

# Sensitivity of *Fusarium graminearum* to tebuconazole, metconazole, and prothioconazole fungicides



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[https://www.google.ca/search?q=fungicides+sprayers+tractor&bm=isch&ved=2ahUKEwinh9Ck8YjoAHWngJ4KHxerDjQQ2-cCegQIABAA&oeq=fungicides+sprayers+tractor&gs\\_l=img\\_3...23242.26527.26800...0.0.0.139.2028.0j16.....0...1.gws-wiz-img.....0i830.olWRSVUQ30E&ei=9iIXueVC6eB-gT31rqAw&bih=722&biw=1462&hl=en#imgrc=Mzshad5Tfzm0OM](https://www.google.ca/search?q=fungicides+sprayers+tractor&bm=isch&ved=2ahUKEwinh9Ck8YjoAHWngJ4KHxerDjQQ2-cCegQIABAA&oeq=fungicides+sprayers+tractor&gs_l=img_3...23242.26527.26800...0.0.0.139.2028.0j16.....0...1.gws-wiz-img.....0i830.olWRSVUQ30E&ei=9iIXueVC6eB-gT31rqAw&bih=722&biw=1462&hl=en#imgrc=Mzshad5Tfzm0OM)

# Integrated Disease Management (IDM)

- Information about the disease
- Field scouting
- Resistant varieties
- Cultural controls
  - field management practices (tillage, crop rotation/ crop selection)
- **Foliar fungicides**

# Foliar fungicides

2020  
For the c

## Trade names

Bravo 500  
Caramba  
Echo 720  
Hornet 432F  
Miravis Ace  
Palliser  
Proline 480SC  
Prosaro 250EC/Prosaro XTR  
Twinline

## Active ingredients

chlorothalonil  
metconazole  
chlorothalonil  
tebuconazole  
pydiflumetofen + propiconazole  
tebuconazole  
prothioconazole  
prothioconazole + tebuconazole  
pyraclostrobin + metconazole

HIGH RISK = 6	<b>Group 11 QoI (Strobilurins)</b> Azoxystrobin Pyraclostrobin Picoxystrobin Trifloxystrobin <b>Group 1 MBC (Benzimidazole)</b> TPM Thiabendazole <b>Group 4 (Phenylamides)</b> Metalaxyl
MEDIUM TO HIGH RISK = 3	<b>Group 7 SDHIs</b> Boscalid Fluxapyroxad Fluopyram Penflufen Sedaxane <b>Group 2 (Dicarboxamides)</b> Iprodione
MEDIUM RISK = 3	<b>Group 3 DMIs (Triazoles)</b> Prothioconazole Propiconazole Metconazole Tebuconazole <b>Group 9 AP (Anilino Pyrimidines)</b> Pyrimethanil Cyprodinil
LOW TO MEDIUM RISK = 1	<b>Group 40 CAA (Carboxylic Acid Amines)</b> Dimethomorph <b>Group 12 (Phenylpyrroles)</b> Fludioxonil <b>M3 (Dithiocarbamate)</b> Mancozeb Thiram Maneb <b>M1/2 (Inorganics)</b> Copper Sulphur
UNKNOWN	Microbial membrane disruptors

\*This is not an exhaustive list, but captures the majority of active ingredients that are relevant for Western Canada

# Fungicide insensitivity (resistance)

- Fungus becomes insensitive (resistant) to the fungicide, i.e. the fungicide does not control the disease anymore.
- Resistance monitoring is crucial to understanding what changes the population may be undergoing.

# Risk factors:

- Single-site mode of action
- Pathogen risk
  - Monocyclic vs polycyclic (disease cycles per year)?
  - High spore production?
  - Soil vs. air dispersed?
  - Infects all growth stages of the crop?
  - Does the pathogen have a sexual stage?
  - Do they overwinter?
- Frequent application of the fungicide

**GERMANY** (Klix 2007) - Sensitivity of *F. graminearum* to epoxiconazole, tebuconazole, metconazole, and prothioconazole

- Epoxiconazole failed to inhibit spore germination even at high concentrations

**CHINA** (Yin 2009) - Reduced sensitivity of *F. graminearum* and *F. asiaticum* to benzimidazole [MBC] and tebuconazole [DMI]

