

Molecular epidemiology of Cercospora leaf spot

Detection of latent CLS in commercial
sugarbeet fields and monitoring fungicide
resistance mutations

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U.S. DEPARTMENT OF AGRICULTURE

Cercospora beticola

- Cercospora leaf spot (CLS) on sugarbeet
- Hemibiotrophic fungus
 - Has a latency period prior to symptoms
- Polycyclic lifecycle
- Genetically diverse
- Primarily controlled through fungicide applications and host resistance



CLS disease cycle

When are spores dispersed in spring?

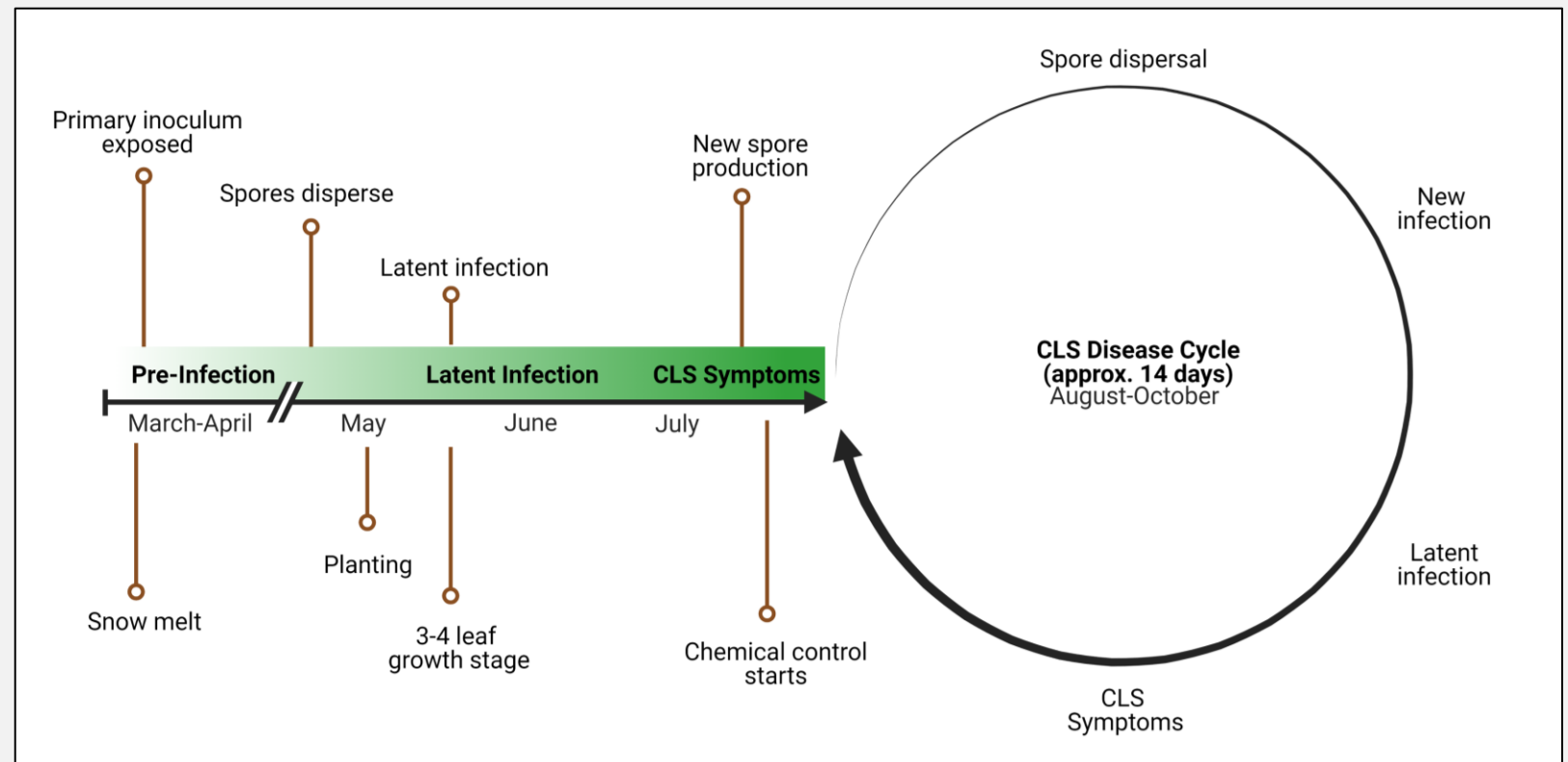
Detected beginning of May.

What conditions are favorable for spore germination?

Temperatures > 50 degrees F
Available free water (Rain/Dew)

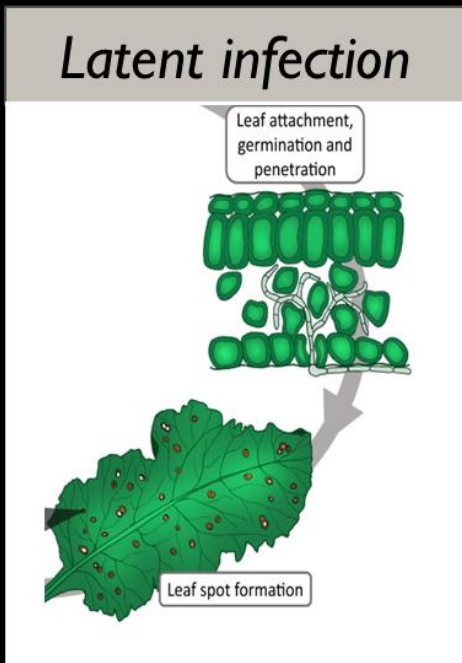
What is latent CLS disease?

When does latent CLS disease begin?

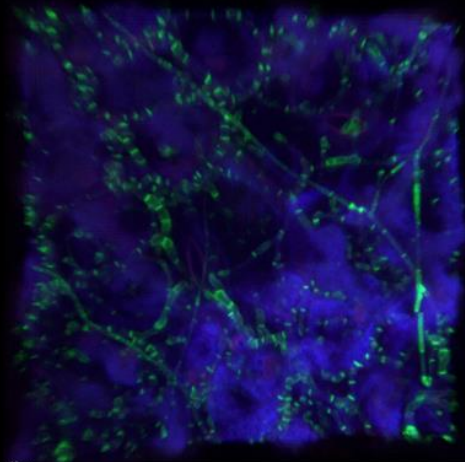


Results from Secor Lab, NDSU Plant Pathology

Latent infection



7 DPI

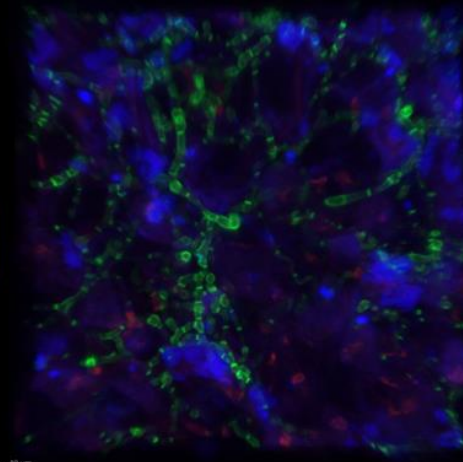


RED: DNA

BLUE: Cellulose

Green: Chitin

10 DPI



Intact plant nuclei

BLUE: Plant Cells

Green: Fungal Cells

Latent infection screening

Setup

With the help of ACSC, MinnDak, SMBSC:

Sample **280** commercial fields from across the RRV weekly.

