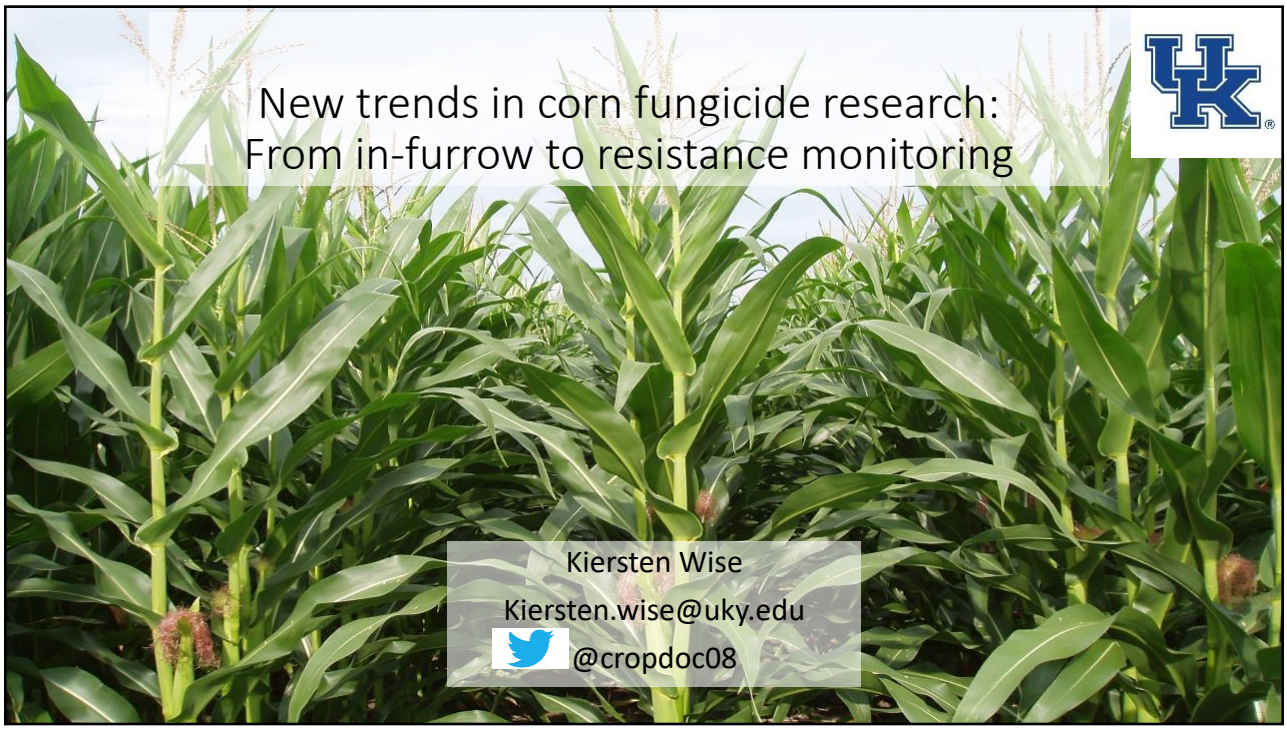

1

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Cooperative Extension Service