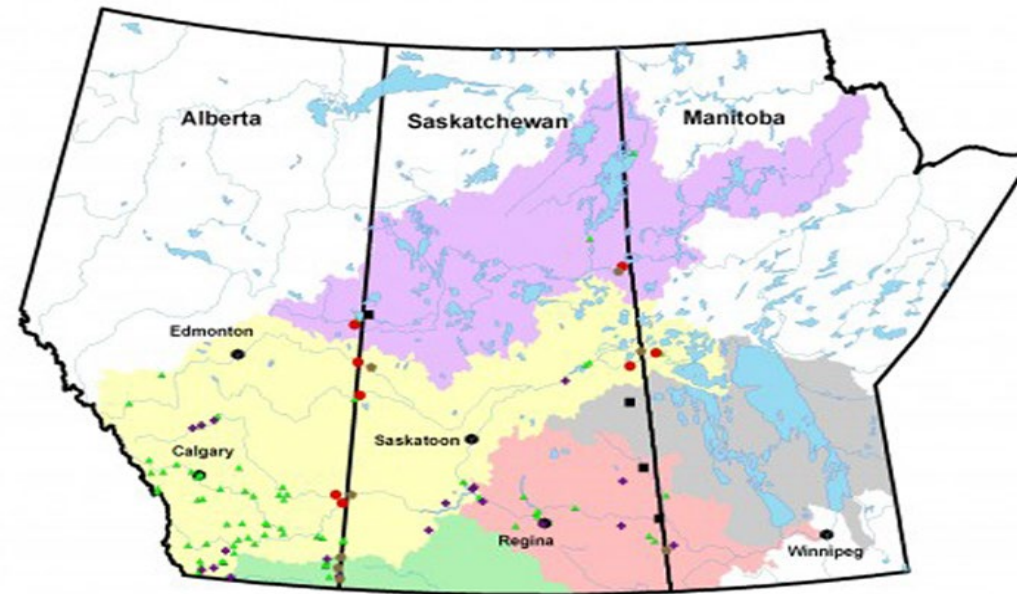
- Nine isolates out of 159 were highly insensitive to the MBC, and three to the DMI

**AMERICA** (Spolti 2014) - Reduced sensitivity of *F. graminearum* isolates to triazole (tebuconazole) fungicides

- One isolate out of 50

# Is there a fungicide resistance problem?

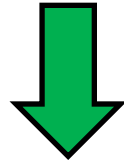
Is there any *Fusarium graminearum* isolates with fungicide resistance in Western Canada



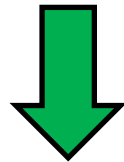
<https://www.google.com/maps/@53.5461111, -110.5461111, 15z>

# How did we start?

**Survey (2014 - 2017)**



**Morphological Identification**



**Molecular Identification**



*Fusarium graminearum*



# Isolates (Total = 253)

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<b>Province</b>	<b>Number of isolates</b>
Saskatchewan (143)	55 (2014) + 10 (2015) + 30 (2016) + 32 (NRRL) + 16 (DAOM)
Manitoba (76)	49 (Dr. M. A. Henriquez) + 23 (NRRL) + 4 (DAOM)
Alberta (34)	26 (NRRL) + 8 (DAOM)

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NRRL culture collection – USDA/ARS Culture Collection (NRRL, Peoria, IL); DAOM- Canadian Collection of Fungal Cultures (DAOM), Ottawa, Ontario, Canada.

# Fungicides

- Triazoles (technical grade -100% Active ingredient)
  - **tebuconazole**
  - **metconazole**
  - **prothioconazole**
- Concentrations of fungicides
  - Seven (0.03, 0.1, 0.3, 1, 3, 10, 30 mg/L)
  - Control