Multiplex qPCR assay:

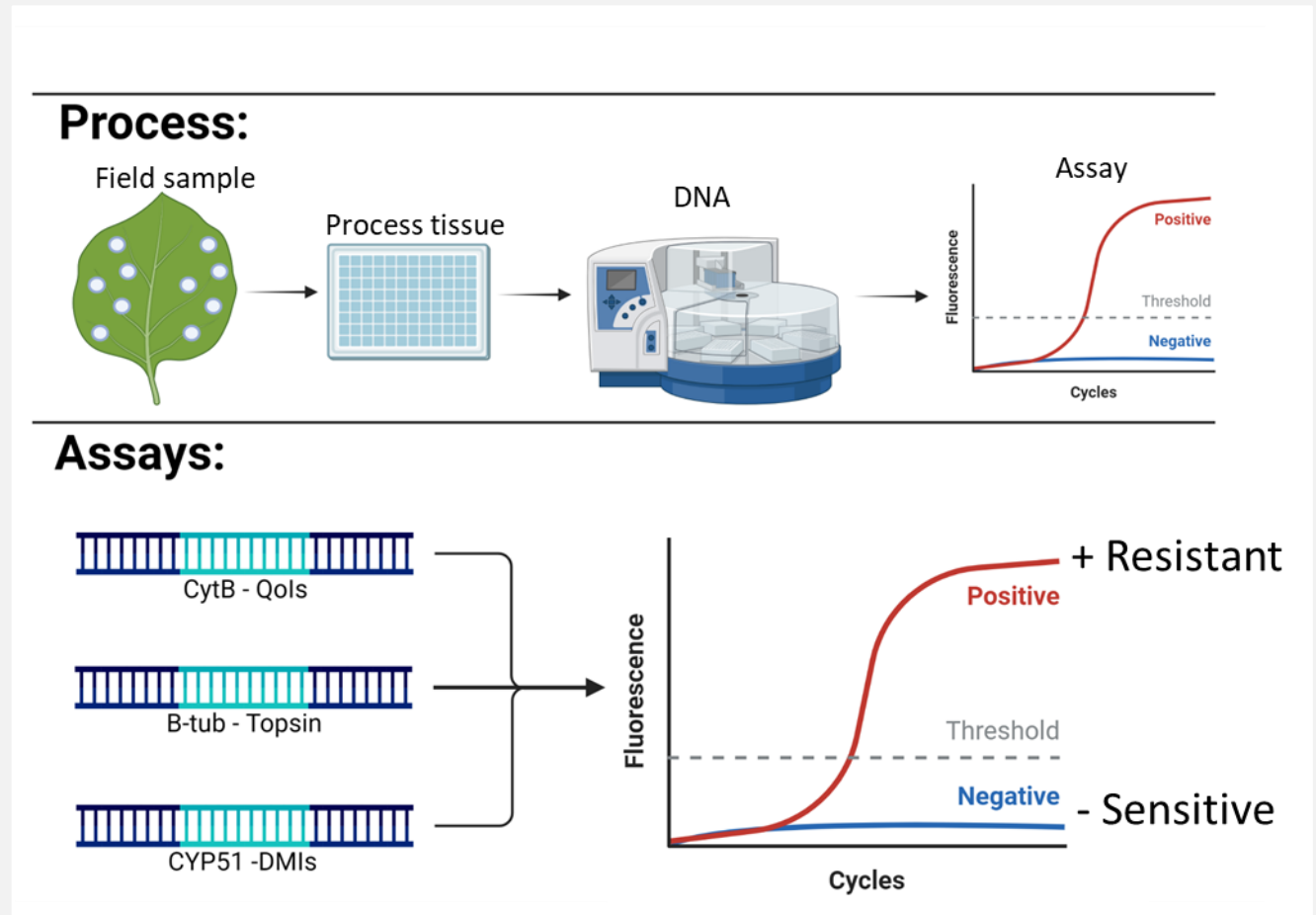
QoI R/S (G143A)

DMI R/S (E170,L144F)

Benzimidazole R (E198A)

Report weekly results.

2 day turn around for 90 samples

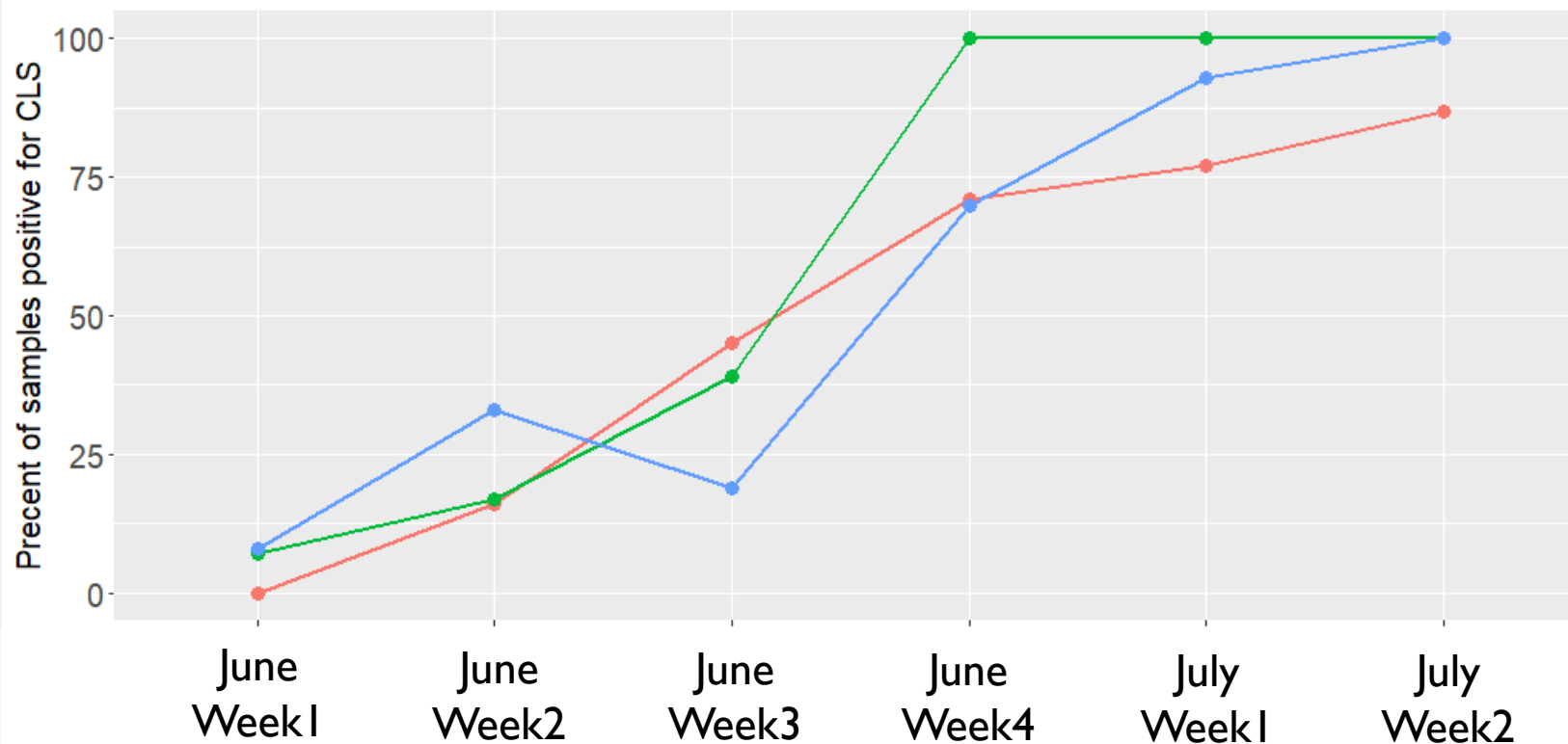


Detecting *C. beticola* DNA in asymptomatic leaves.