kycorn GROWERS ASSOCIATION

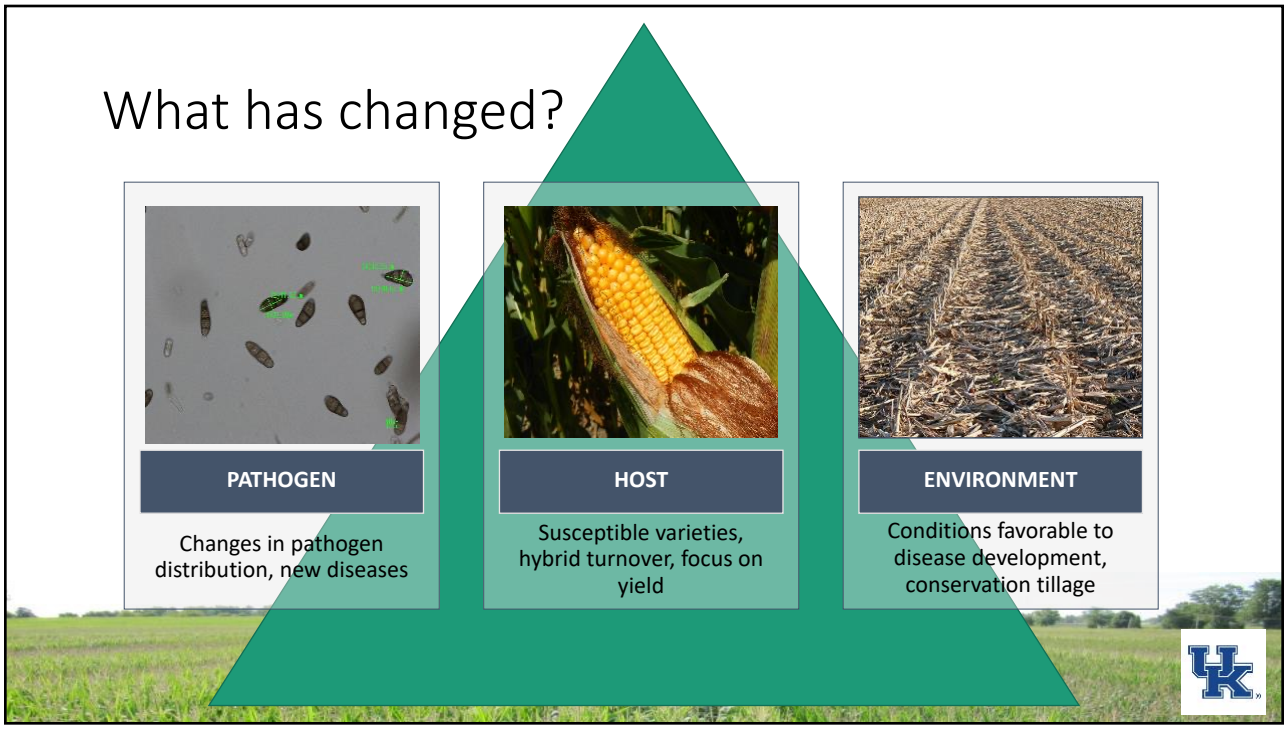
U.S. Wheat & Barley Scab Initiative

FMC An Agricultural Sciences Company

2


New trends in fungicide use
20 YEARS AGO…
• Foliar disease not a primary concern for farmers most years
• Fungicides cost prohibitive
NOW…
• Foliar diseases are yield-limiting and fungicides are a common input
• Primary defense against certain diseases

3


What has changed?
PATHOGEN
Changes in pathogen distribution, new diseases
HOST
Susceptible varieties, hybrid turnover, focus on yield
ENVIRONMENT
Conditions favorable to disease development, conservation tillage

4

Fungicides are a primary defense

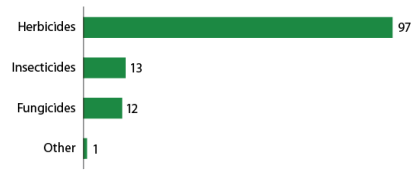
Curvularia leaf spot

New leaf spot

5

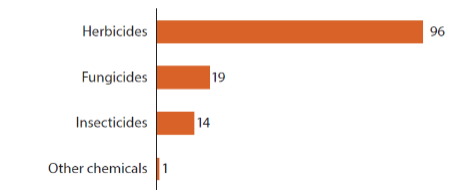
Fungicide use in field crops has increased

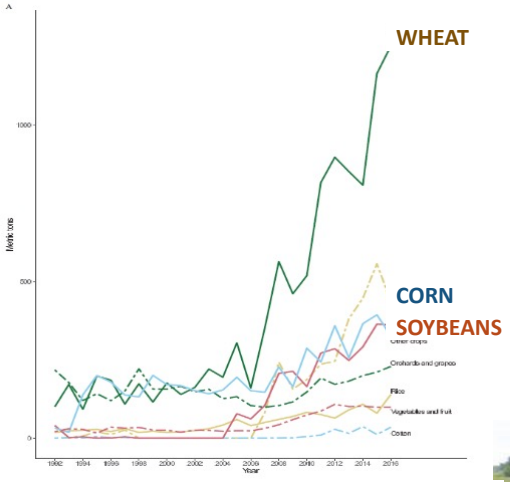
Fig. 2. Pesticides Applied to Corn Planted Acres, 2014 Crop Year [a]
(% of planted acres)