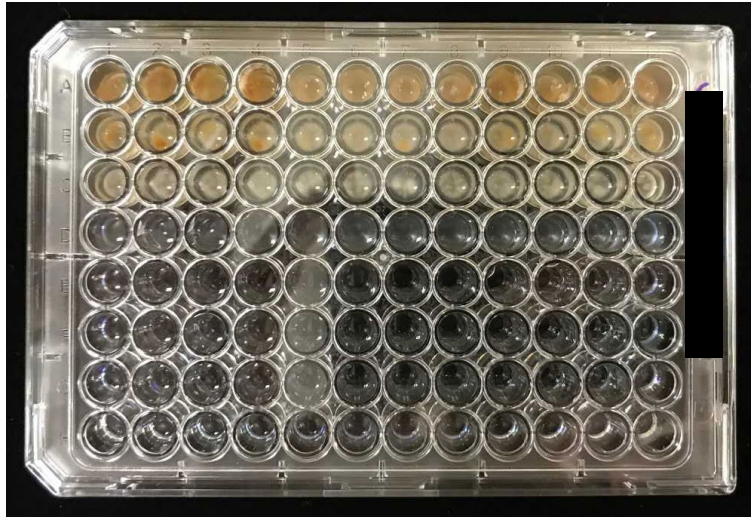




Control

30 mg/L

# Microtiter plate method



Incubated in dark for **3 days** at **~22°C** on a standard rotary shaker (**150 rpm**)