2021-2023 Latent CLS prevalence

Detction of latent CLS 2021 – 2023

Year ● Prevalence_2021 ● Prevalence_2022 ● Prevalence_2023

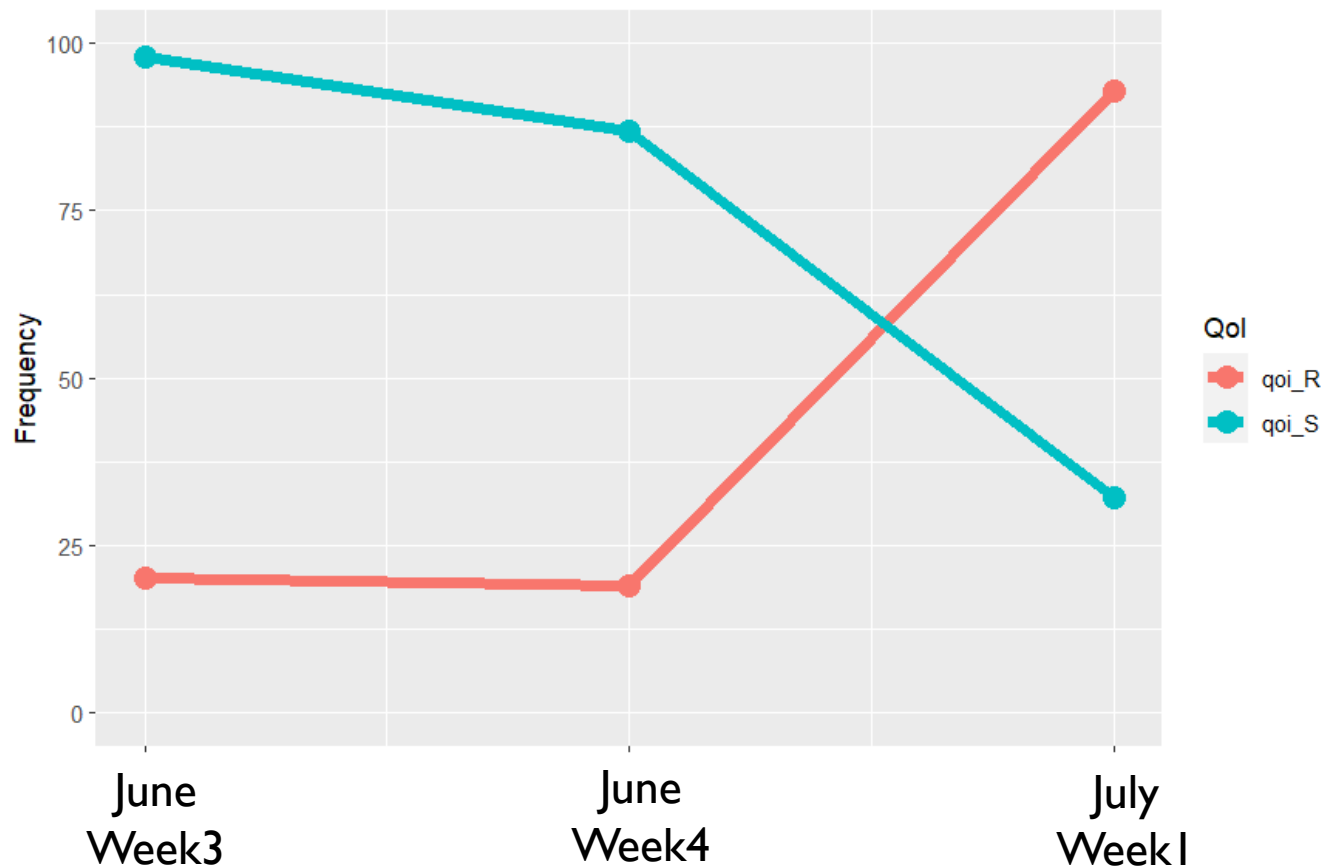


Near **100%** of submitted samples are **positive** for latent CLS infection by the **first week of July** (~row closure).

Time to symptom development variable.

2023 Latent CLS Fungicide Resistance

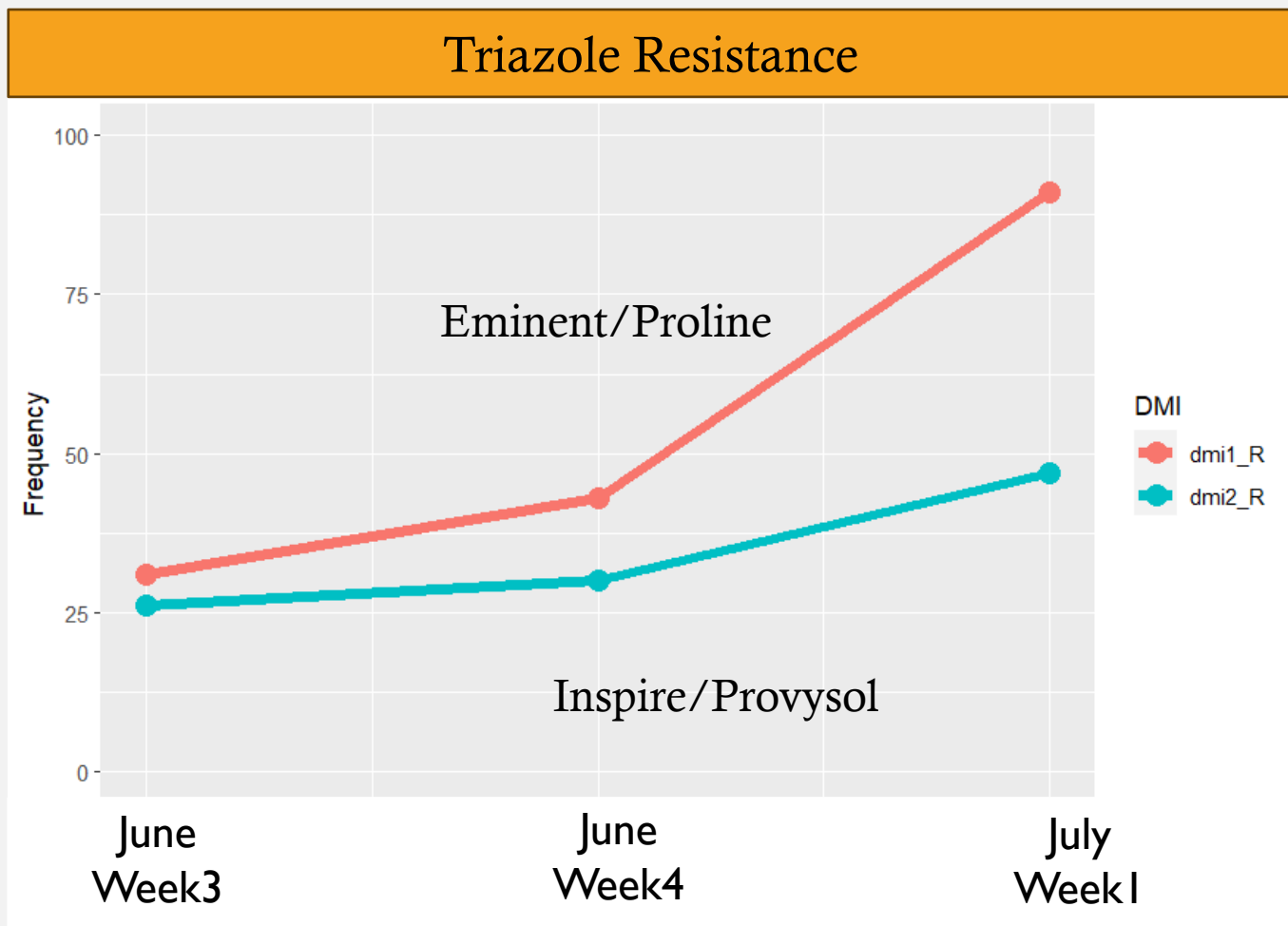
Strobilurin Sensitivity/Resistance



Early latent infection was mostly sensitive.

Late surge in QoI resistance.