[a] *The one-year period beginning after the 2013 harvest and ending after the 2014 harvest. Source: USDA NASS.*

Fig. 2. Pesticides Applied to Corn Planted Acres, 2021 Crop Year
(% of planted acres)



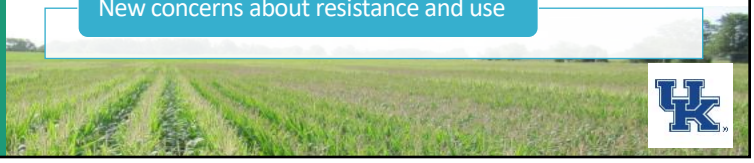


Average agricultural triazole fungicide use by crop 1992-2016; Toda et al., 2021

6

Drivers for fungicide growth in recent years

- New active ingredients
- New pre-mixes
- New application timings/uses
- New application methods
- New disease threats
- New concerns about resistance and use



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Drivers for fungicide growth in recent years

- New active ingredients
- New pre-mixes
- New application timings/uses
- New application methods
- New disease threats
- New concerns about resistance and use

8

Premise for in-furrow applications

- Promoted to improve disease control of soil-borne pathogens above and beyond seed treatments
  - Also improve vigor, health
- Kentucky data indicates these are only potentially effective in VERY early plantings

9

Other ways to use in-furrow fungicides?

- Fungicides applied in-furrow for **foliar** disease control
- FMC product = flutriafol
- Xyway 3D 3RIVE and Xyway LFR

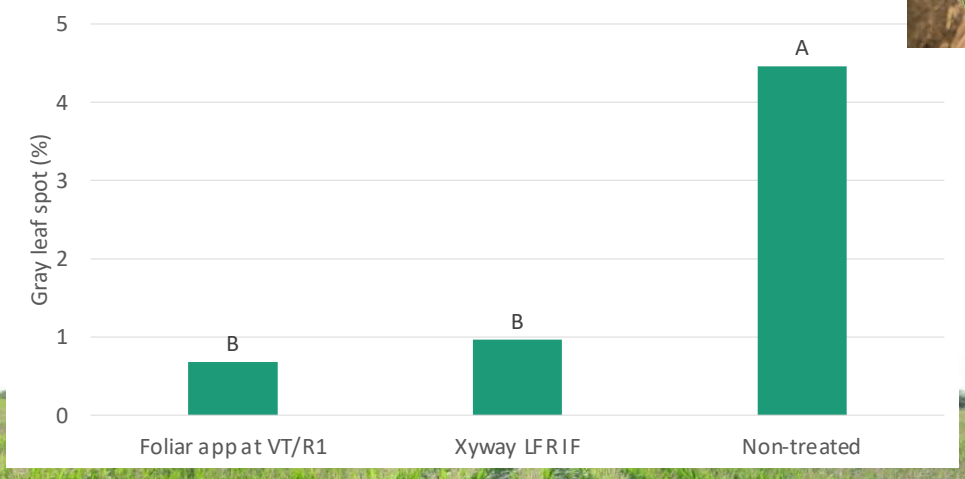
10

Summary of University of Kentucky Xyway data

- Overview of four years of trials (2019-2022)
- Separated into 3 treatment groups comparing:
  - Xyway LFR IF
  - Foliar fungicide application at VT/R1
  - Non-treated control
  - n = 57
- Examined efficacy of product on common foliar diseases under average disease pressure

