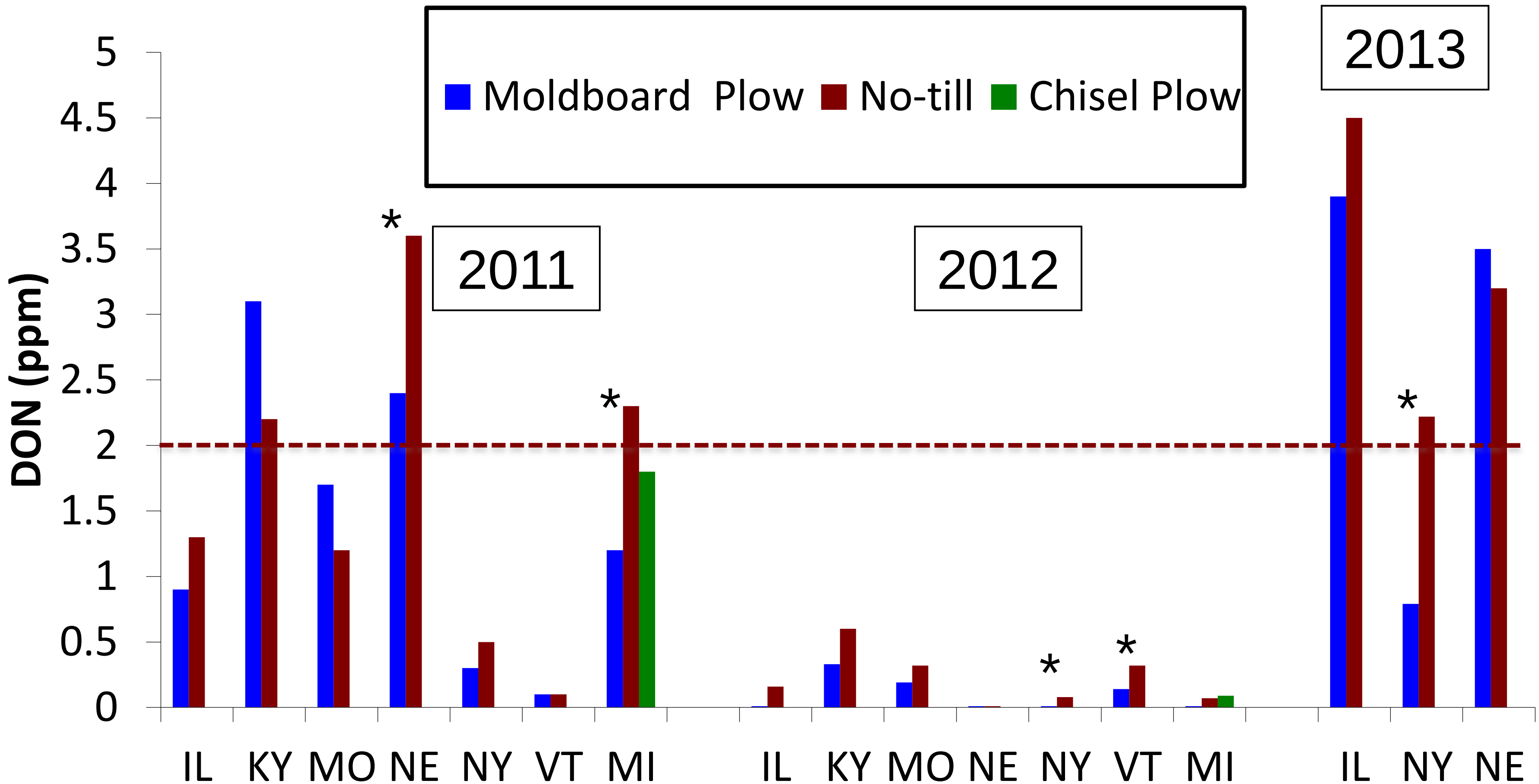
Average increase in DON of 22% (0.24 ppm) associated with no-till corn residue in wheat strips