2023 Latent CLS Fungicide Resistance

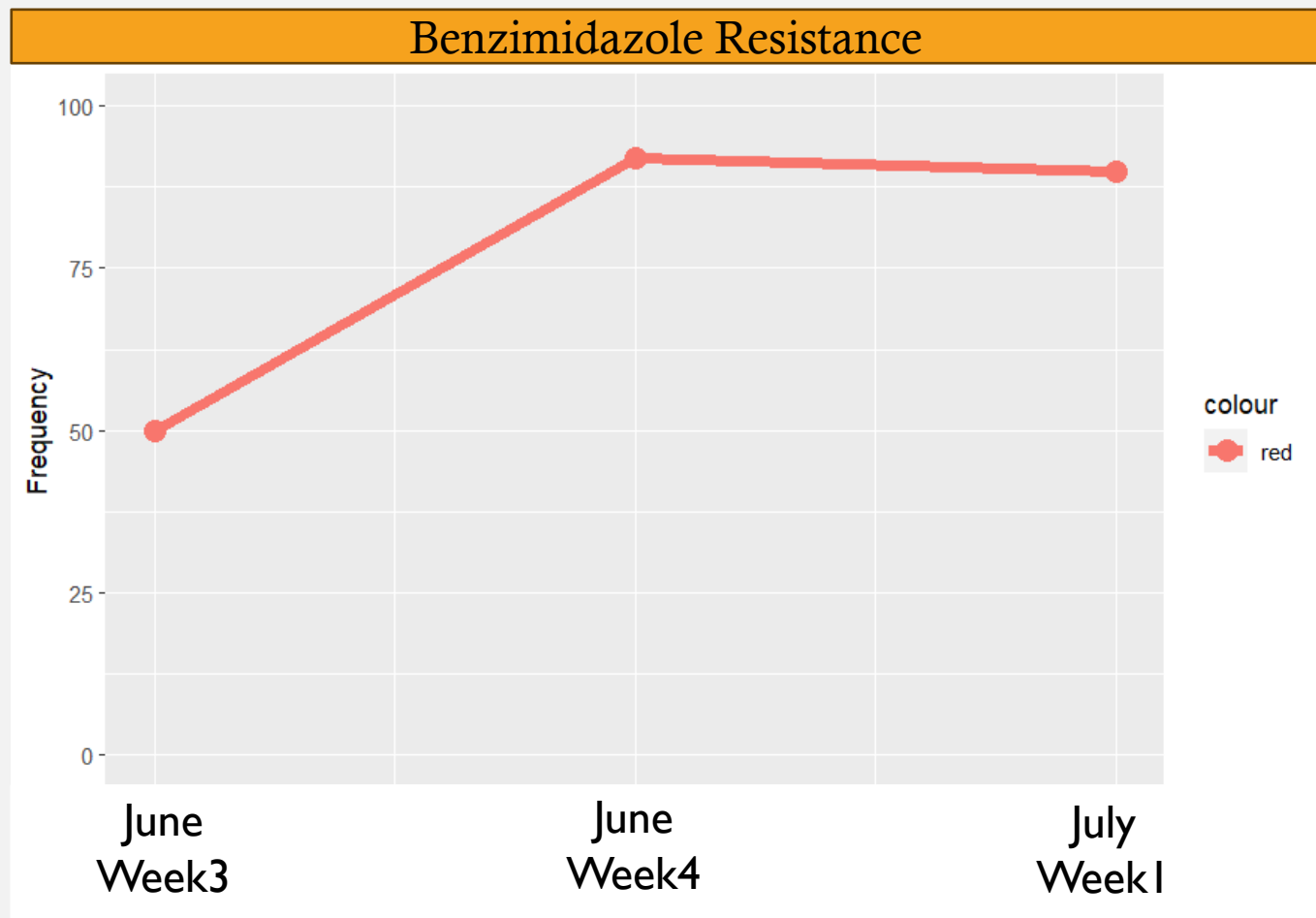


DMI resistance begins low and steadily rises.

Eminent and Proline (**red**) resistance higher than Inspire and Provysol resistance (**blue**)

*Note we are not screening for sensitivity.

2023 Latent CLS Fungicide Resistance



Topsin resistance begins low and steadily rises.

*Note we are not checking for sensitivity

CLS disease cycle

When are spores dispersed in spring?

Detected beginning of May.

What conditions are favorable for spore germination?

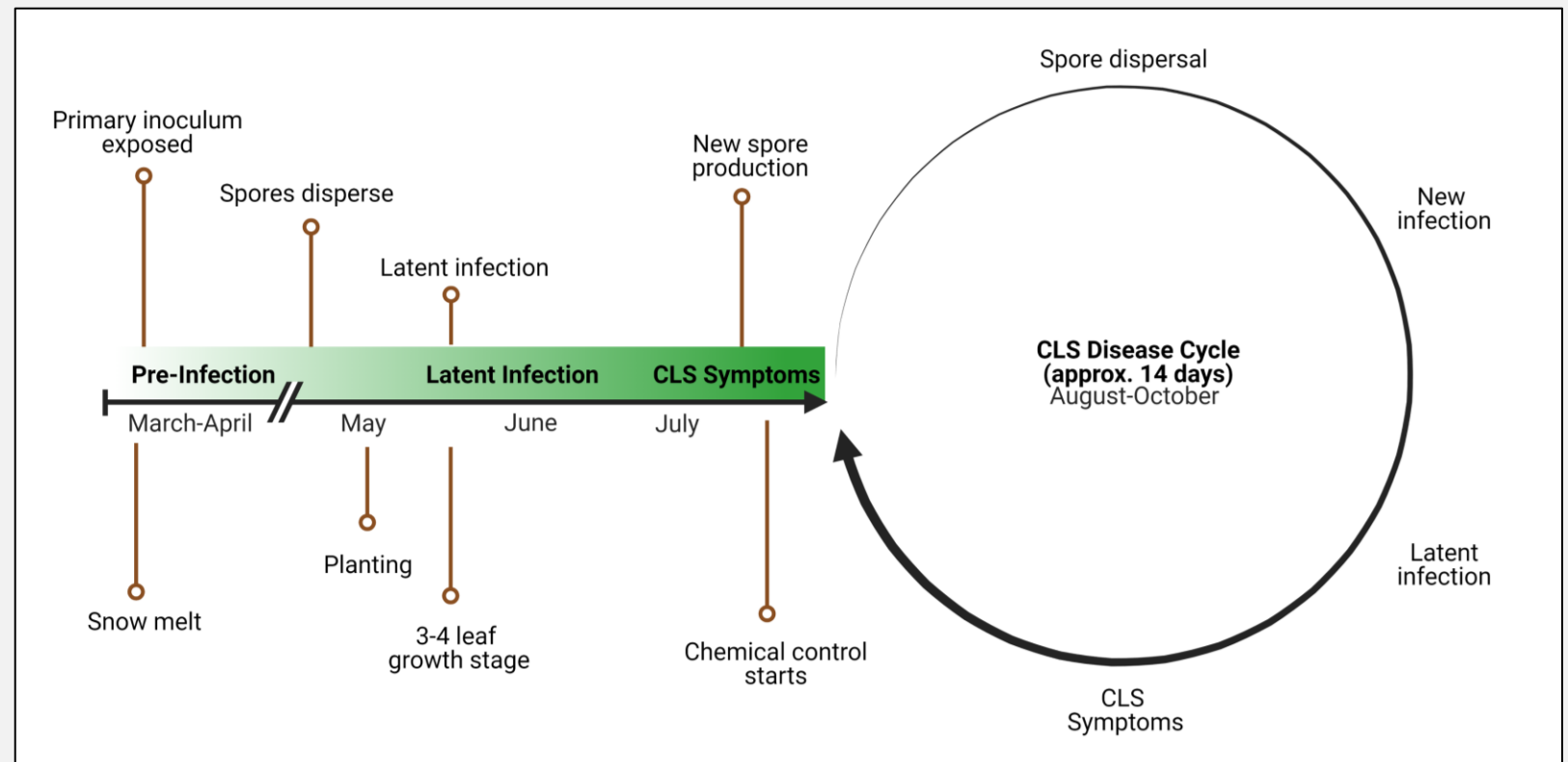
Temperatures > 50 degrees F
Available free water (Rain/Dew)

What is latent CLS disease?

C. beticola infection before spots.

When does latent CLS disease begin?