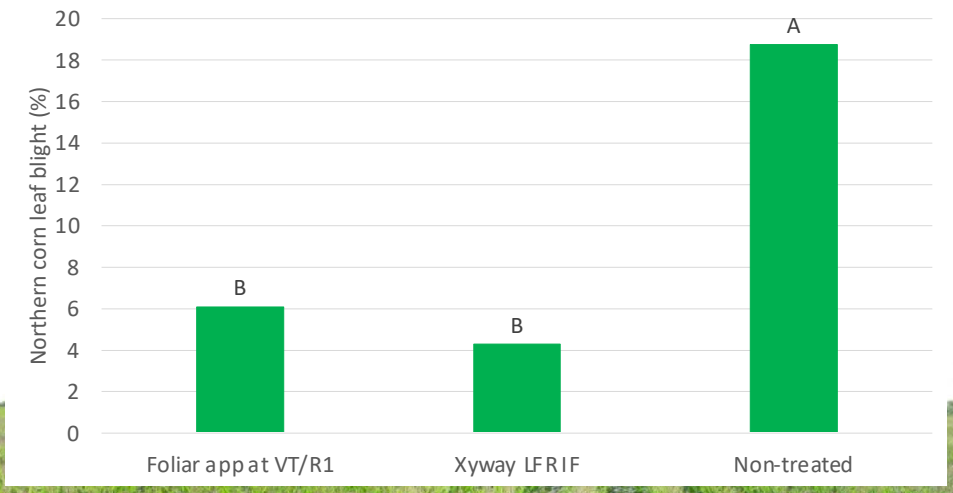
11

Effect of Xyway on gray leaf spot 2019-2022, Princeton, KY



12

Effect of Xyway on northern corn leaf blight 2019-2022, Princeton, KY



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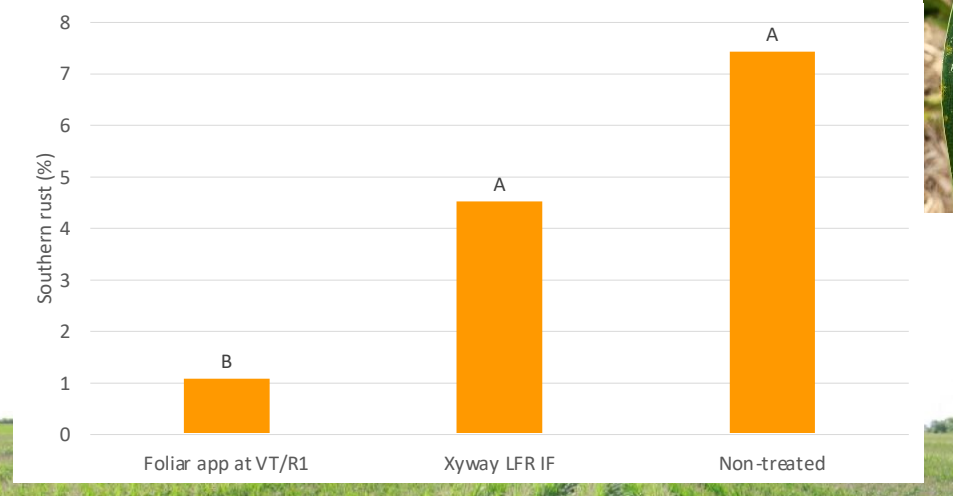
Effect of Xyway on southern rust 2019-2022, Princeton, KY



14

Is Xyway a fit for your production system?

- Xyway treatment significantly reduced GLS and NCLB in KY, compared to non-treated controls
- May need follow-up foliar application for southern rust management
- Keep in mind impact of temperature at/after planting
  - 2 x 2 application
  - Check equipment often to ensure agitation and precision in application
  - Leave check strips (multiple if possible)
- KY: Good fit in areas where any foliar applications difficult/impossible or as a first application pass
  - Replaces V10 application
  - Still learning about impact on other diseases

15

Crown rot of corn

- Old disease, but has re-surged in recent years
- Hard to diagnose in-season
- Emerged as a yield-limiting and confusing issue

16

17

Do in-furrow fungicides control crown rot?