Fungal growth was measured by optical density at 620 nm



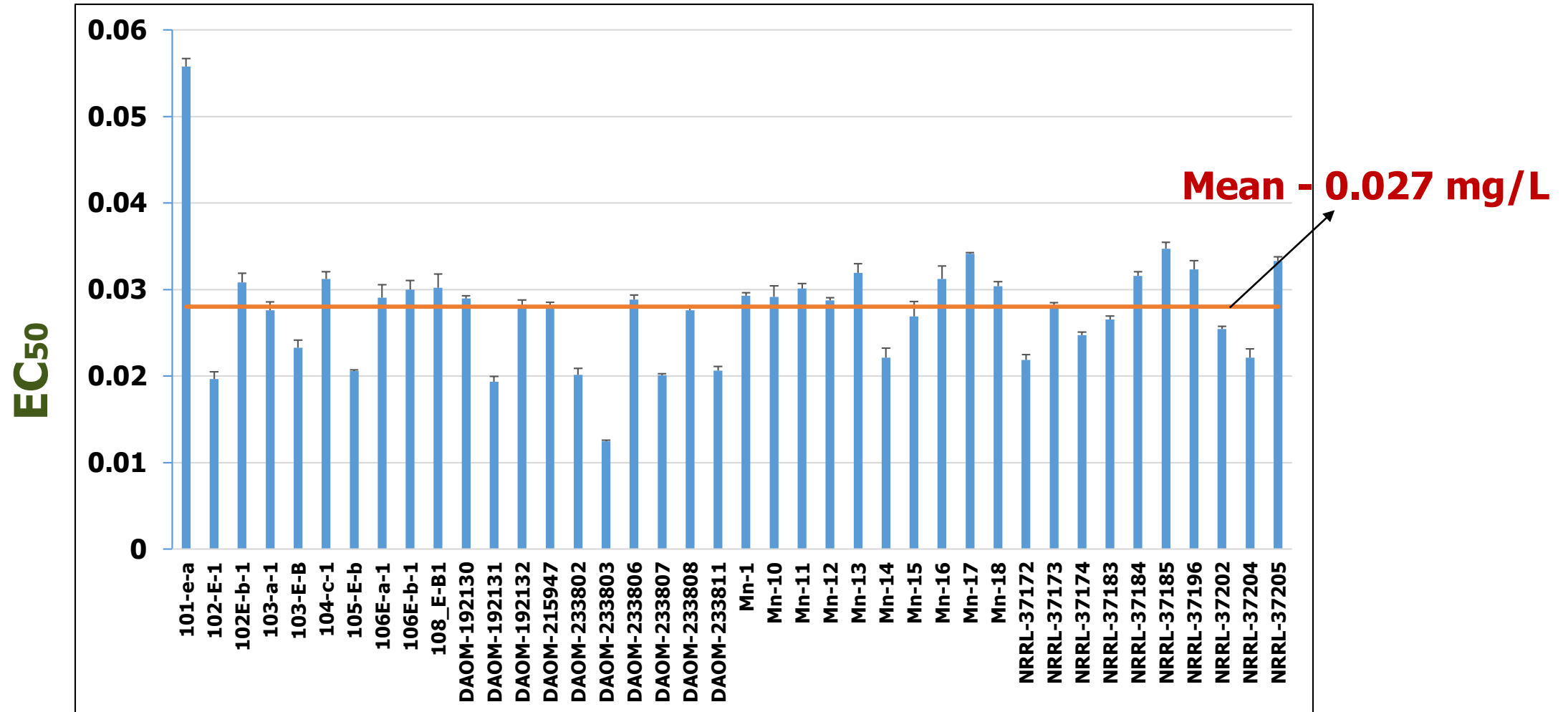
Spectrophotometer

# Assessment parameters

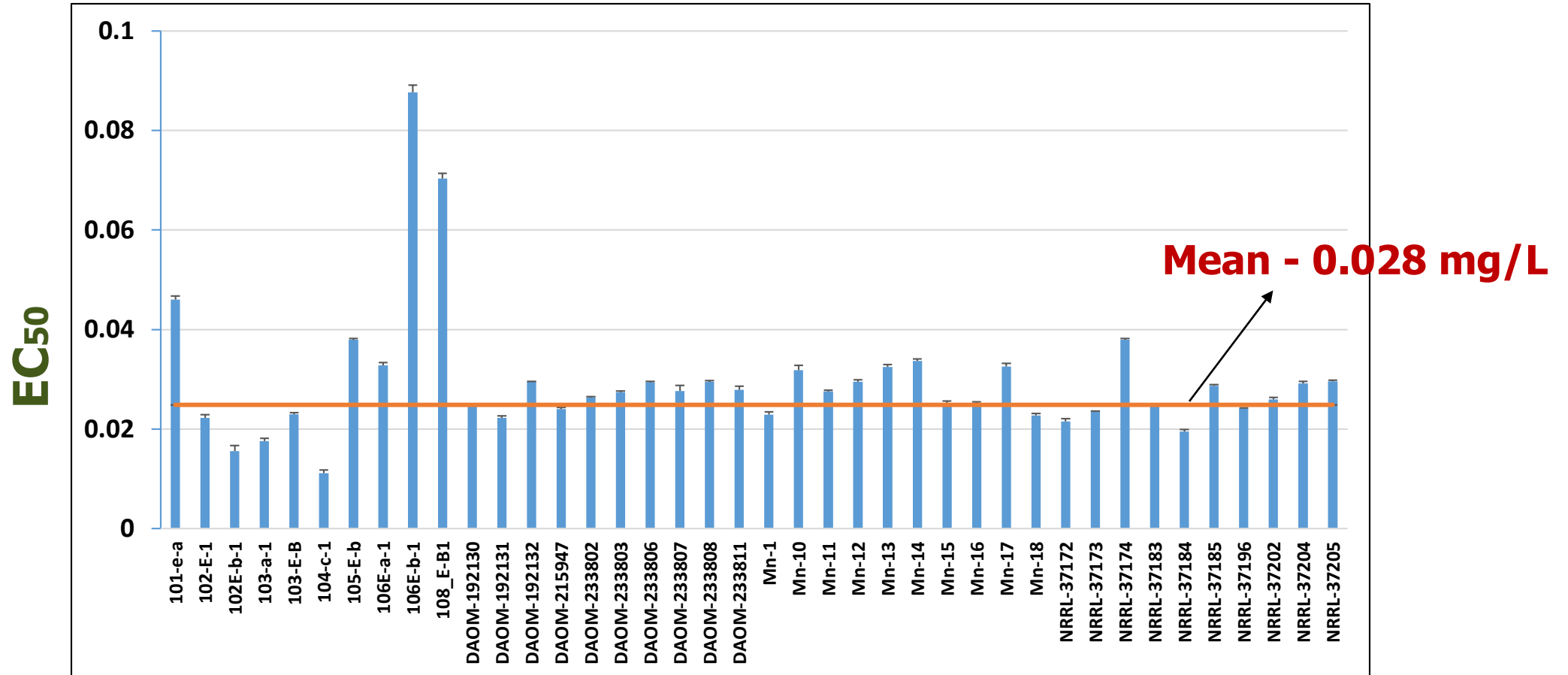
**EC50** - the dose that **reduces the growth** or other parameter (of mycelium or spores) to a value of **50%** of that of growth in the absence of fungicide.

**Cross-resistance** - insensitivity to one product may result in insensitivity to other related products even though the 'other' product was not used.