Late June

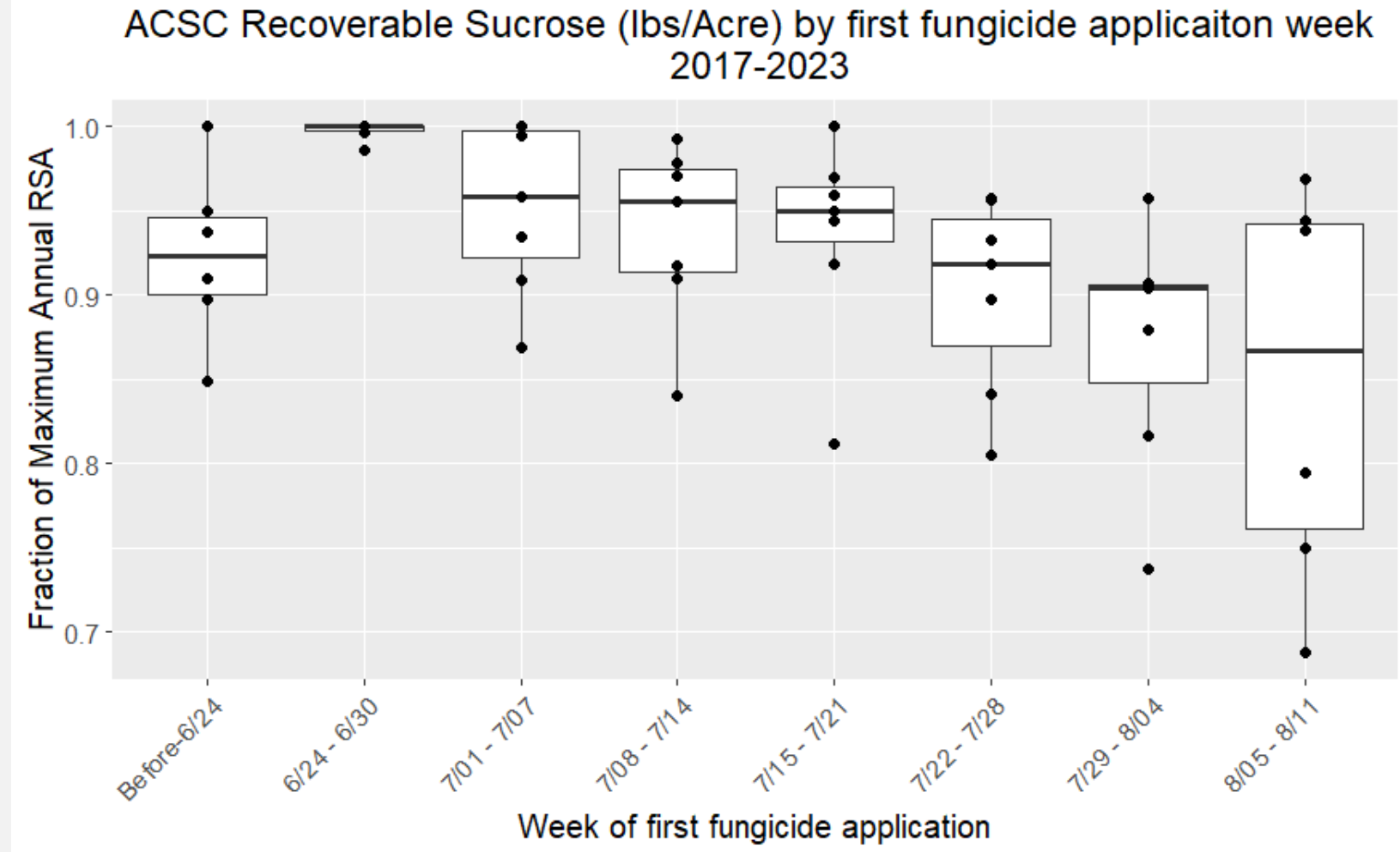


Results from Secor Lab, NDSU Plant Pathology

Why do we care if there are no symptoms?

Primary results

- ACSC data from 2017-2023 shows higher recoverable sucrose with earlier start date for fungicide applications.
- Data based on 96-99% of ACSC fields

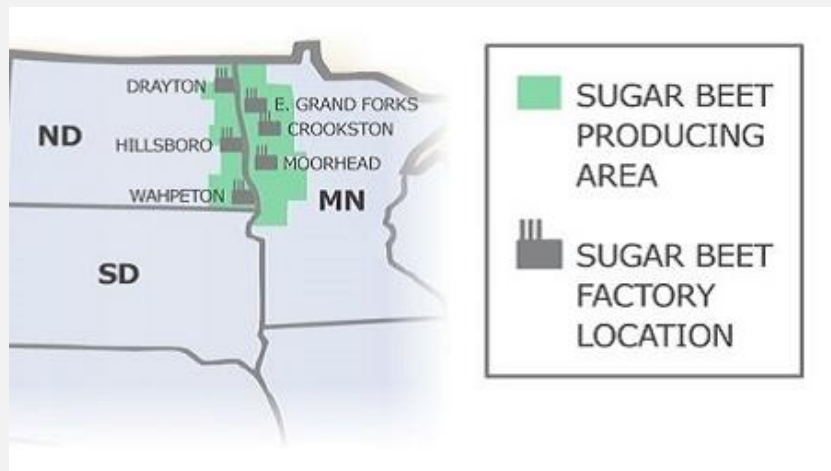


Shorter Timescales

What affect to fungicide treatments have on the pathogen population throughout the season?

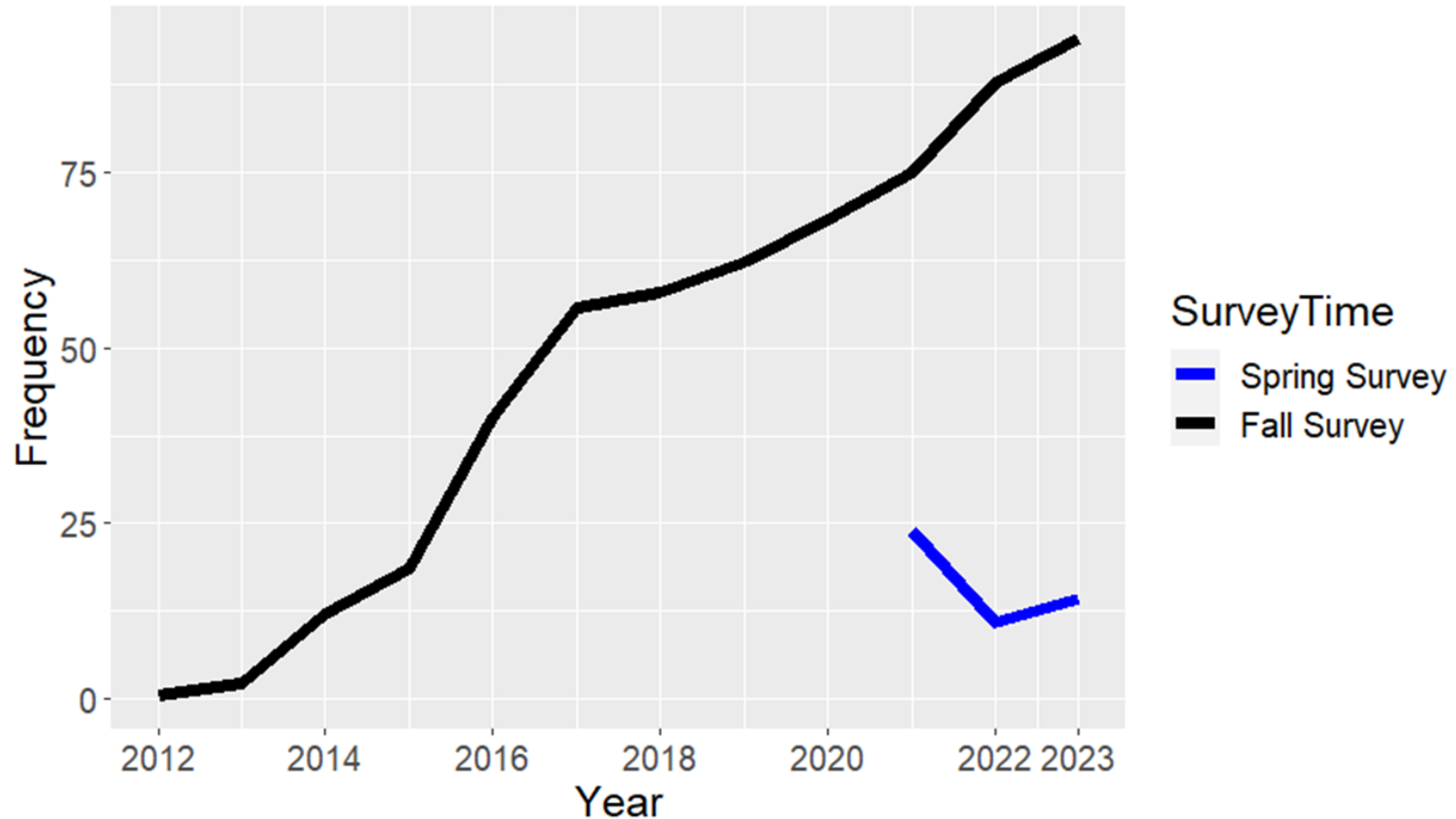
DNA extracted and assayed for fungicide resistance mutations

Samples taken before any fungicide application and after each subsequent application.