Reports of foliar applications providing a benefit (V5, VT)

- No consistent findings from University trials….yet

In-furrow applications

- Potential?
- Testing in-furrow products that have long residual and efficacy against other fungal diseases

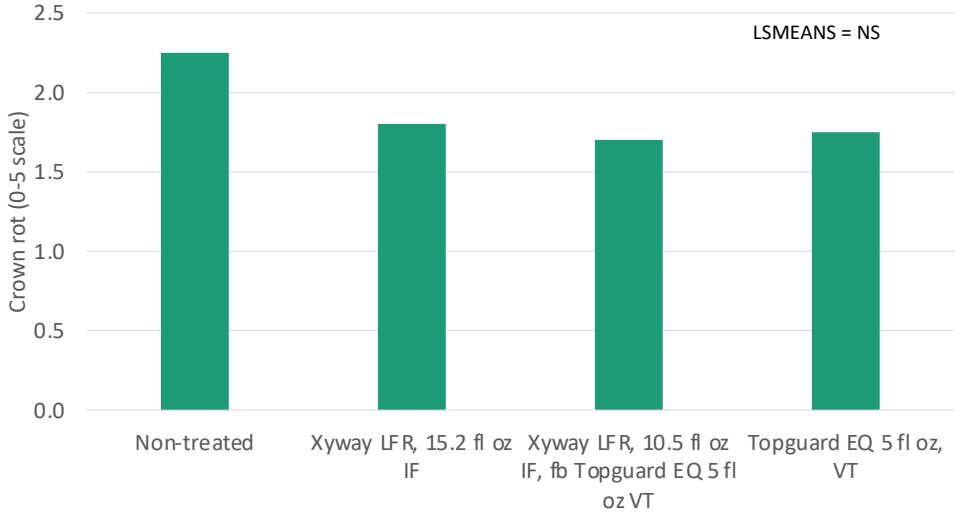
18

Univ. Kentucky crown rot trials 2021 and 2022

- Trials conducted at UKREC, Princeton KY
- Tested in-furrow and foliar applications
- Inoculated with *Fusarium graminearum*
  - Commonly isolated from plants with crown rot in KY
- Rated 28 DAE and at harvest for crown rot symptoms
  - 0-5 scale of crown discoloration
  - No symptoms observed until late-season

19

Fungicide application effect on crown rot Princeton, KY 2021



20

Fungicide application effect on crown rot Princeton, KY 2022

21

Do in-furrow fungicides control crown rot?

Maybe?
More research is needed and underway

- No consistent findings from University trials….yet

- Potential?
- Testing in-furrow products that have long residual and efficacy against other fungal diseases

22

What can we do to manage crown rot

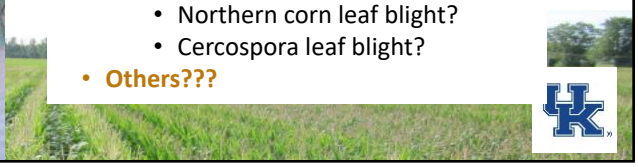
- Minimize plant stress
  - Plant at recommended timings, seeding rates and follow good fertility and weed management plans
- Scout fields at the end of the season
  - Send samples in for diagnosis if symptoms of crown rot are observed
- Take notes about hybrids affected, production practices
- Stay tuned!
  - More research, particularly fungicide research coming soon

23

Fungicide Resistance Impacts Crop Yield

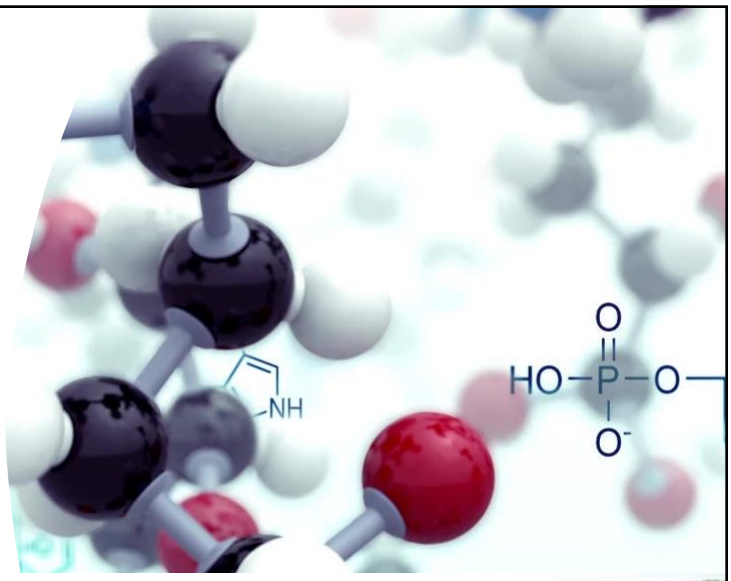
Confirmed Fungicide Resistance in:

