NDSU | EXTENSION

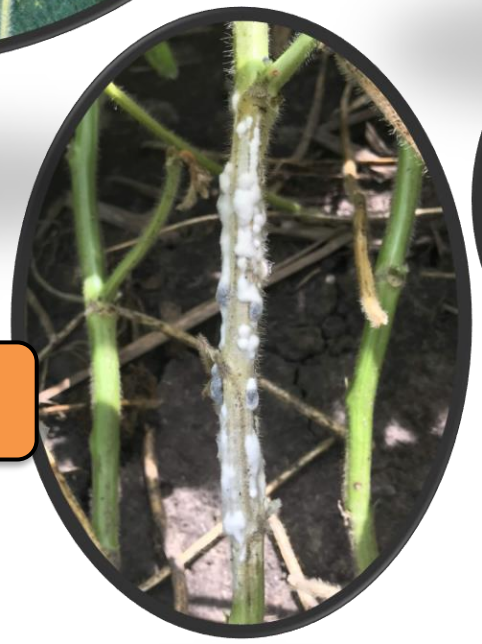
2024: A Cornucopia of Soybean Diseases

Dr. Wade Webster
Extension Soybean Pathologist
Richland County Meeting
February 11th, 2025

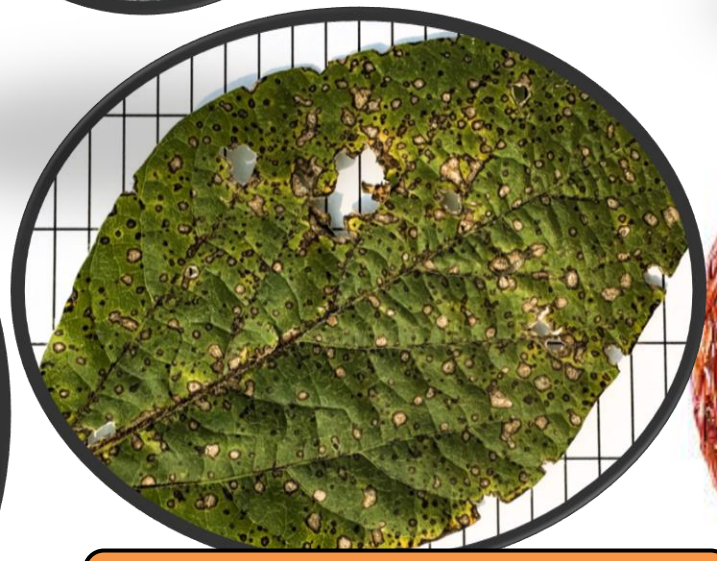
Soybean Cyst Nematode

Seedling Diseases

Sudden Death Syndrome



White Mold



Frogeye Leaf Spot

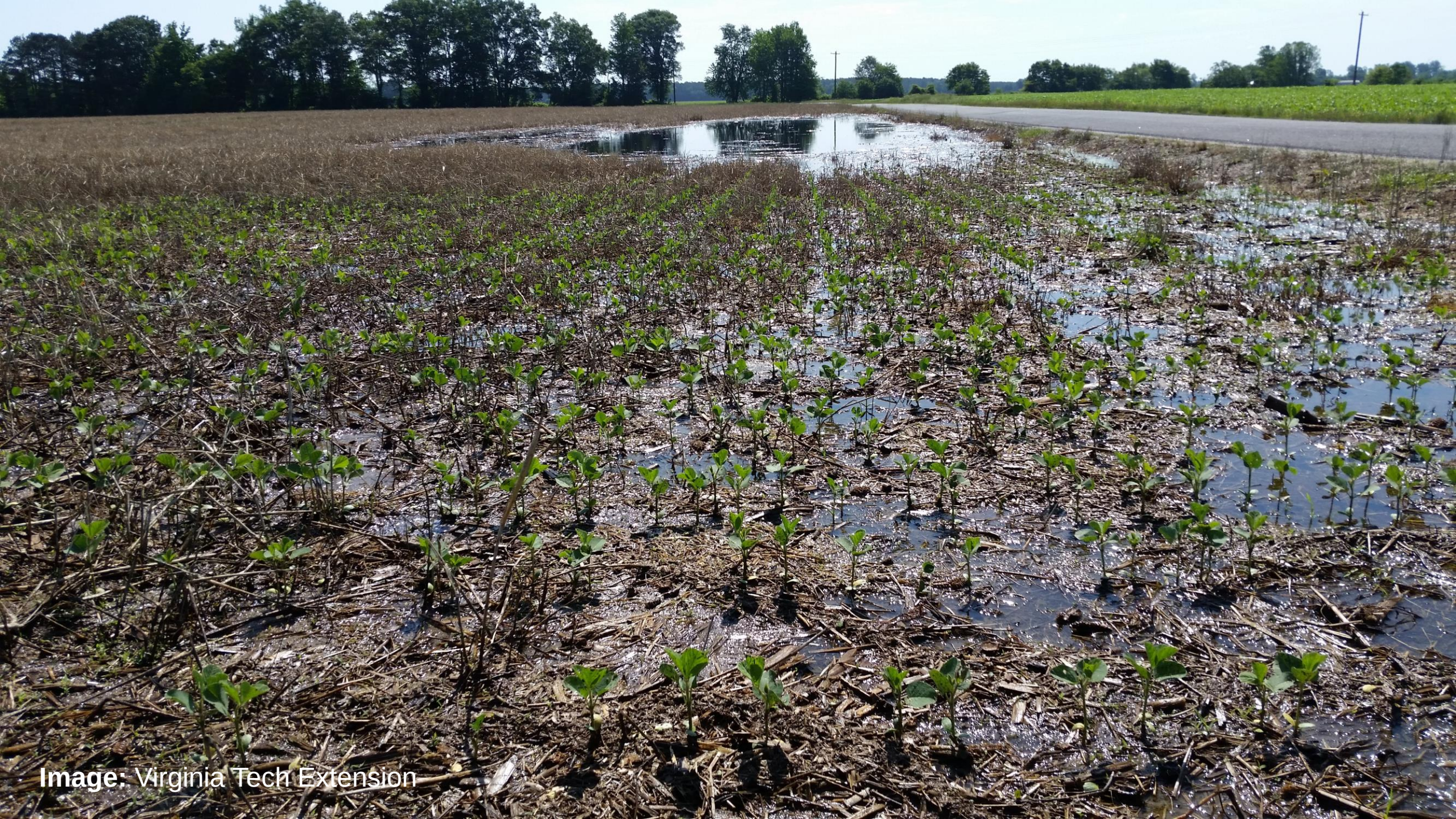


Image: Virginia Tech Extension

Factors Increasing Risk of Seedling Disease

- Field History
  - Flooding
  - Seedling disease or emergence issues
- Planting Conditions
  - Wet vs Dry
  - Cool vs Warm
- Compacted Soils

- Seeding Rates (less than 140,000 seeds/ac)
- Tillage
  - No-tillage and reduce tillage can maintain moisture
- Crop Rotation
- Variety selection with known susceptibility

Seedling Diseases and Root Rot

Pythium species

Phytophthora sojae

Rhizoctonia solani

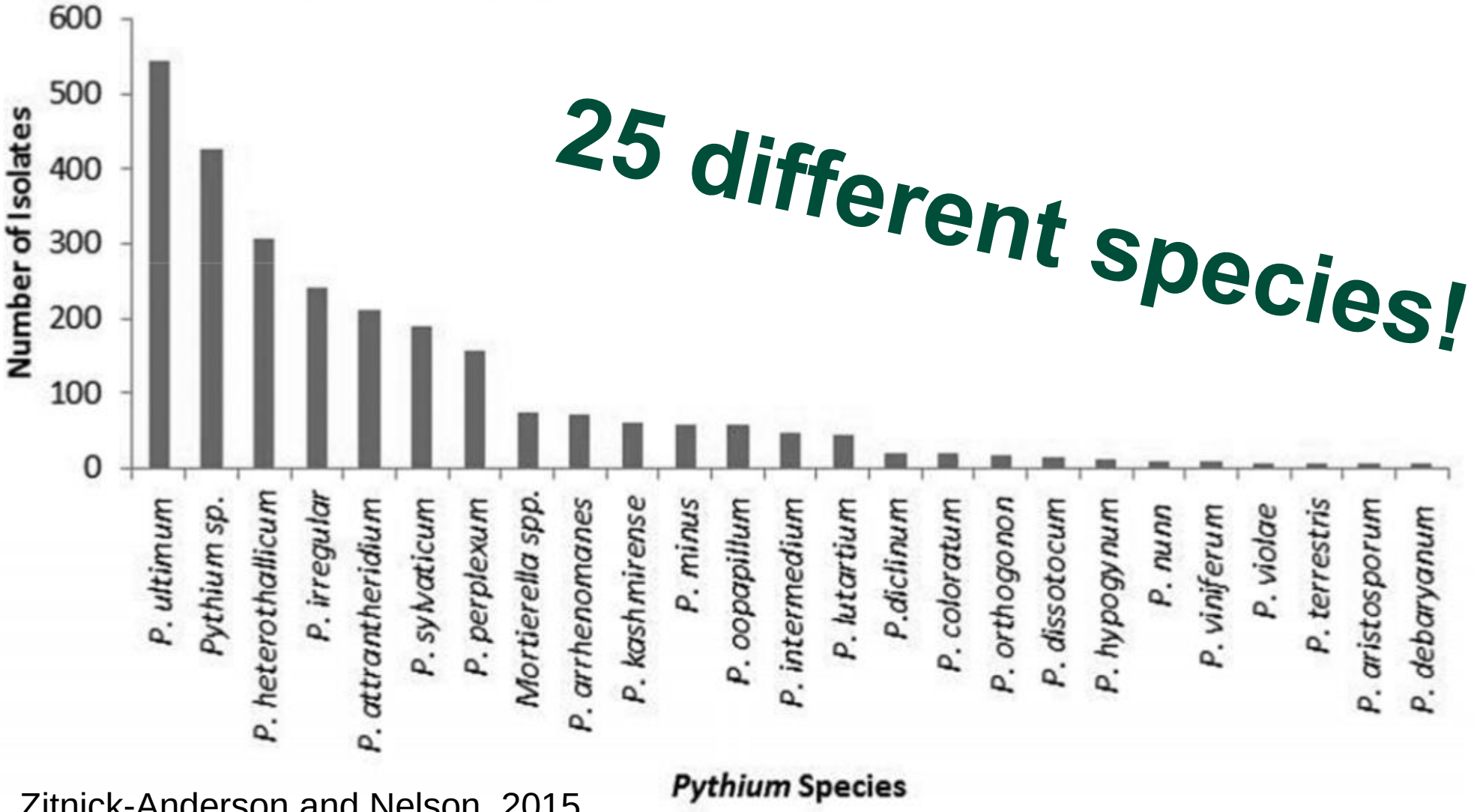
Fusarium species

Seedling Diseases - Pythium

Photo: Tristan Mueller

- **Pathogen:** Multiple Pythium species
- **Environment:** Cool and Wet soils
- **Identification:**
  - Seed rot
  - Seedling death/ Damping off
  - Root rot and plant stunting