Annual Strobilurin Resistance Fluctuations

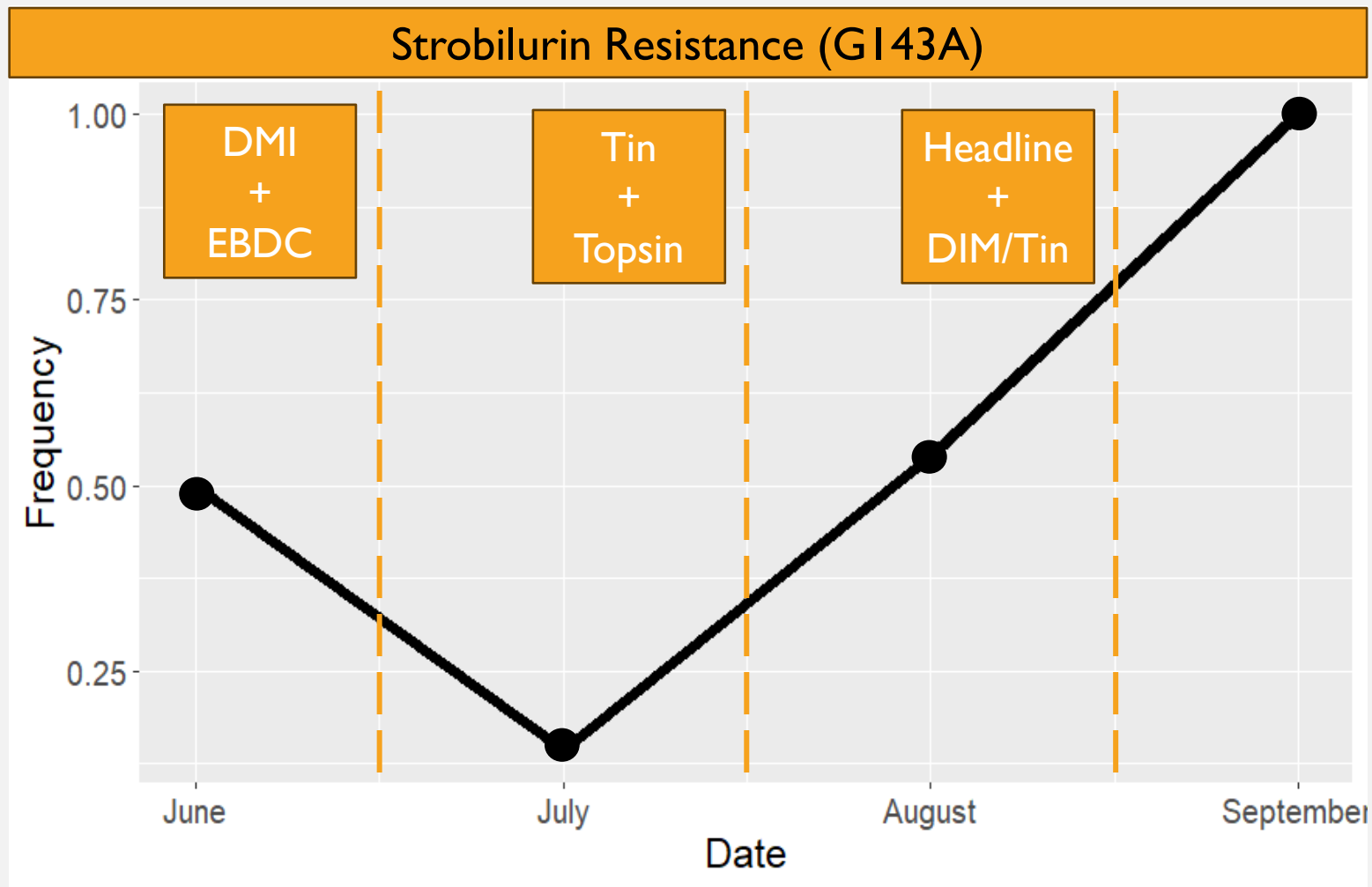
G143A Strobilurin Resistance Frequency



Primary results

- Strobilurin resistance is lower in the spring
- Spring survey based on Spore trap data and Latent infection data

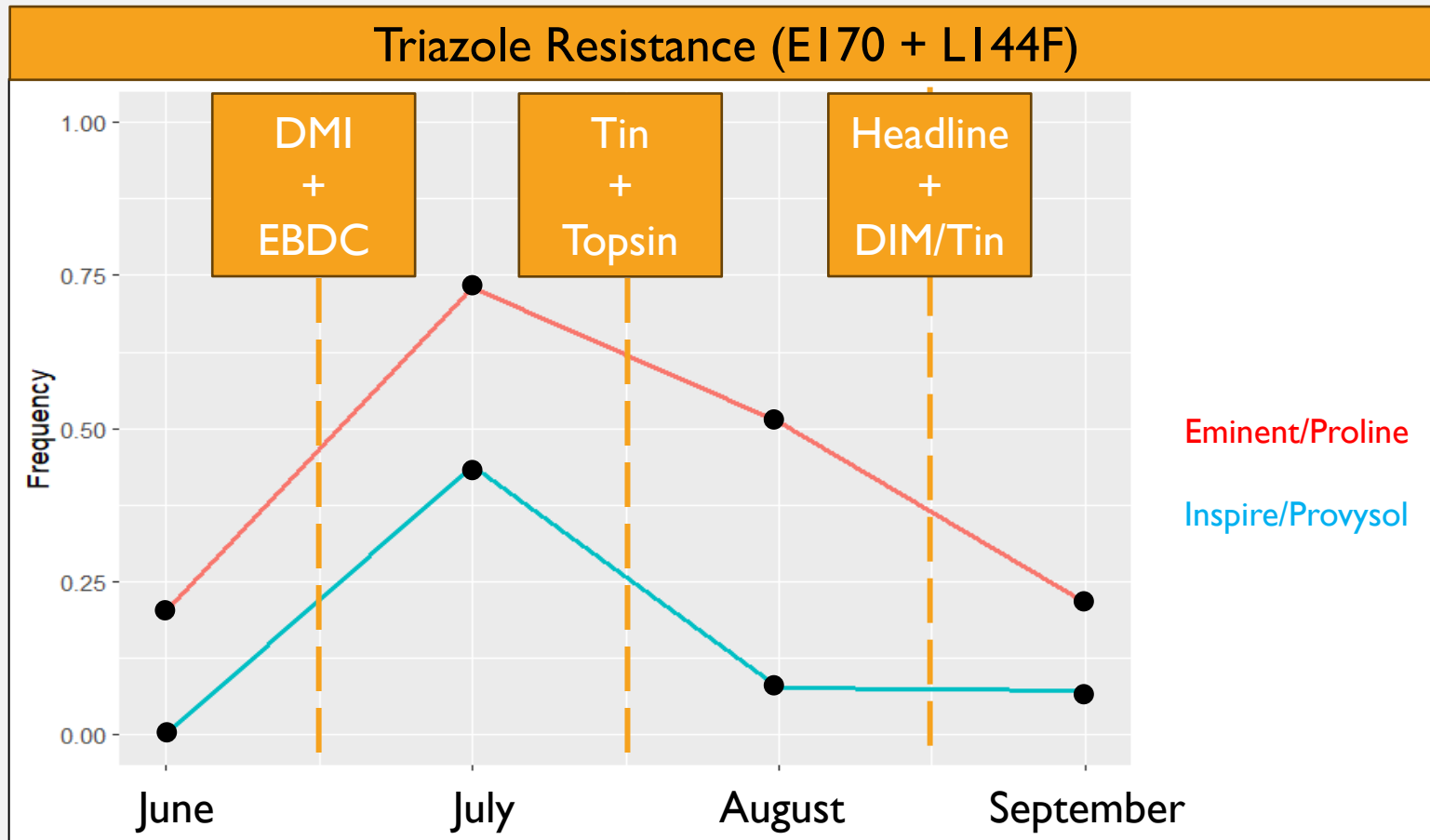
Annual Strobilurin Resistance Fluctuation