- **Soybeans**
  - Frogeye leaf spot
  - Septoria brown spot
  - Target spot
  - Cercospora leaf blight
- **Wheat**
  - Stagonospora nodorum blotch
  - Fusarium head blight
- **Corn**
  - Northern corn leaf blight?
  - Cercospora leaf blight?
- **Others???**



24

Triazole group = FRAC code 3



- One of the largest fungicide groups
- Introduced in the 1970s
- MOA: Sterol biosynthesis inhibitors (SBI)
  - Four groups of SBI fungicides---
  - Group name = DMIs = demethylation inhibitors
    - Sub-group = triazoles
  - Triazoles inhibits enzyme production essential for cell membranes
  - Results in abnormal fungal growth and death

25

MOA	TARGET SITE AND CODE	GROUP NAME	CHEMICAL GROUP	COMMON NAME	COMMENTS	FRAC CODE
G: sterol biosynthesis in membranes	G1: C14- demethylase in sterol biosynthesis *(erg11/cyp51)*	DMI-fungicides (DeMethylation Inhibitors) (SBI: Class I)	piperazines	triforine	There are big differences in the activity spectra of DMI fungicides. Resistance is known in various fungal species. Several resistance mechanisms are known incl. target site mutations in cyp51 (erg 11) gene, e.g. V136A, Y137F, A379G, I381V; cyp51 promotor; ABC transporters and others. Generally wise to accept that cross resistance is present between DMI fungicides active against the same fungus. DMI fungicides are Sterol Biosynthesis Inhibitors (SBIs), but show no cross resistance to other SBI classes. **Medium risk.** **See FRAC SBI Guidelines for resistance management.**	3
			pyridines	pyrifenox pyrisoxazole		
			pyrimidines	fenarimol nuarimol		
			imidazoles	imazalil oxpoconazole pefurazoate prochloraz triflumizole		
			triazoles	azaconazole bitertanol bromuconazole cyproconazole difenoconazole diniconazole epoxiconazole etaconazole fenbuconazole fluquinconazole flusilazole flutriafol hexaconazole imibenconazole ipconazole metconazole myclobutanil penconazole propiconazole simeconazole tebuconazole tetraconazole triadimefon triadimenol triticonazole prothioconazole		
			triazolinthiones			
	G2:		morpholines	aldimorph dodemorph	Decreased sensitivity for powdery mildews.	

26

Fungicide sensitivity testing of *Fusarium graminearum*

- *F. graminearum* isolates collected from 1981 to 2014
  - Widespread national representation
- For analysis, isolates separated into two categories
  - Before widespread triazole foliar applications in wheat (Pre-2000)
  - After triazole use in wheat increased (2000 to 2014)

27

Fungicide sensitivity testing

- Common "poison plate" assay
- Technical grade fungicide added to PDA at six concentrations (0, 0.001, 0.01, 0.1, 1, 10, 100 ppm)
- Tested metconozole tebuconazole
- Measured diameter of colony growth 5 days after plating and EC_{50} values determined