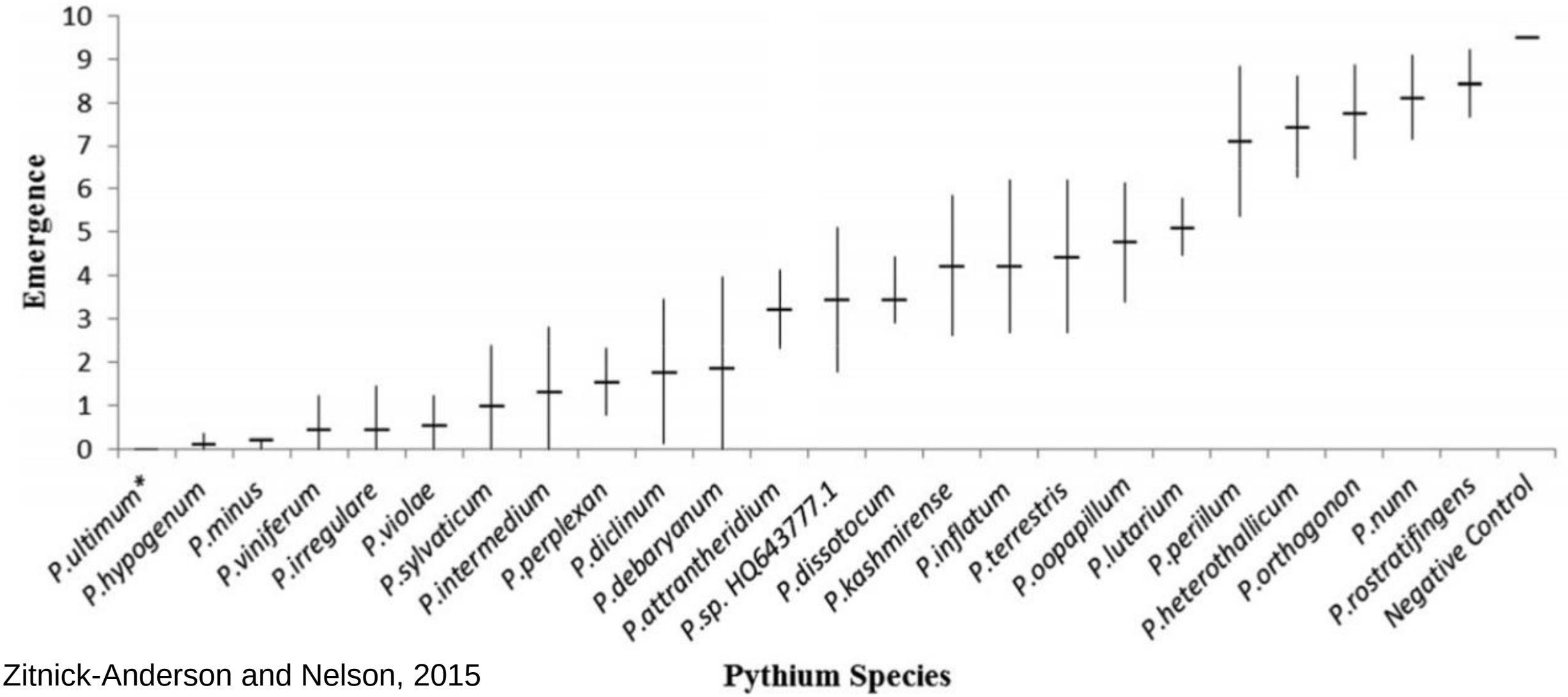
High Diversity of Pythium Species in North Dakota



25 different species!

Zitnick-Anderson and Nelson, 2015

Varying Degree of Aggressiveness



Zitnick-Anderson and Nelson, 2015

Seedling Diseases - Phytophthora

- **Pathogen:** *Phytophthora sojae*
- **Environment:** Warm and Wet soils
- **Identification:**
  - Seedling death/ Damping off
  - Root rot and plant stunting
  - Can cause season-long disease

Seedling Diseases - Rhizoctonia

Photo: Carl Bradley

- **Pathogen:** *Rhizoctonia solani*
- **Environment:** Warm and Wet soils
- **Identification:**
  - Seedling death/ Damping off
  - Root rot and plant stunting
  - Reddish/brown lesions near the soil line
  - Can cause season-long disease

Seedling Diseases - Fusarium

- **Pathogen:** *Fusarium* species
- **Environment:** Warm soils
- **Identification:**
  - Seedling death/ Damping off
  - Rotten taproot
  - Poor lateral root development
  - Triggered with plant stress

Photo: Loren Giesler

No Seed Treatment

Seed Treatment

Product Name	Active Ingredient	FRAC
Non-Treated	-	-
Allegiance	Metalaxyl	4
Relenya	Mefentrifluconazole	3
Allegiance + Relenya	Metalaxyl + Mefentrifluconazole	3 + 4
Vibrance Trio	Fludioxanil + Sedaxane + Mefenoxam	4 + 7 + 12
CruiserMaxxAPX	Mefenoxam + Picarbutrazox + Fludioxonil + Sedaxane + Thiamethoxam	4 + 7 + 12 + U17 + 4A(ins)
Lumisena + Lumiderm	Oxathiapiprolin + Cyantraniliprole	49 + 28(ins)
Allegiance + Acceleron-D281	Metalaxyl + Fluoxastrobin	4 + 11
Vibrance Trio + Cruiser 5FS	Fludioxanil + Sedaxane + Mefenoxam + Thiamethoxam	4 + 7 + 12 + 4A(ins)
Allegiance + Acceleron-D281 + Cruiser 5FS	Metalaxyl + Fluoxastrobin + Thiamethoxam	4 + 11 + 4A(ins)

Vanessa Louks

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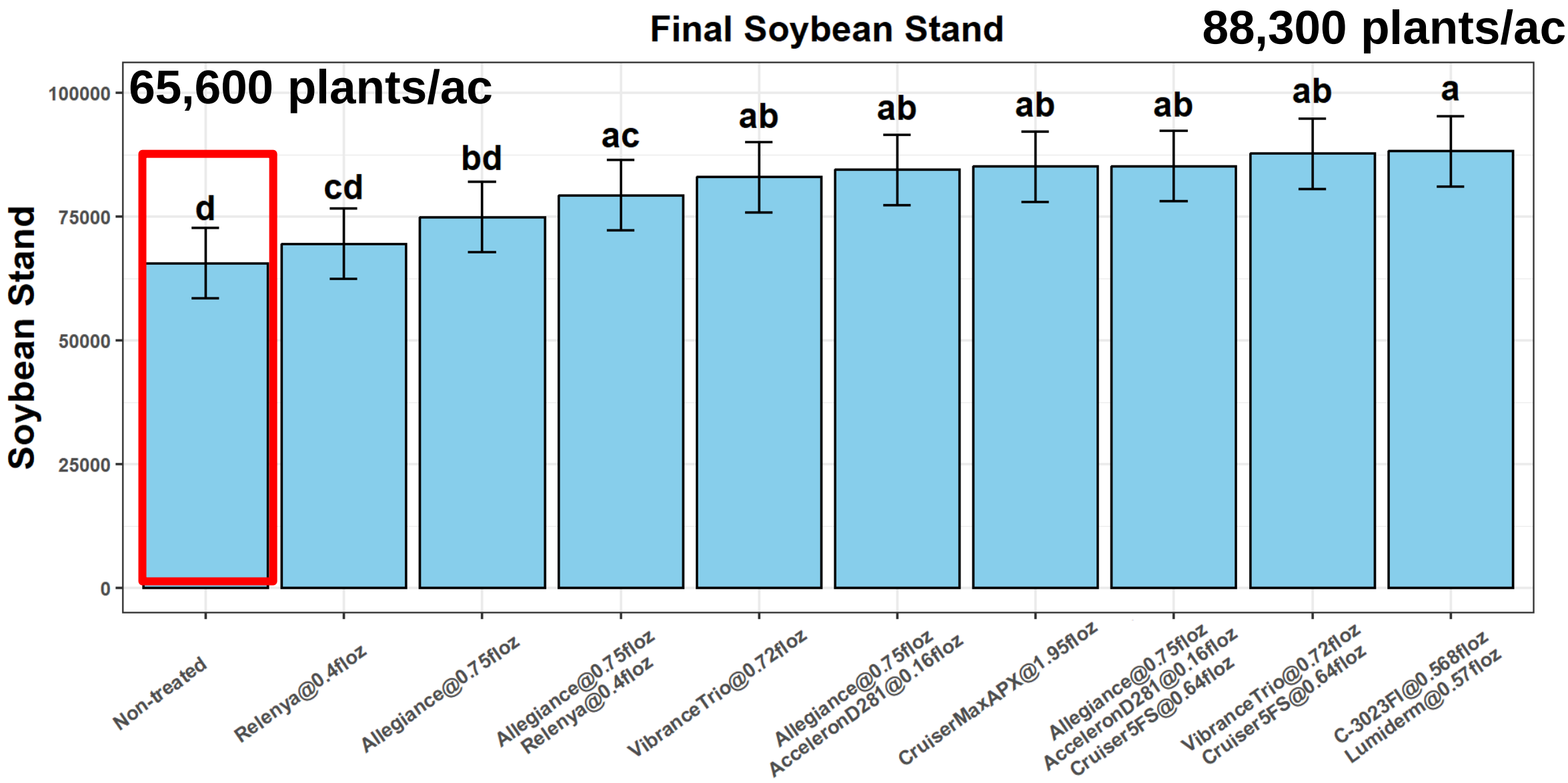
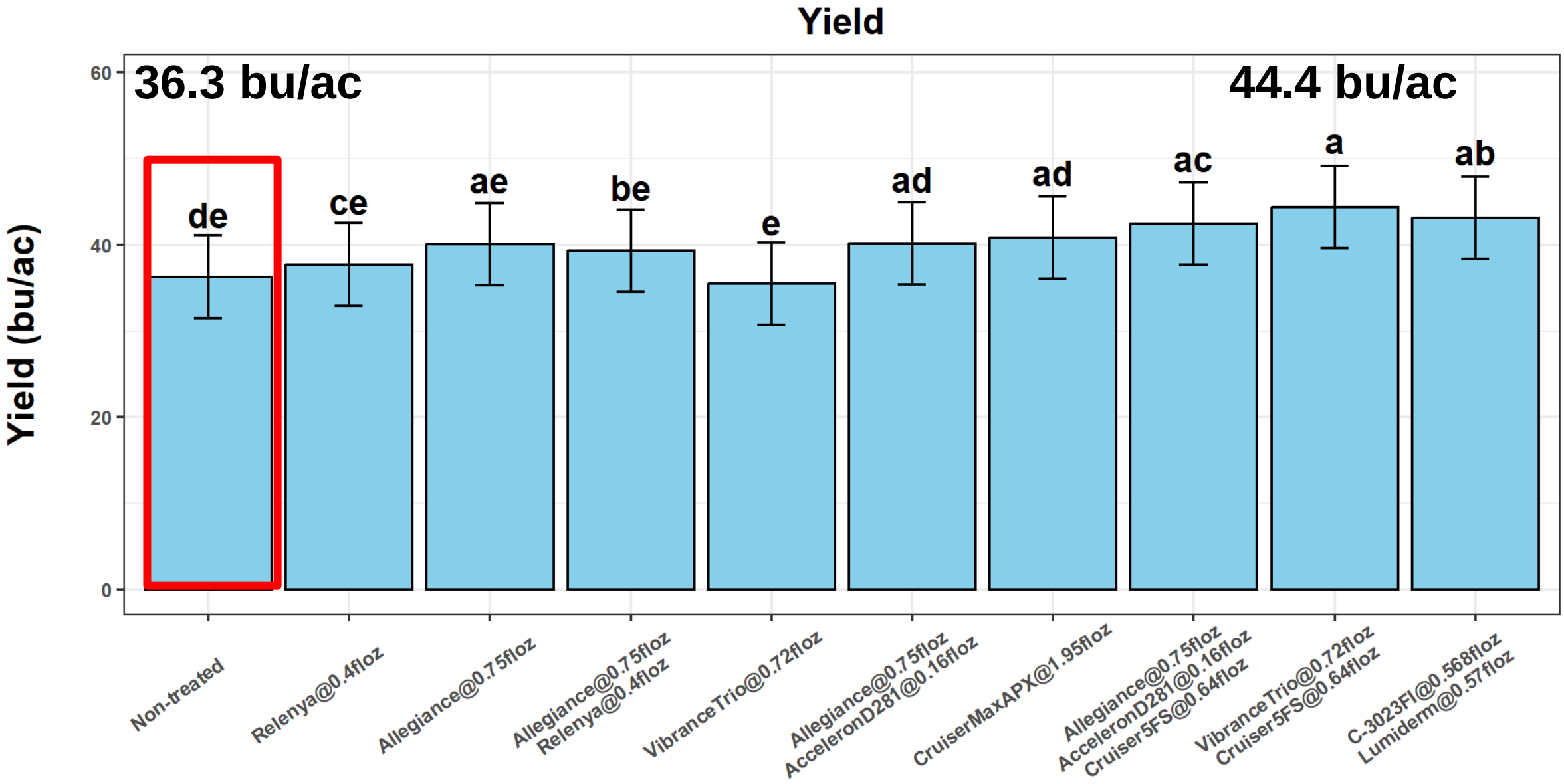