Average 17% (0.38 ppm) increase when background level > 0.50 ppm

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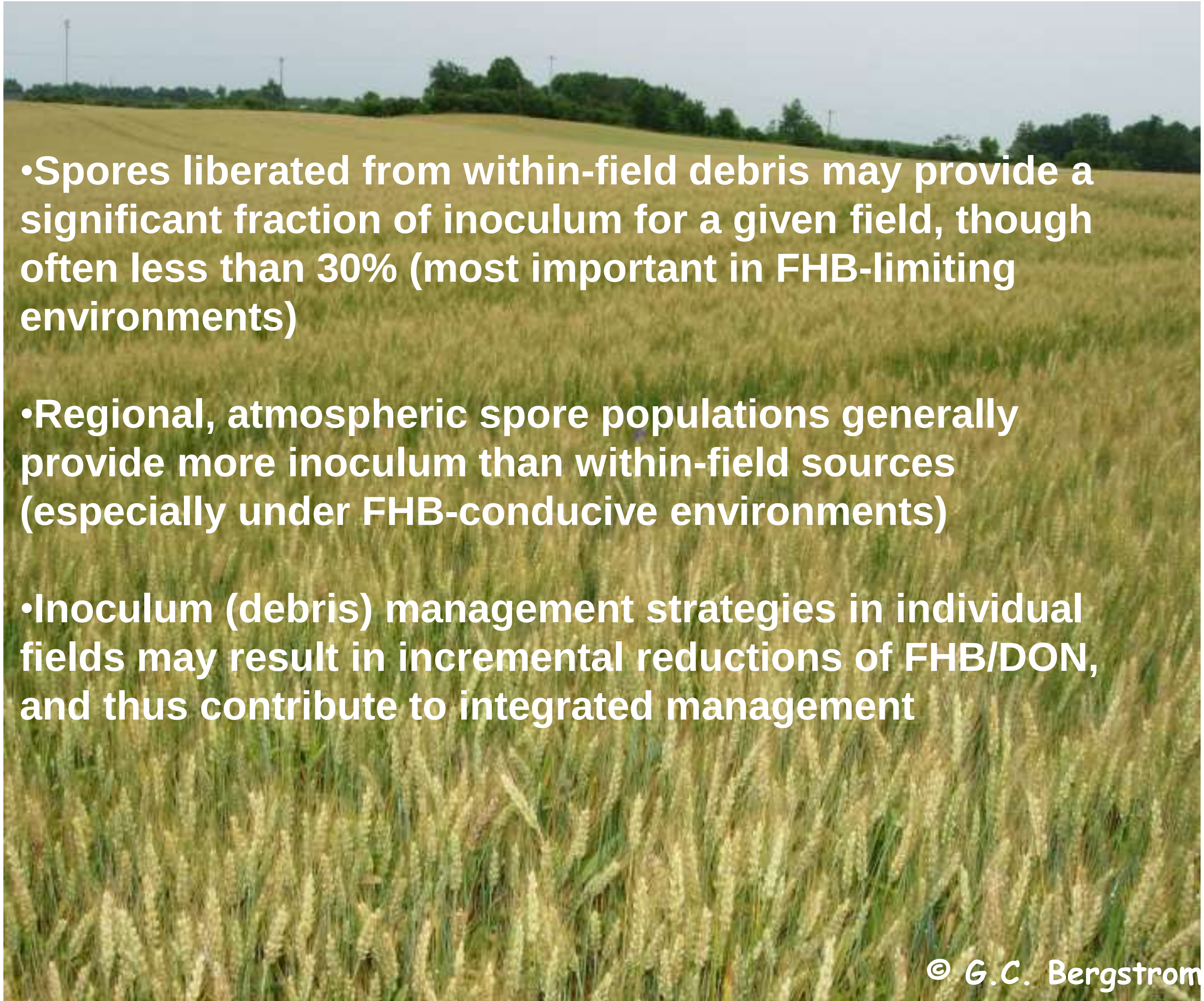
Conclusions about management of inoculum sources for FHB



- Spores liberated from within-field debris may provide a significant fraction of inoculum for a given field, though often less than 30% (most important in FHB-limiting environments)

- Regional, atmospheric spore populations generally provide more inoculum than within-field sources (especially under FHB-conducive environments)

- Inoculum (debris) management strategies in individual fields may result in incremental reductions of FHB/DON, and thus contribute to integrated management

Questions?