28

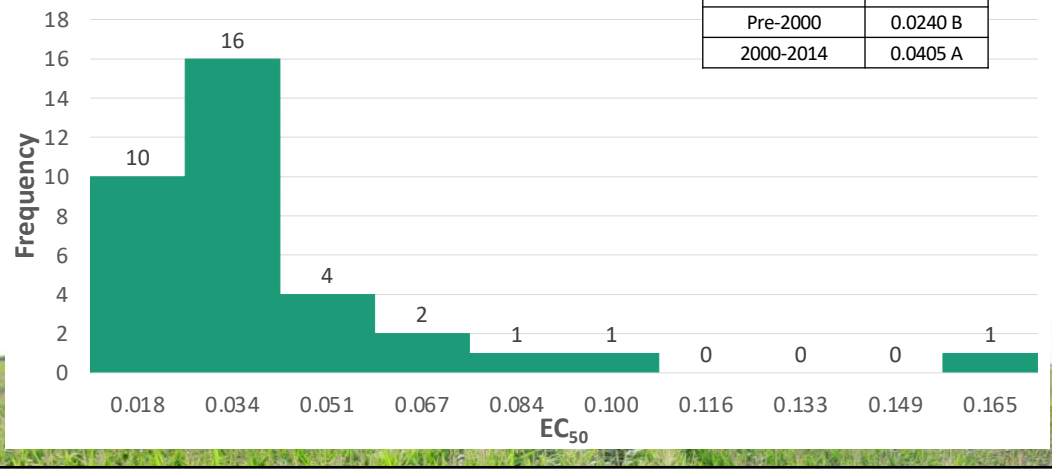
Pre-2000 isolates

Fungicide	Range of EC_{50} values	Mean EC_{50} values
Metconazole n=12	0.0071 to 0.0588	0.0240
Tebuconazole n=8	0.0362 to 0.5877	0.1138

29

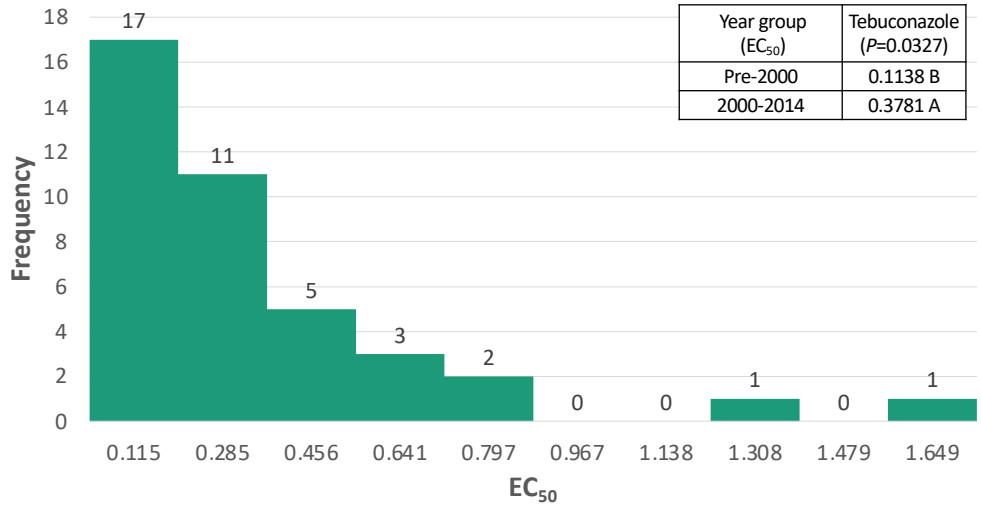
Sensitivity of 2000 to 2014 *Fusarium graminearum* isolates to metconazole (n=35)

Year group (EC_{50})	Metconazole (*P*=0.0031)
Pre-2000	0.0240 B
2000-2014	0.0405 A



30

Sensitivity of 2000 to 2014 *Fusarium graminearum* isolates to tebuconazole (n=40)



Year group (EC_{50})	Tebuconazole (P=0.0327)
Pre-2000	0.1138 B
2000-2014	0.3781 A

31

Fungicide sensitivity results

- Significant differences in EC_{50} values between pre-2000 and 2000-2014
- Two isolates potentially resistant
  - Shifts detected to both fungicides tested
- Work is continuing….more forthcoming
- **Critically important because triazole fungicides are essential to managing Fusarium head blight**

32

Adhere to practices that delay fungicide resistance

Cultural Practices	Focus on cultural practices to reduce fungal populations in environment
Hybrid resistance	Plant varieties resistant to disease
Predictive tools	Spray fungicides preventatively, in response to predicted disease threat
Tank-Mix	Tank mix fungicides with multiple modes of action and multiples sites of action

33

34