Trials were conducted in Fargo and Oakes, ND
Seeding rate: 140,000 seeds/ac
$P < 0.01$
$\alpha = 0.05$



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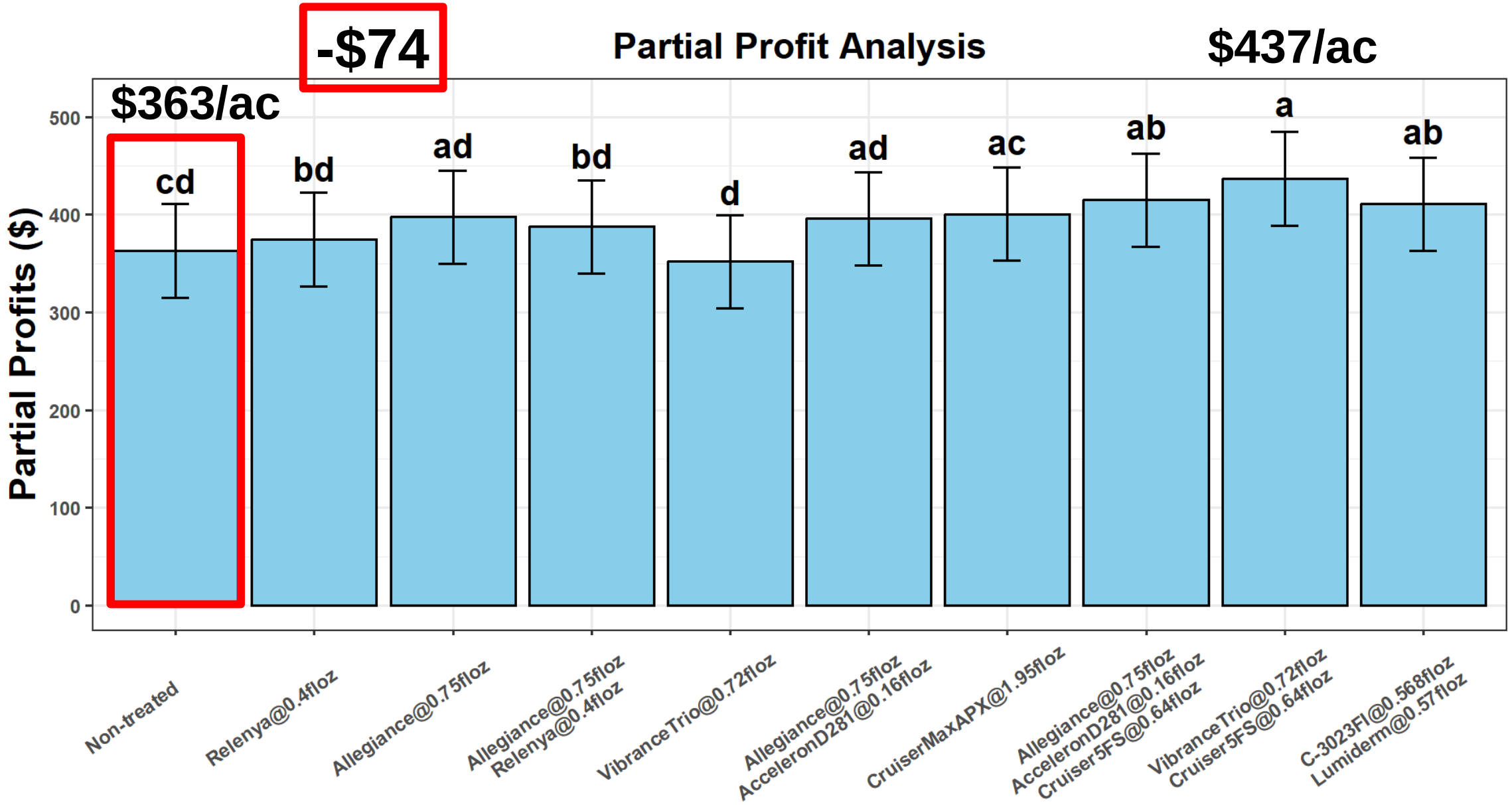

Trials were conducted in Fargo and Oakes, ND
Seeding rate: 140,000 seeds/ac
P = 0.02
α = 0.05

Primary Fungicide Seed Treatment FRAC Groups

- **FRAC Group 3 – Demethylation Inhibitors/DMIs**
  - **Target Pathogens: Primarily Fusarium and Rhizoctonia**
  - Prothioconazole
- **FRAC Group 7 – Succinate Dehydrogenase Inhibitors/SDHIs**
  - **Target Pathogens: Primarily on Rhizoctonia, but some activity on Fusarium. Fluopyram is only labeled for SDS fungus**
  - Sedaxane
  - Penflufen
  - Fluxapyroxad
  - Fluopyram *SDS and SCN activity
  - Pydiflumetofen *SDS and SCN activity
- **FRAC Group 11 – QoIs/Strobilurins**
  - **Target Pathogens: Primarily Rhizoctonia, but some minor activity on Fusariums and Pythiums**
  - Azoxystrobin
  - Pyraclostrobin
- **FRAC Group 12 – Phenylpyrroles**
  - **Target Pathogens: Primarily Fusarium and Rhizoctonia**
  - Fludioxonil

Primary Fungicide Seed Treatment FRAC Groups

- **FRAC Group 4 – Phenylamides**
  - **Target Pathogens: Oomycetes (Pythiums and Phytophthoras)**
  - Metalaxyl
  - Mefenoxam
- **FRAC Group 22 Benzamid and Thiazole Caboximides**
  - **Target Pathogens: Oomycetes (Pythiums and Phytophthoras)**
  - Ethaboxam
- **FRAC Group 49 – Oxysterol-binding Protein Modulators**
  - **Target Pathogens: Mostly Phytophthoras**
  - Oxathiapiprolin
- **FRAC Group U17**
  - **Target Pathogens: Oomycetes (Pythiums and Phytophthoras)**
  - Picarbutrazox/PCBX

Efficacy categories:
NR = not recommended: P = Poor; F = Fair; G = Good; VG = Very Good; E = Excellent; NL = Not labeled for use against this disease; U = Unknown efficacy or insufficient data to rank active ingredient.

Fungicide active ingredient	*Pythium* spp.[1]	*Phytophthora*	*Rhizoctonia* spp.	*Fusarium* spp.[1,3]	Sudden death syndrome (SDS) *Fusarium virguliforme*	*Diaporthe* spp.
Azoxystrobin	P-G	NL	VG	F-G	P	P
Carboxin	NL	NL	G	NL	NL	NL
Ethaboxam	E	E	NL	NL	NL	NL
Fludioxonil	P	P	G	F-VG	P	G
Fluopyram	NL	NL	NL	NL	VG	NL
Fluoxastrobin	NL	NL				NL
Fluxapyroxad	NL	NL	E	G	P	NL
Ipconazole	NL	NL	F-G	F-E	P	G
Mefenoxam	E[2]	E	NL	NL	NL	NL
Metalaxyl	E[2]	E	NL	NL	NL	NL
Oxathiapiprolin	NL	E	NL	NL	NL	NL
Penflufen	NL	NL	G	NL	NL	NL
Prothioconazole	NL	NL	G	G	NL	NL
Pydiflumetofen	NL	NL	NL	NL	VG	NL
Pyraclostrobin	NL	NL	F-G	F	P	G
Sedaxane	NL	NL	E	NL	NL	NL
Thiabendazole	NL	NL	NL	U	P	G
Trifloxystrobin	NL	NL	F-E	F-G	P	NL

[1] Active ingredients may vary in efficacy against different *Fusarium* and *Pythium* species.
[2] Areas with mefenoxam or metalaxyl insensitive populations may see less efficacy with these products.
[3] Listed active ingredients for *Fusarium* spp. do not have efficacy against *Fusarium virguliforme*, causal agent of sudden death syndrome.

Common Fungicide Trade Names and Active Ingredients
(01/2024)

Product trade name	Active ingredient(s)
Acceleron	DX-612 Fluxapyroxad, DX-309 Metalaxyl, DX-109 Pyraclostrobin
Allegiance FL	Metalaxyl
Allegiance LS	Metalaxyl
Apron XL LS	Mefenoxam
ApronMaxx RFC	Fludioxonil, Mefenoxam
ApronMaxx RTA	Fludioxonil, Mefenoxam
CruiserMaxx	Fludioxonil, Mefenoxam
CruiserMaxx Advanced or CruiserMaxx Plus	Fludioxonil, Mefenoxam
CruiserMaxx Vibrance or Vibrance Trio	Fludioxonil, Mefenoxam, Sedaxane
Dynasty	Azoxystrobin
EverGol Energy SB	Metalaxyl, Penflufen, Prothioconazole
ILEVO	Fluopyram
Inovate Pro	Ipconazole, Metalaxyl
Intego	Ethaboxam
Lumisena	Oxathiopiprolin, Metalaxyl
Maxim 4FS	Fludioxonil
Mertect 340 F	Thiabendazole
Prevail	Carboxin, Metalaxyl, PCNB
Saltro	Pydiflumetofen
Trilex 2000	Metalaxyl, Trifloxystrobin
Vibrance	Sedaxane
Warden CX	Fludioxonil, Mefenoxam, Sedaxane
Warden RTA	Fludioxonil, Mefenoxam

Crop Protection Network Efficacy Guide

NDSU Fungicide Guide

“What’s on Your Seed”