Primary results

- Strobilurin resistance changes throughout the year in response to management practices
- Data based on 8 fields in 2023 and 3 fields in 2022

Annual Triazole Resistance Fluctuation

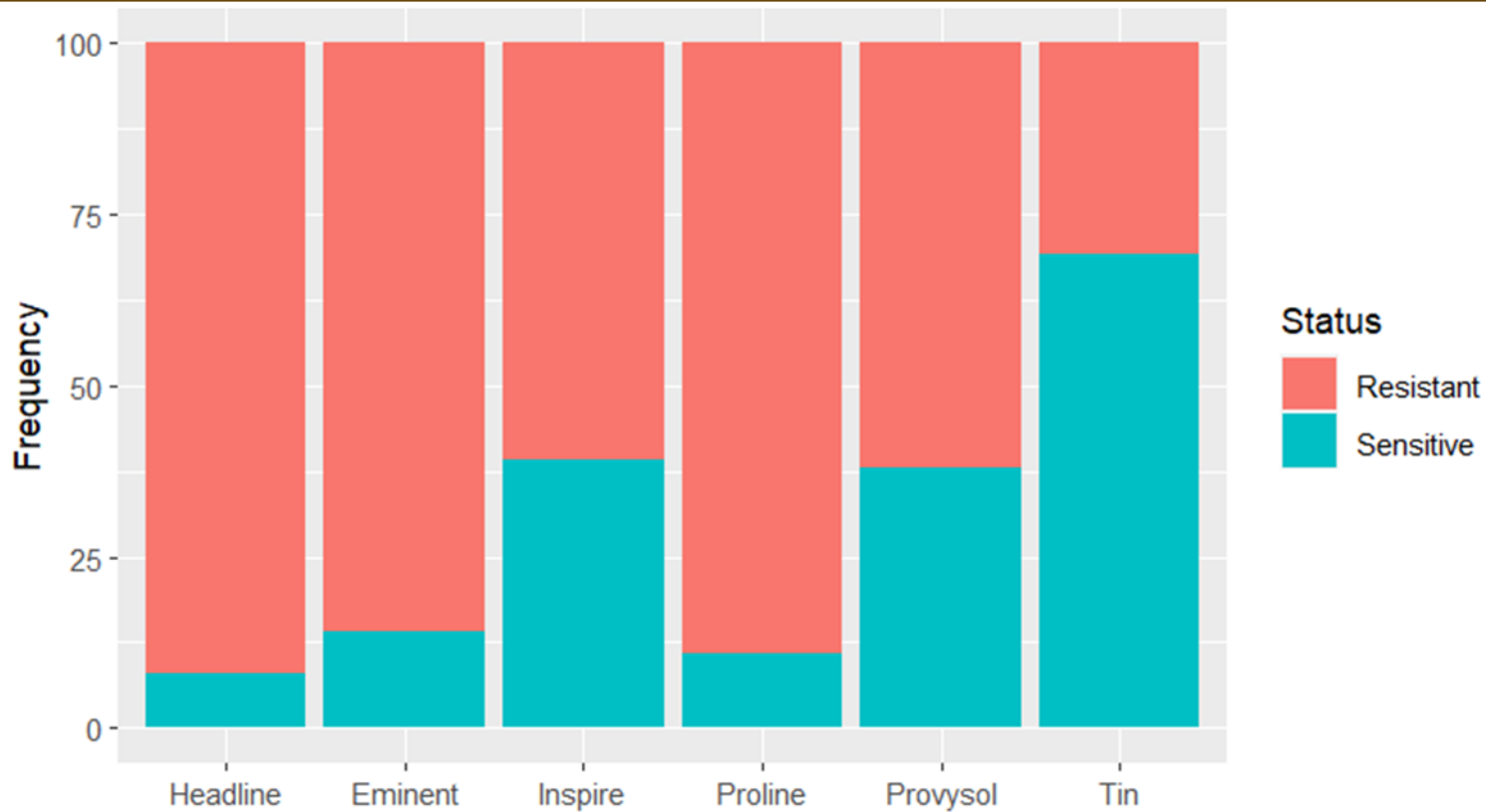


Primary results

- Triazole resistance changes throughout the year in response to management practices
- Data based on 8 fields in 2023 and 3 fields in 2022
- Note that increased detection of Triazole resistance in September resulted if Triazole was also applied (2 fields).