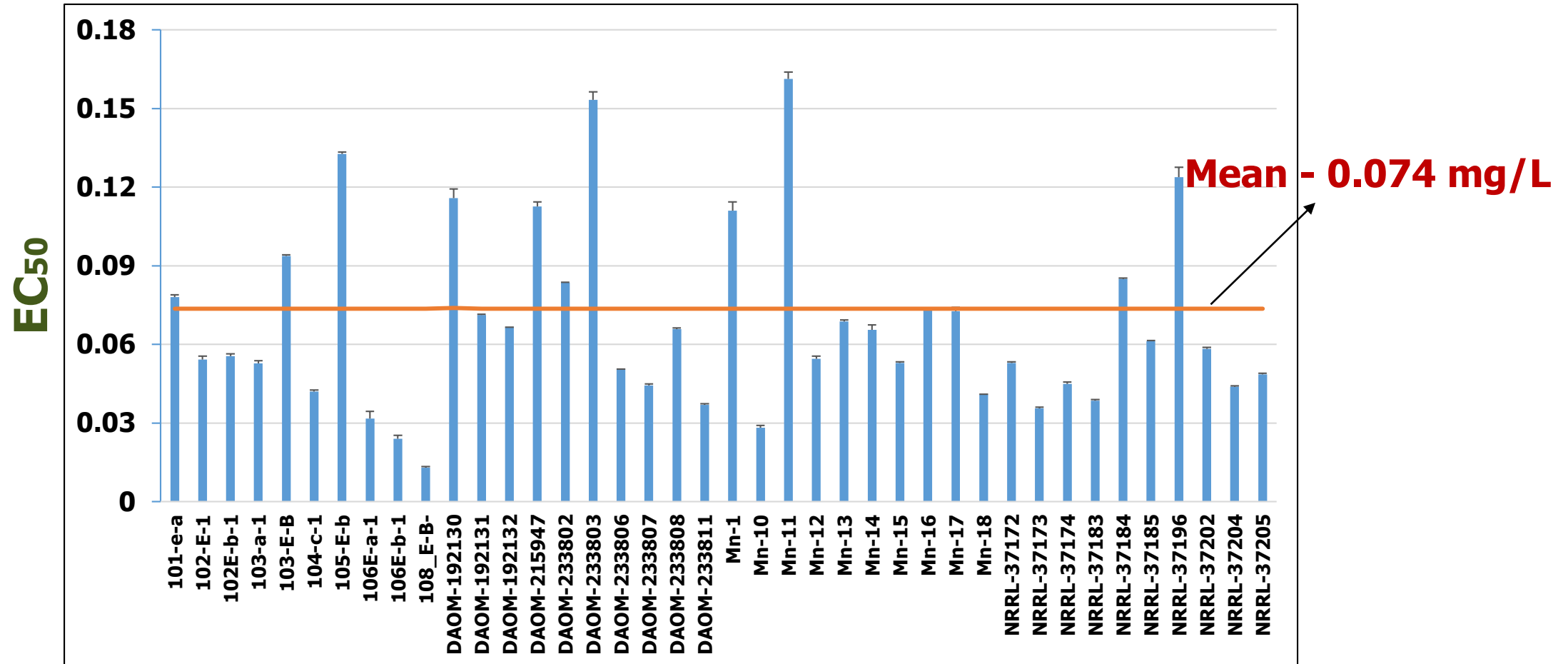
# EC<sub>50</sub>-prothioconazole



# EC<sub>50</sub>-metconazole



# EC<sub>50</sub>-tebuconazole





# Conclusion

- We tested sensitivity of three triazoles fungicides recommended for suppression of FHB.
- **No insensitive isolate was found.**
- *F. graminearum* isolates associated with FHB in Western Canada are **sensitive to triazoles** at various levels.

# Risk Management Strategies

- Use clean seed and seed treatment
- Rotate crops/ select disease resistant varieties
- Scout for disease and apply based on risk of disease
- Rotate fungicide within groups/ different groups
- DO NOT apply more than the maximum number of applications listed on the label
- Don't overuse the same group in the same season
- Fungicide use should be based on IPM program that includes scouting and cultural control practices

# Acknowledgements

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