CROP PROTECTION NETWORK
A Product of Land Grant Universities

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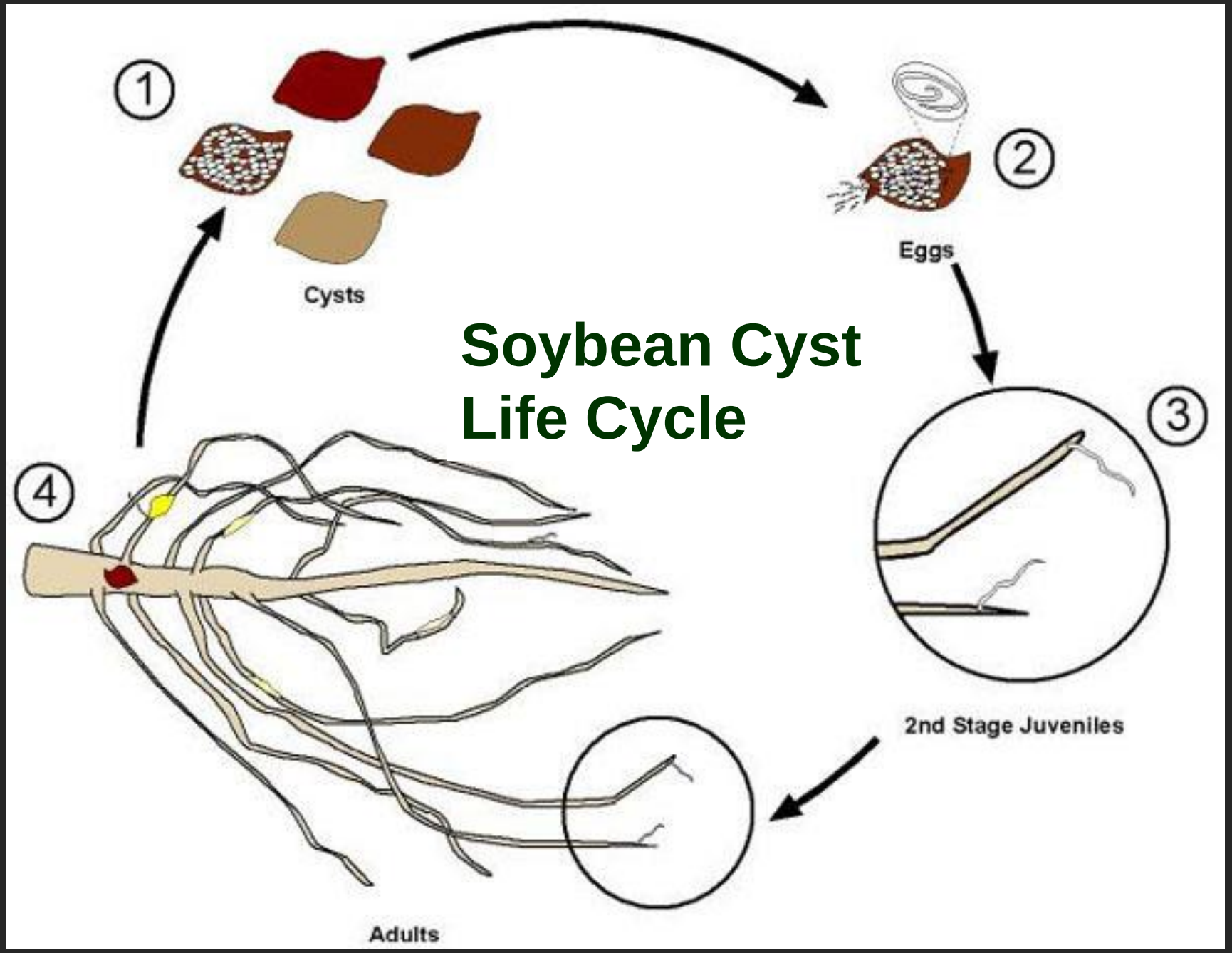
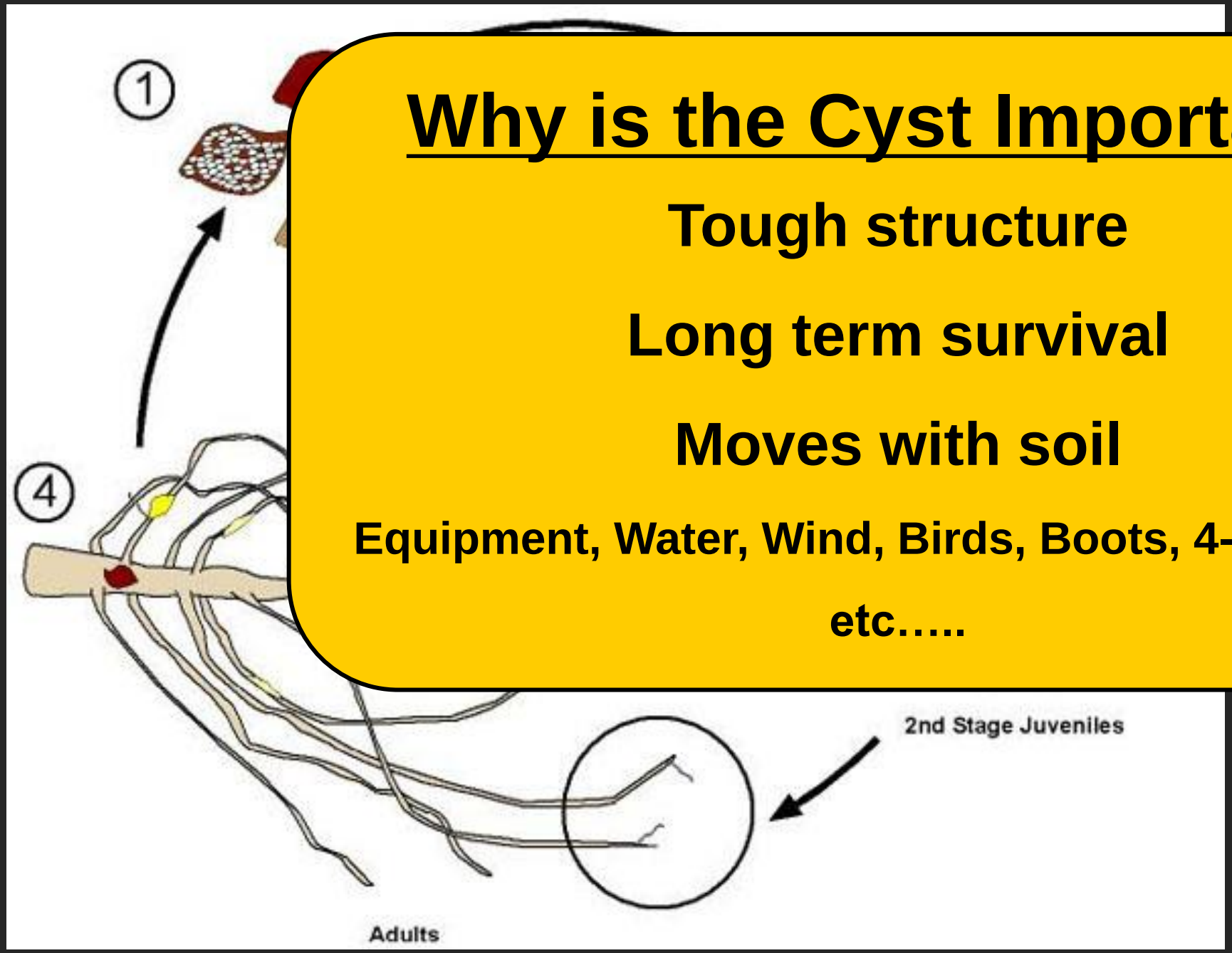
Soybean Cyst Nematode (SCN)

https://en.wikipedia.org/wiki/Soybean_cyst_nematode


Photo: Sam Markell



Source: www.entm.purdue.edu/nematology/lifecycle.html



Why is the Cyst Important?

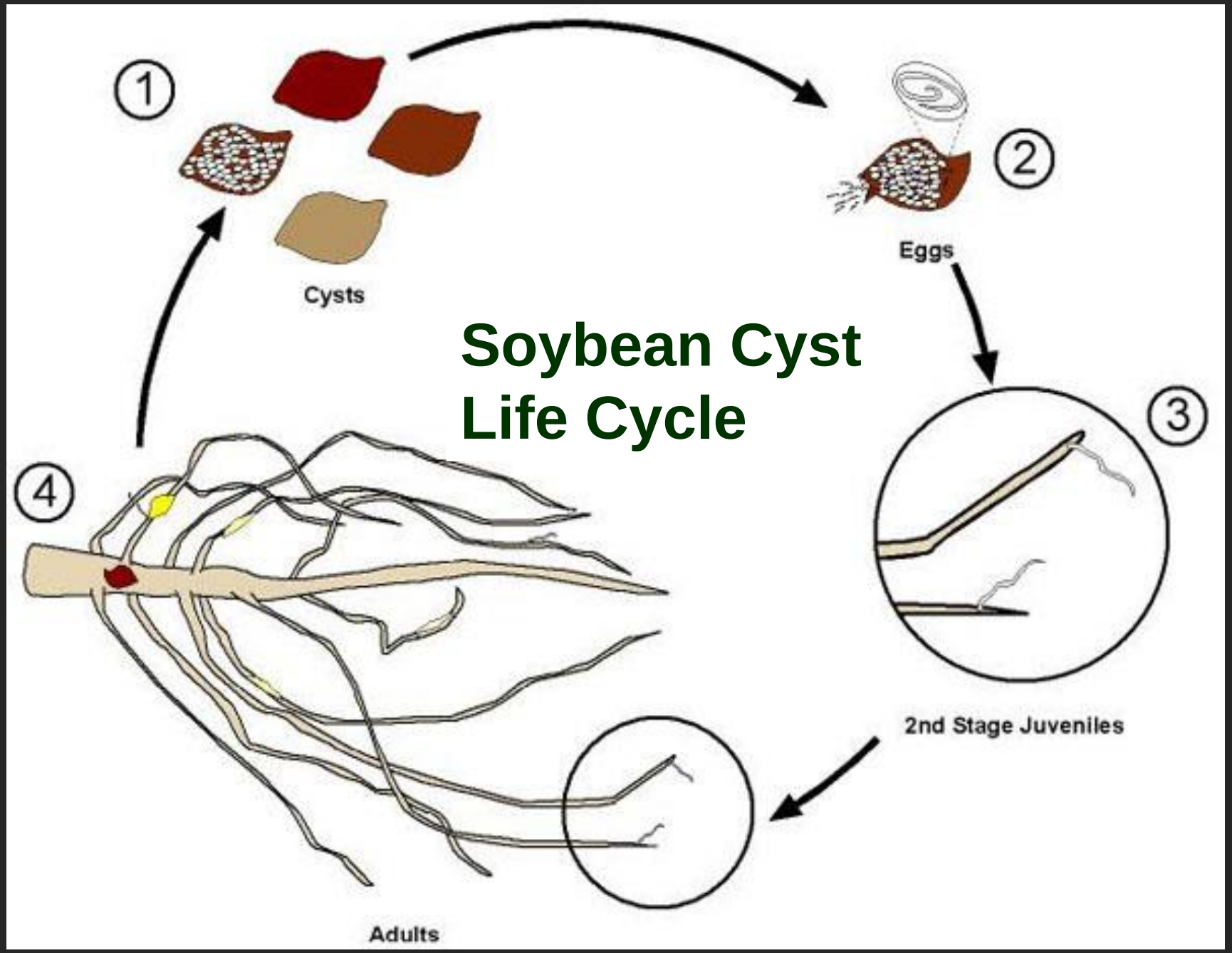
Tough structure

Long term survival

Moves with soil

Equipment, Water, Wind, Birds, Boots, 4-wheelers, etc…..