Fungicide resistance 2023

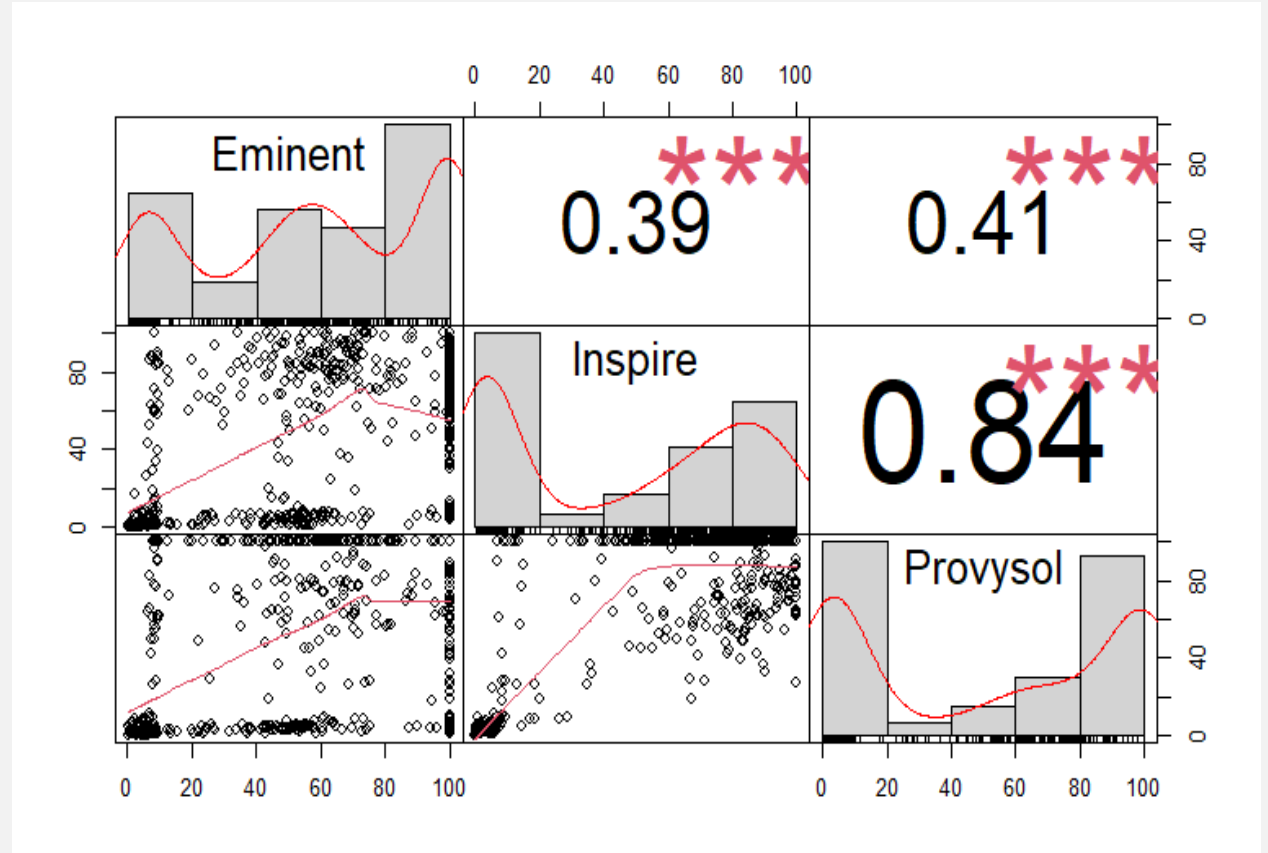
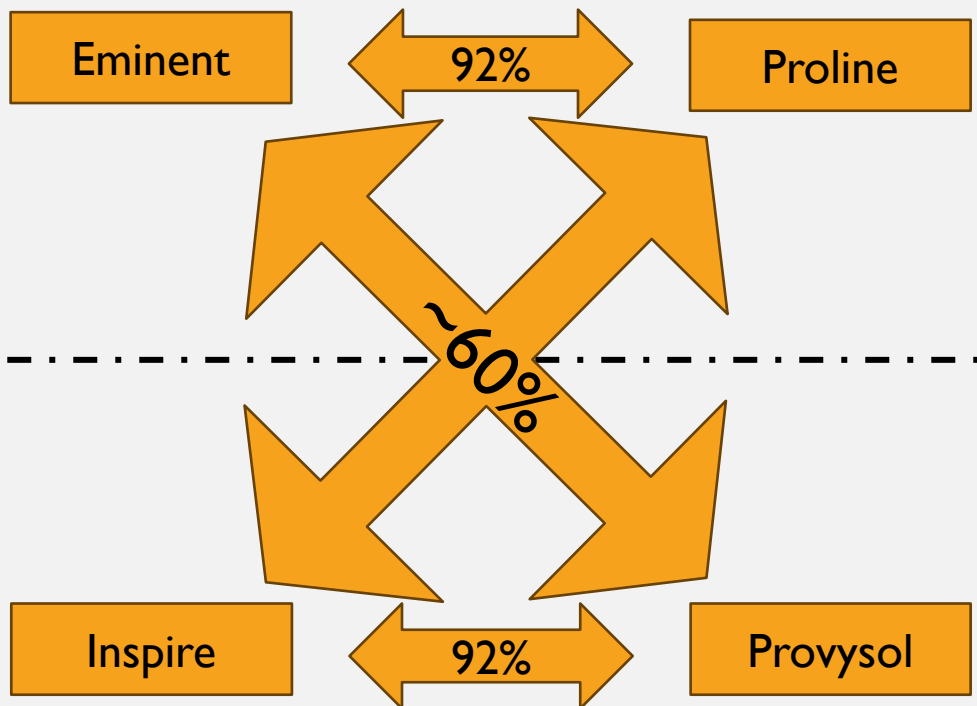
2023 RRV Fungicide Sensitivity/Resistance



- Headline resistance frequency is high at the End of the Year (EOY) – 92%
- Triazole resistance frequency is high at the EOY
 - Eminent: 86%
 - Proline: 89%
 - Inspire: 61%
 - Provysol: 62%
- Tin resistance is lower than previous years:
 - 2023: 31%
 - 2022: ~98%
 - 2021: ~95%

2023 Fungicide Cross Resistance – RRV

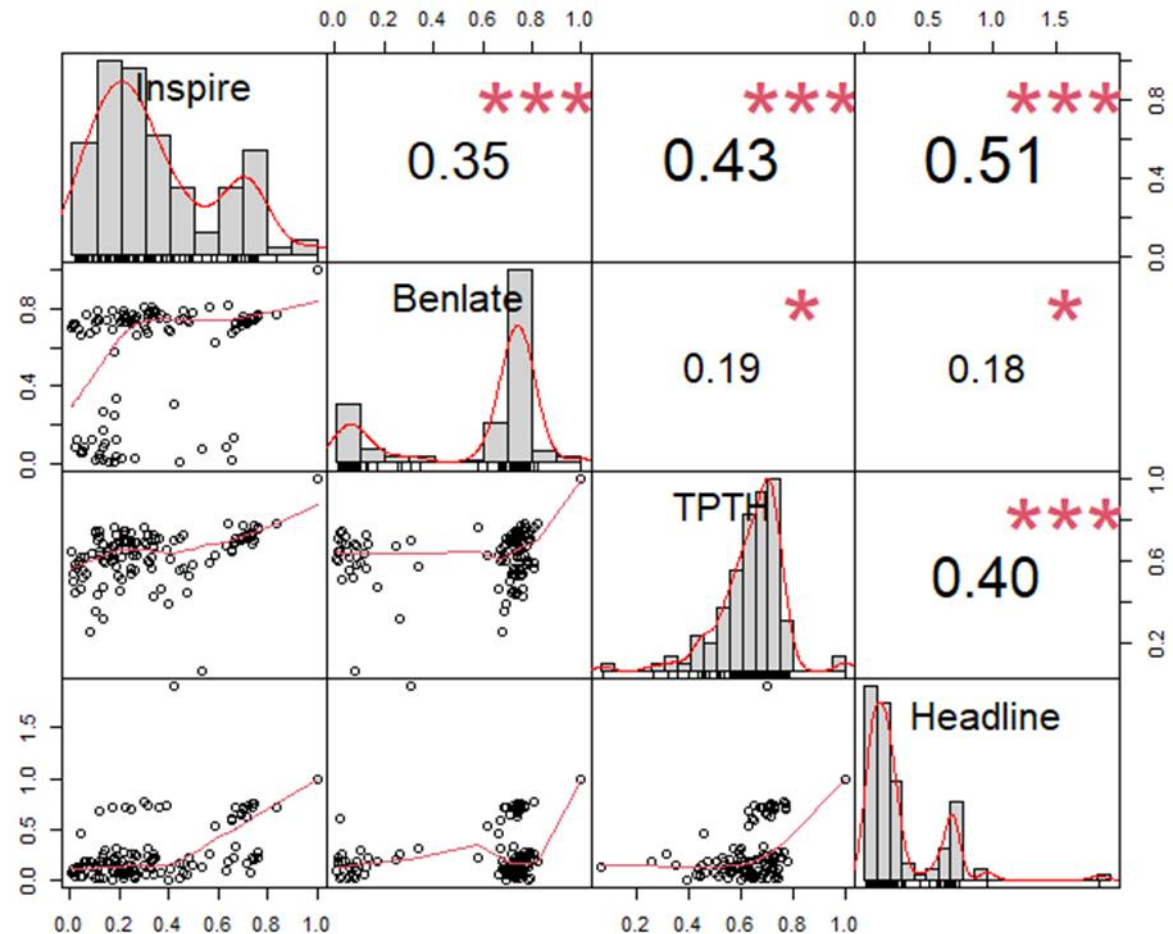
Triazole cross-resistance



2023 Fungicide Cross Resistance – RRV

Cross-resistance

- Low cross resistance between different chemistries
- Utilize tank mix partners with different fungicidal chemistries
- Rotate chemistries for subsequent applications



Take aways

- CLS latent infection prevalence reached ~100% at the beginning of July in 2021-2023 and corresponds to row closure.
- Molecular assays can be used to detect latent infection as well as detect fungicide resistance mutations.
- Fungicide resistance is not fixed, management practices influence development and maintenance of resistance in the *Cercospora beticola* population
- Cross resistance is low between fungicide chemistries.
 - Rotate chemistries
 - Tank mix

Acknowledgements

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Sugarbeet Research & Education Board



BEET SUGAR DEVELOPMENT FOUNDATION

NDSU NORTH DAKOTA STATE UNIVERSITY



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