Source: www.entm.purdue.edu/nematology/lifecycle.html



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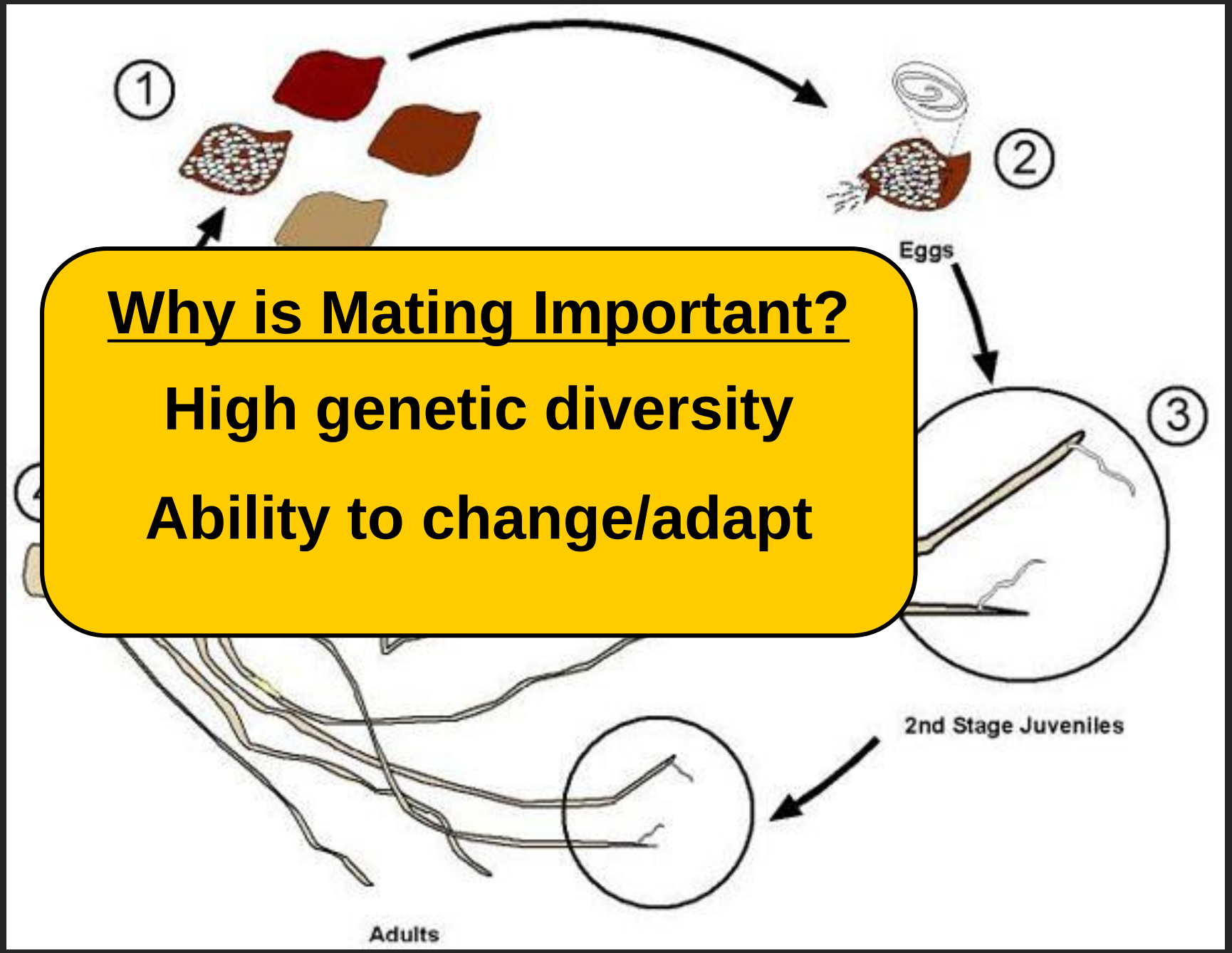
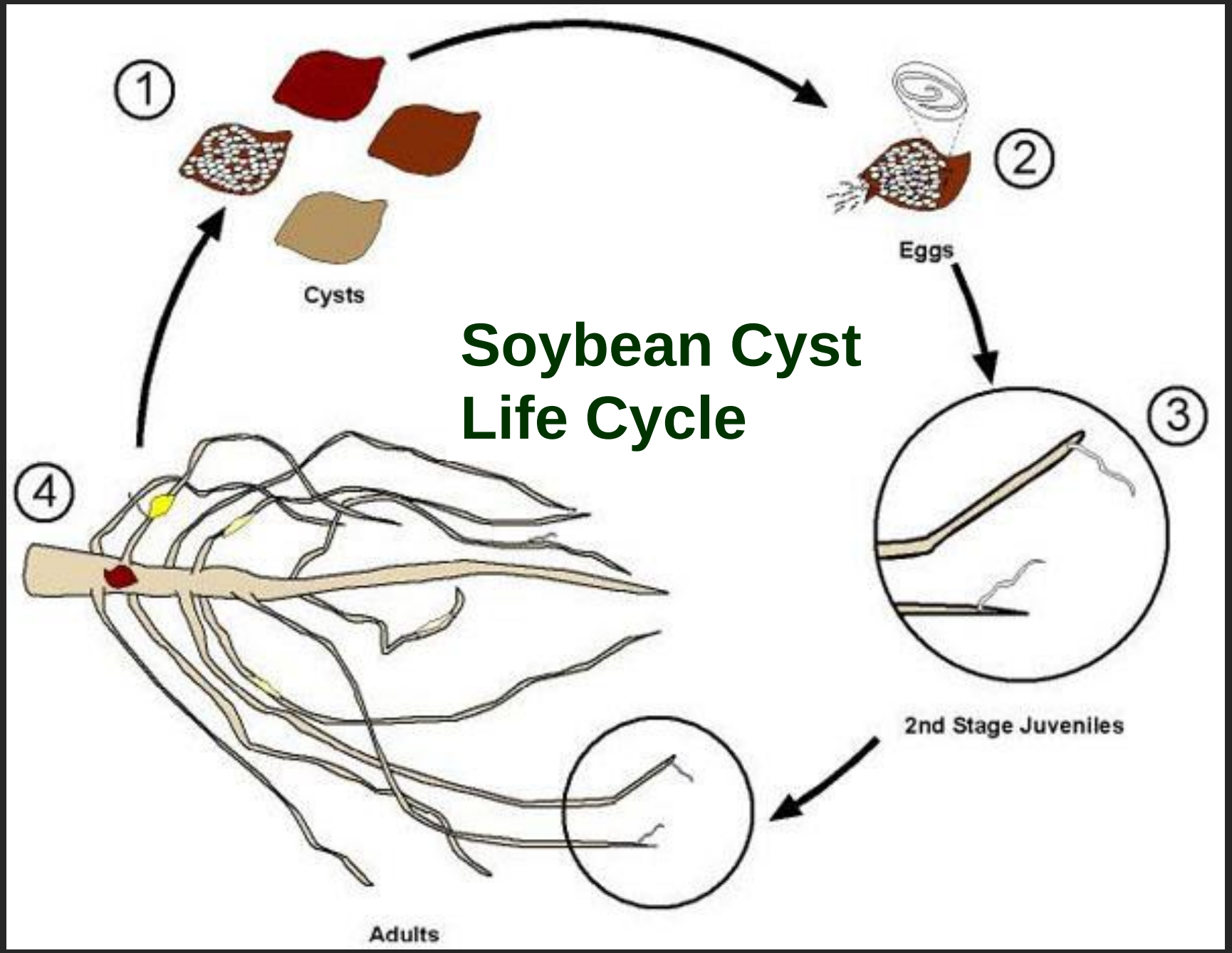


Why is Mating Important?

High genetic diversity

Ability to change/adapt

Source: www.entm.purdue.edu/nematology/lifecycle.html



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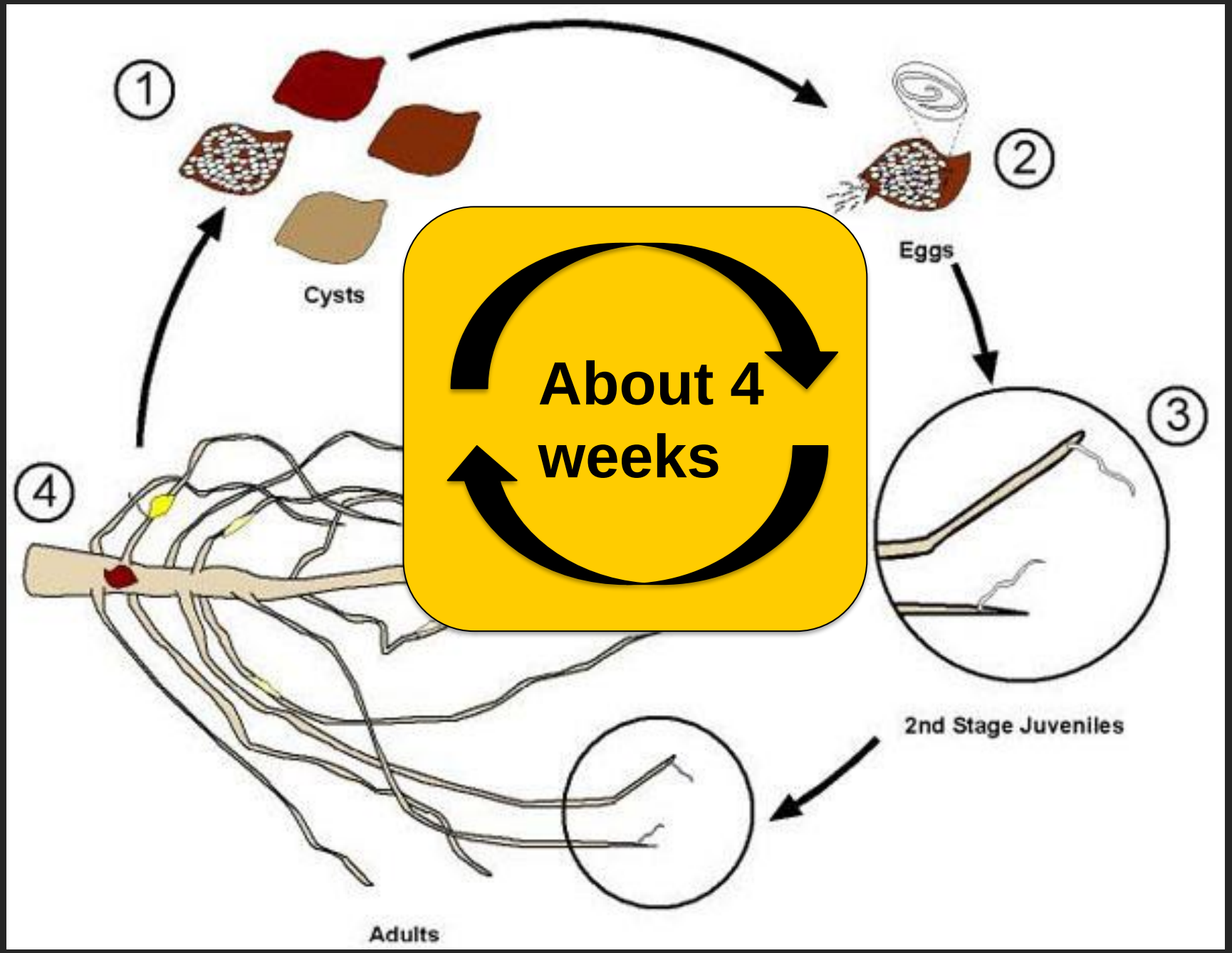

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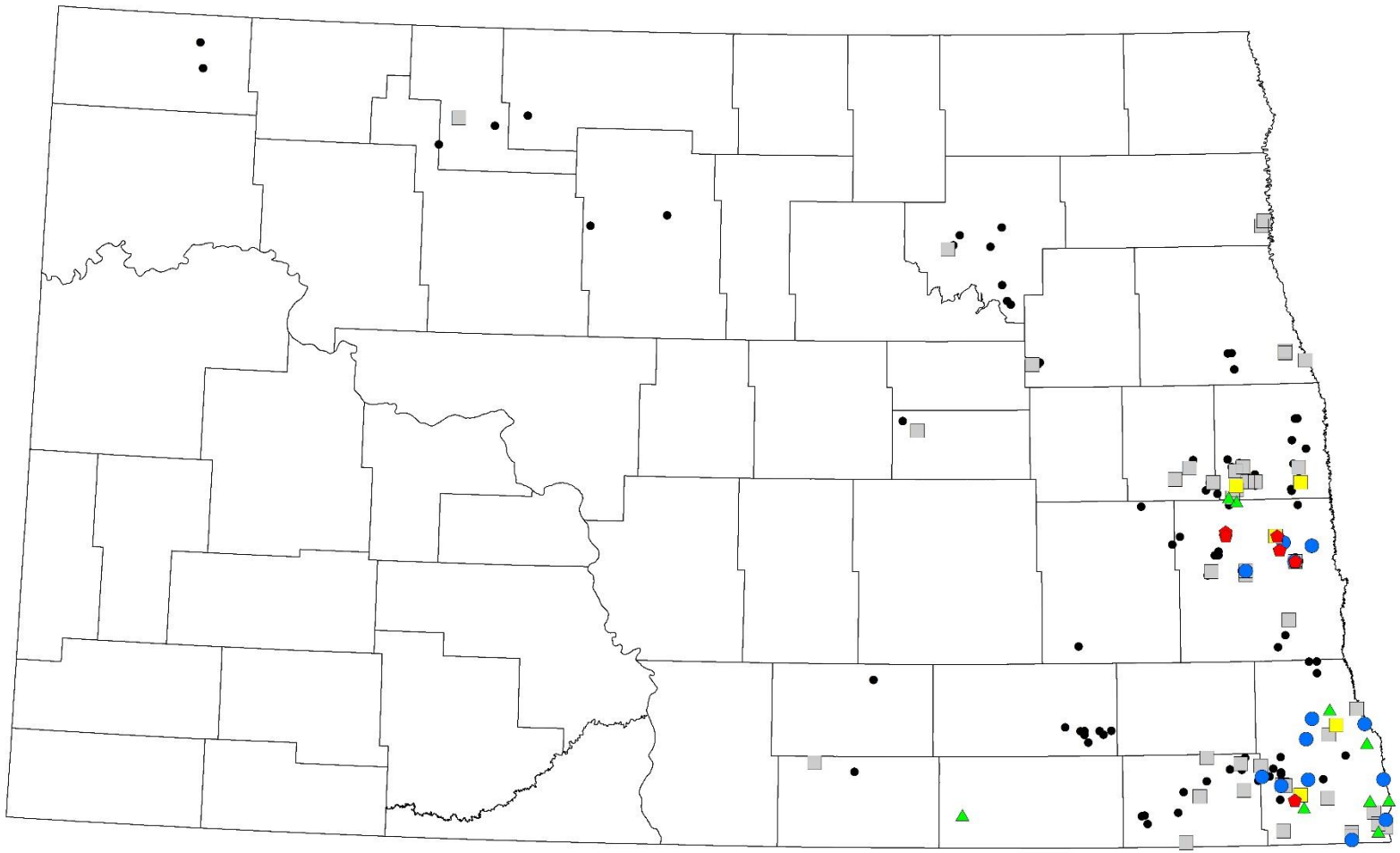
North Dakota SCN Sampling Program (2013-2024)

- **Funding = North Dakota Soybean Council**
- **Pick up sample bags at County Extension Office (Mid-August or later)**
- **Soil Sample – Send in sample**
- **Data mailed to you**
- **Reported in eggs/100cc**

SCN Survey 2013

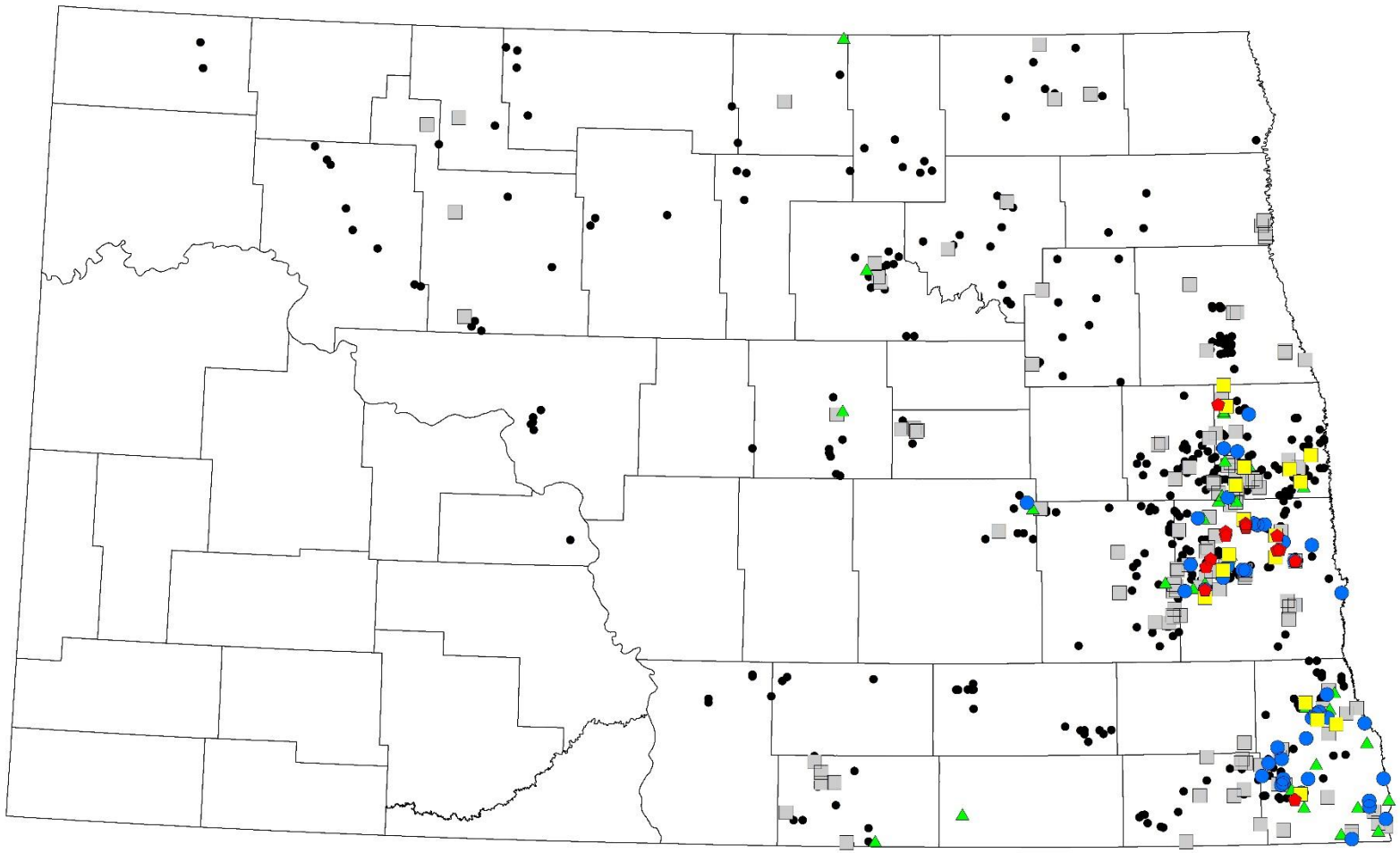


Eggs/100cc

0 12.5 25 50 Miles

• 0 ■ 50 - 200 ▲ 201 - 200 ● 2001 - 10000 ■ 10001 - 20000 ⬟ 20000 +

SCN Survey 2013-2014



Eggs/100cc

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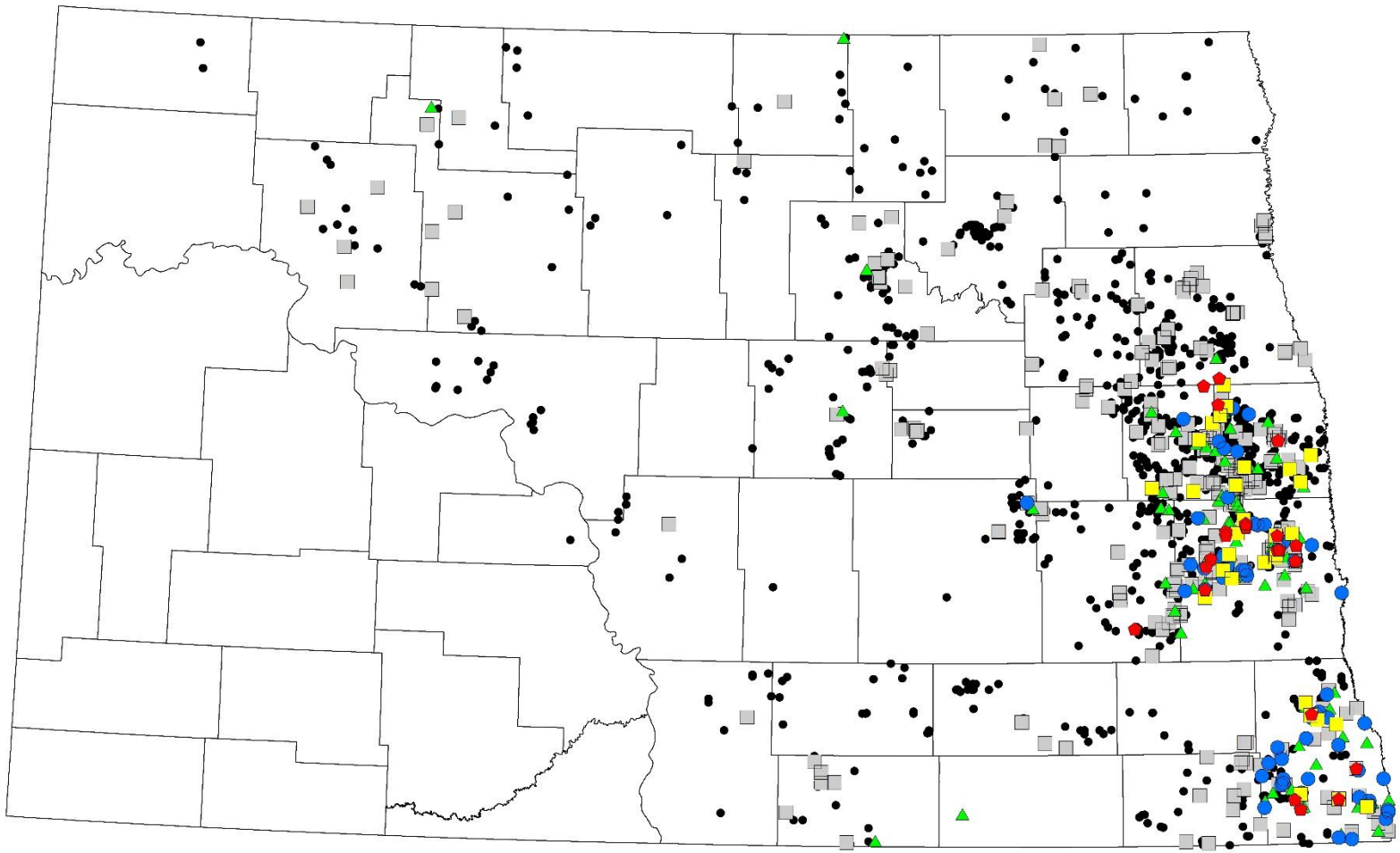
SCN Survey 2013-2015



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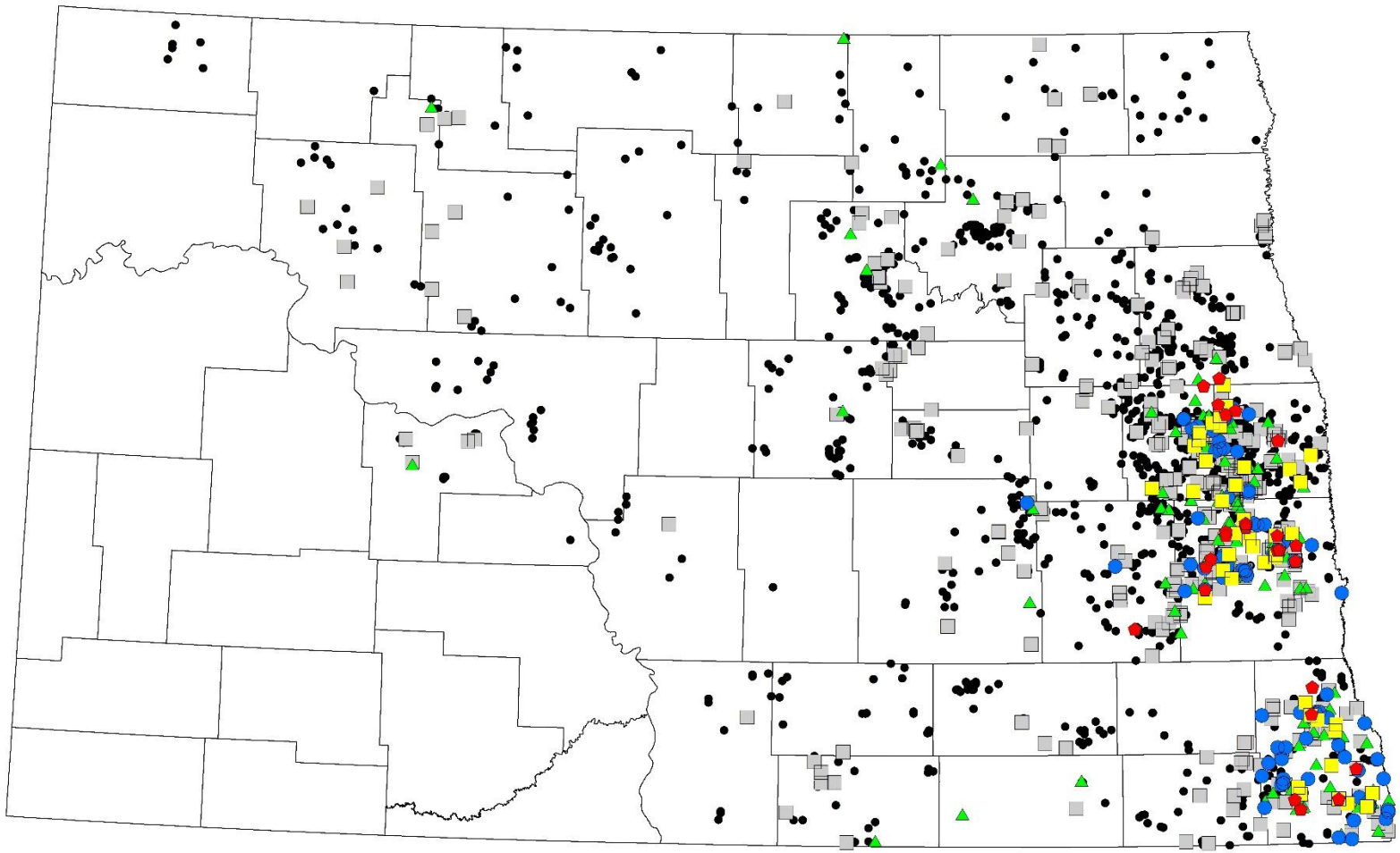
SCN Survey 2013-2016



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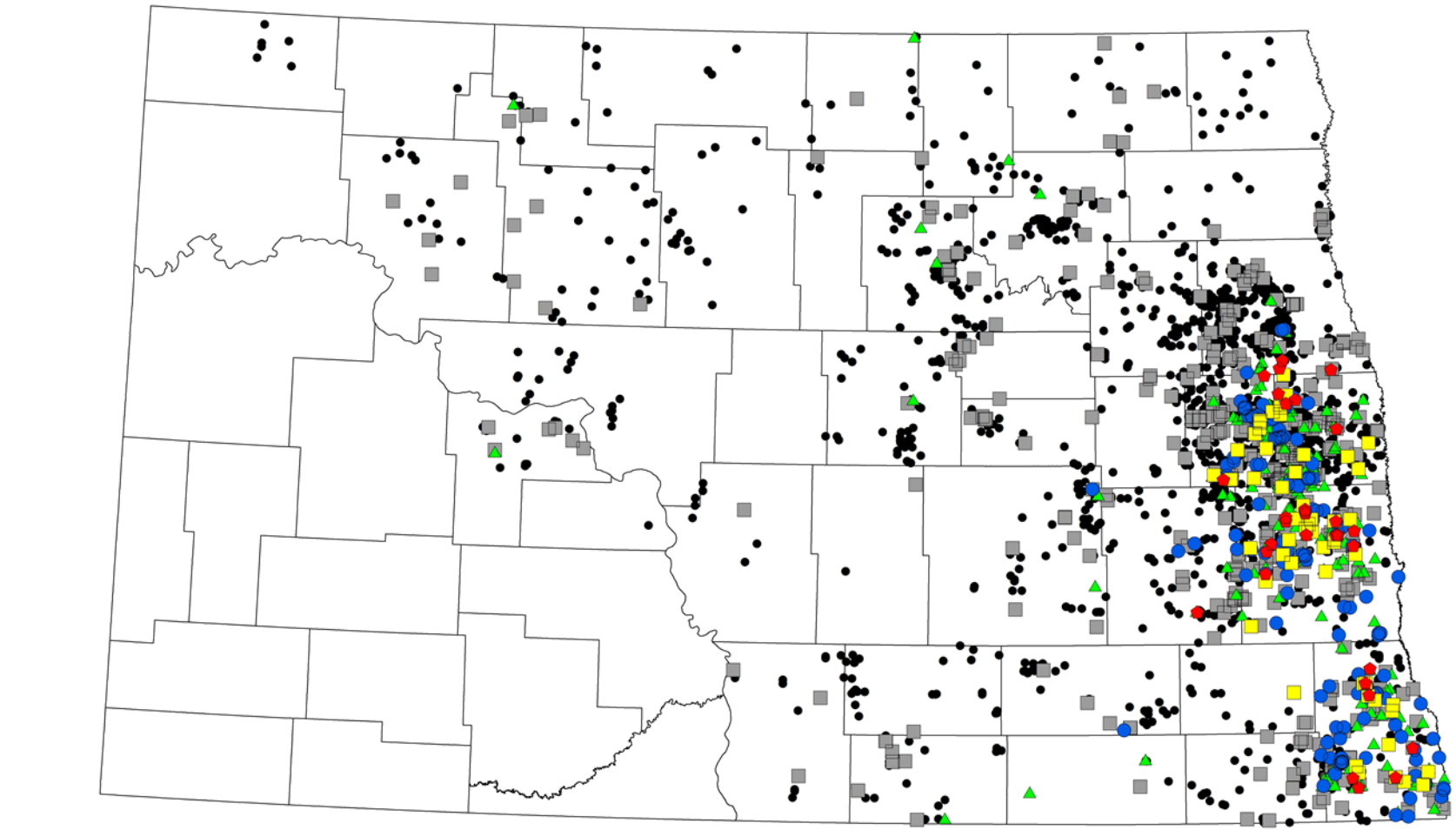
SCN Survey 2013-2017



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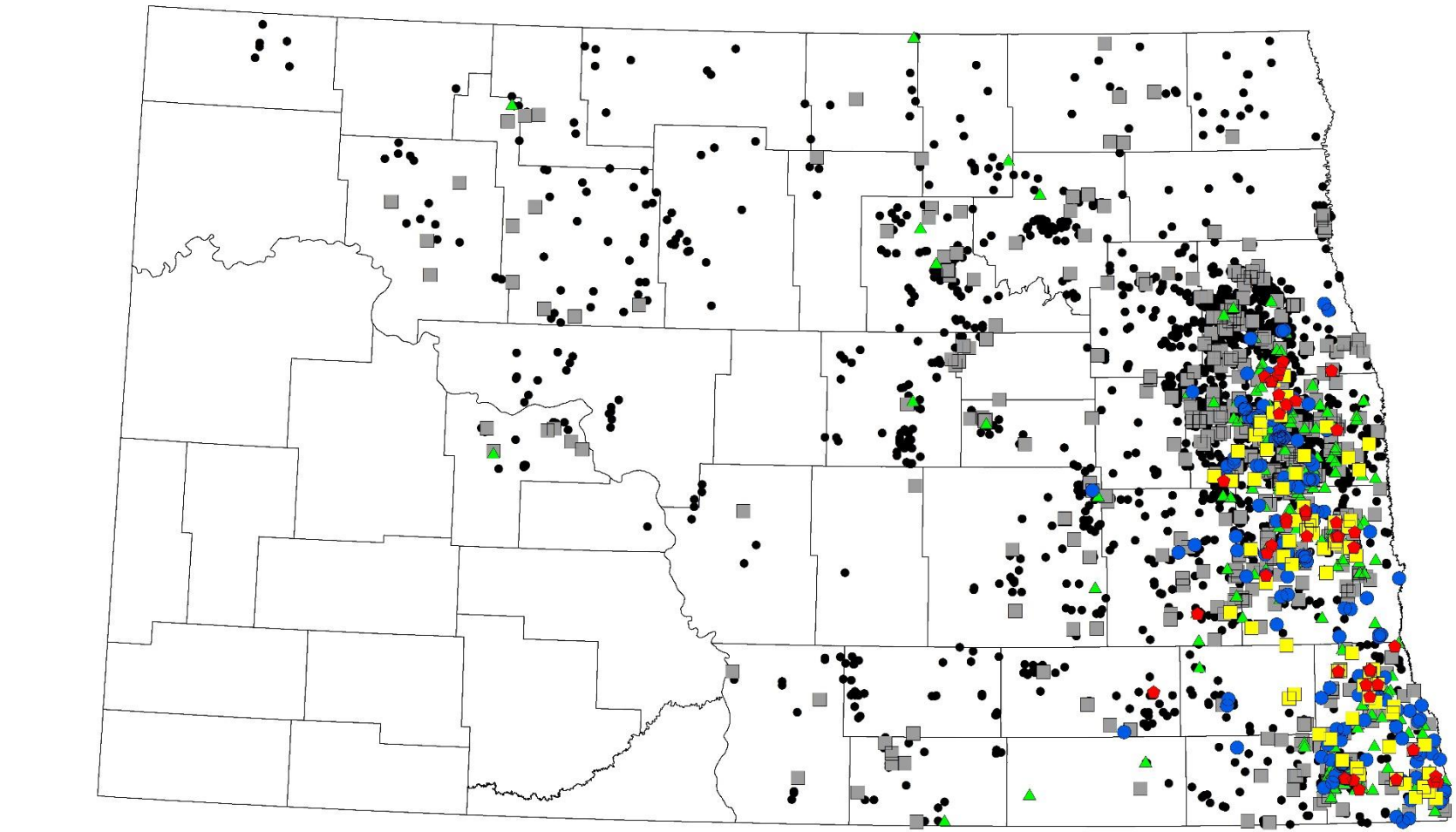

Eggs/100cc

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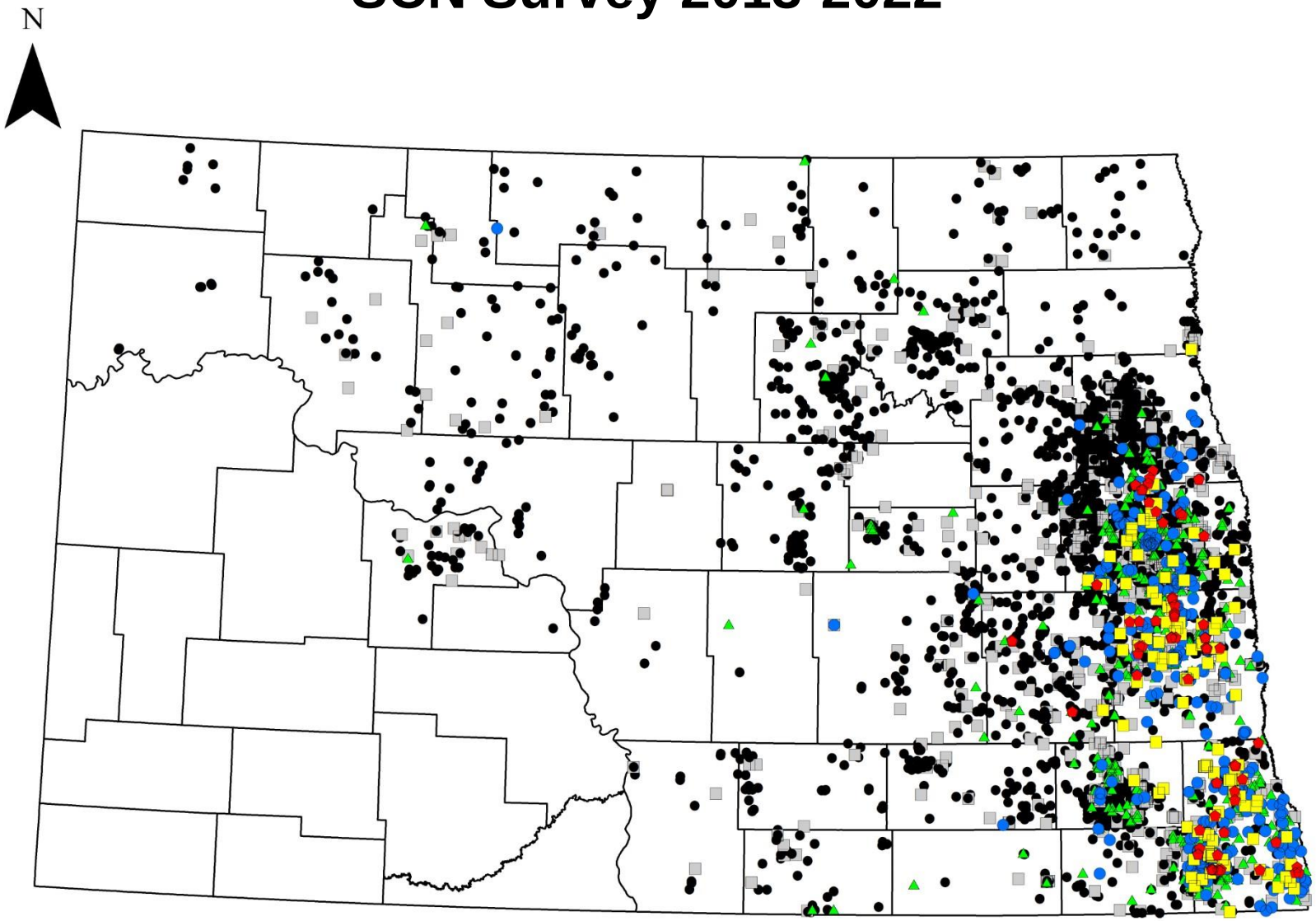
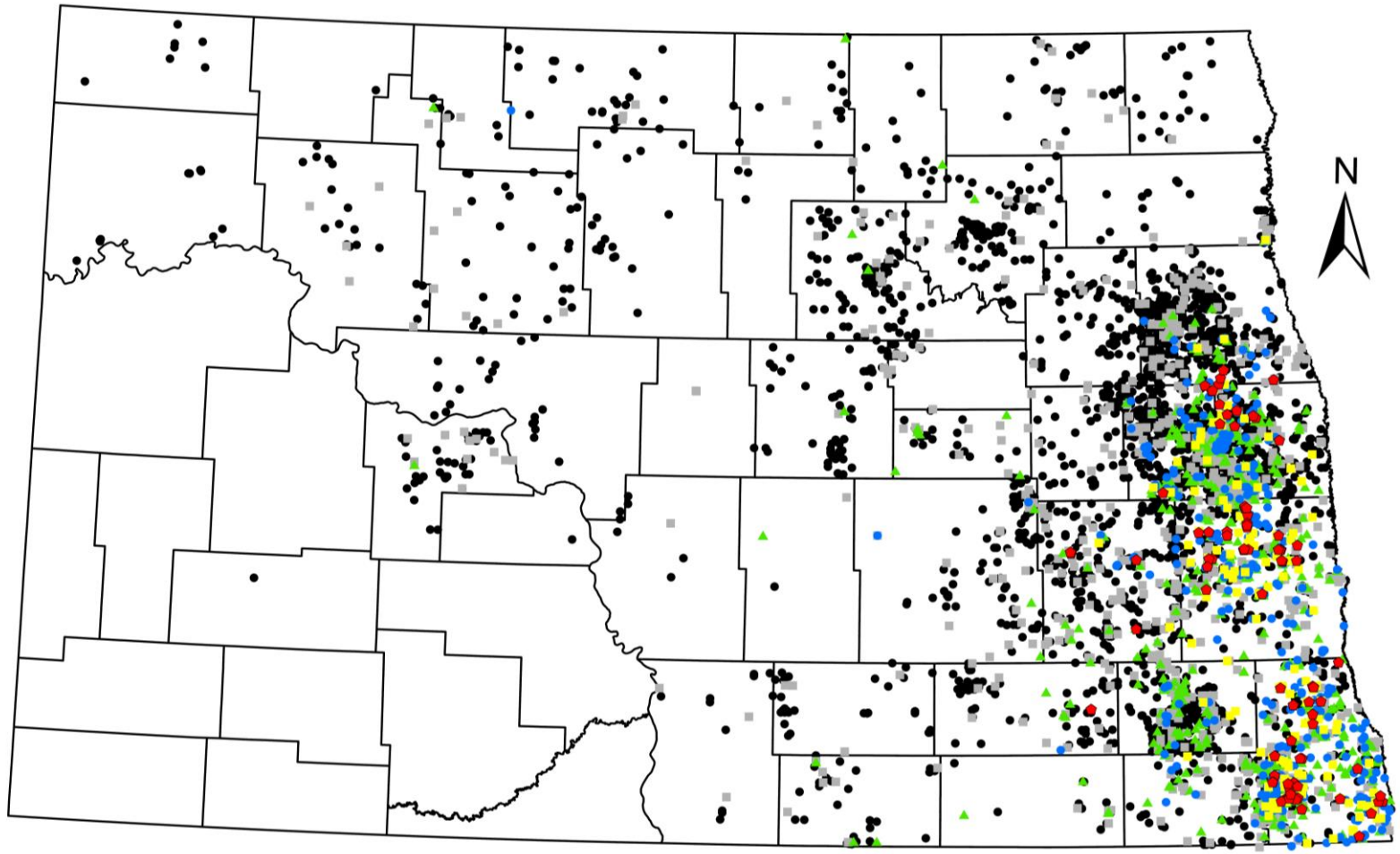


SCN Survey 2013-2023



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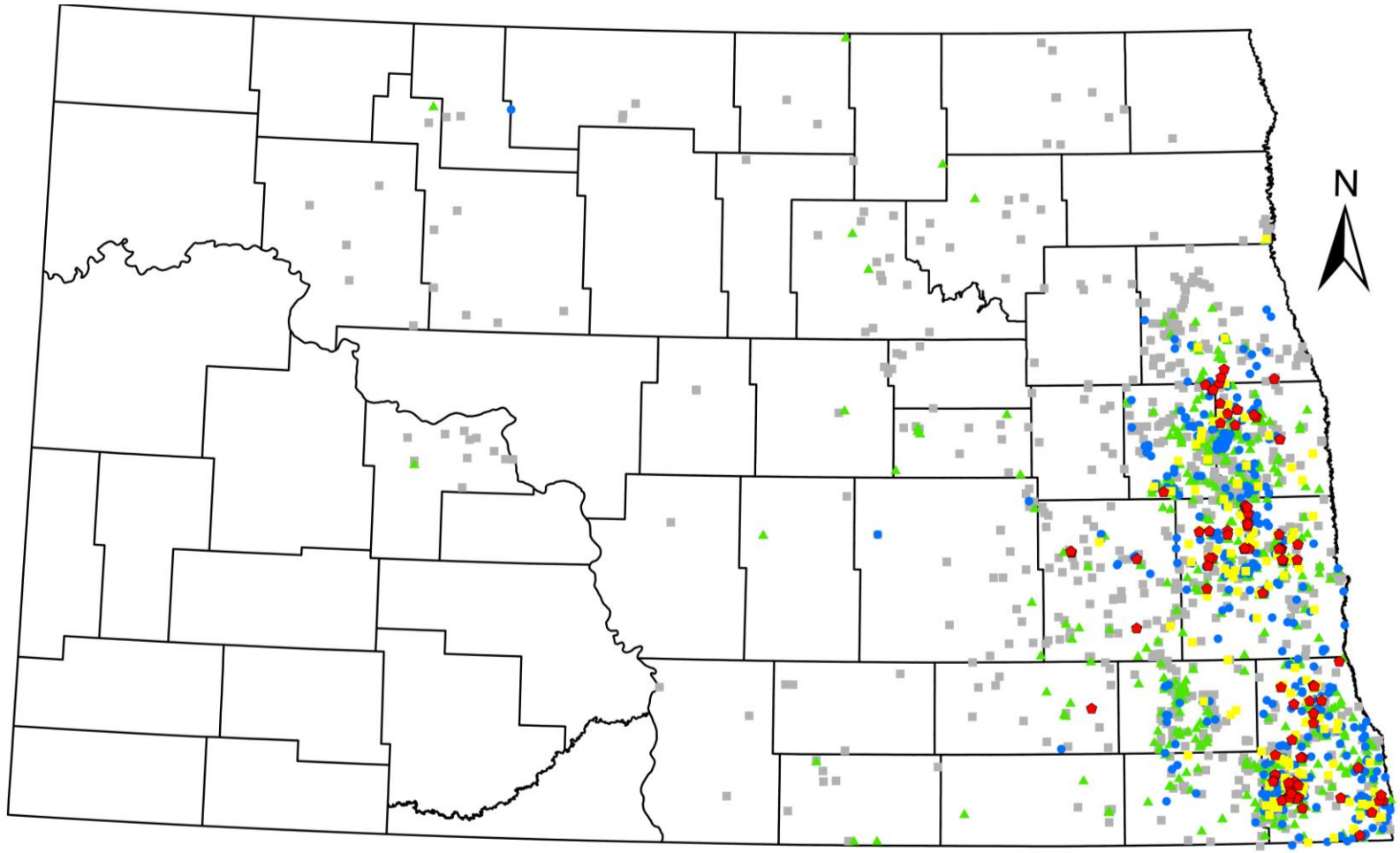
SCN Survey 2013-2023



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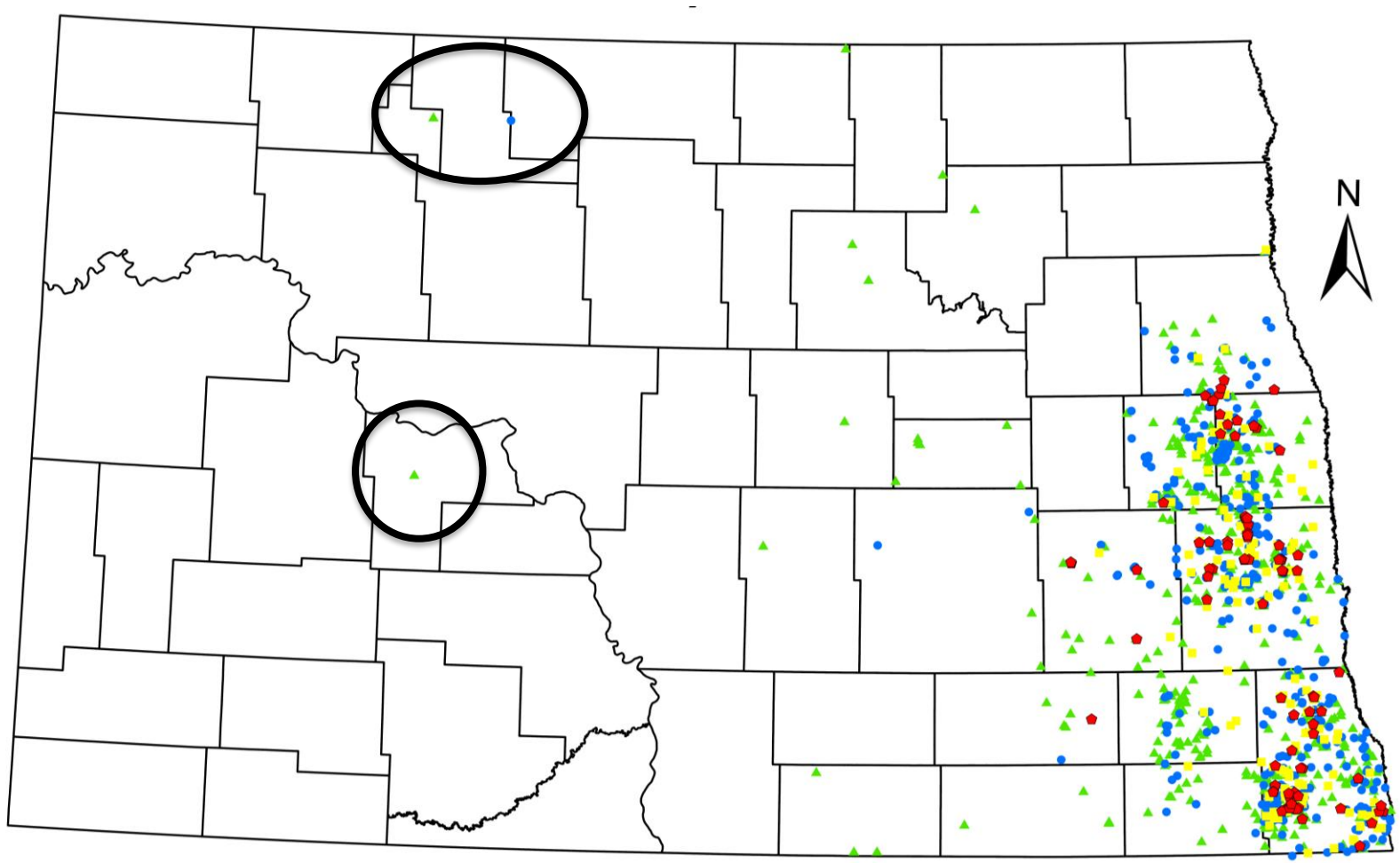

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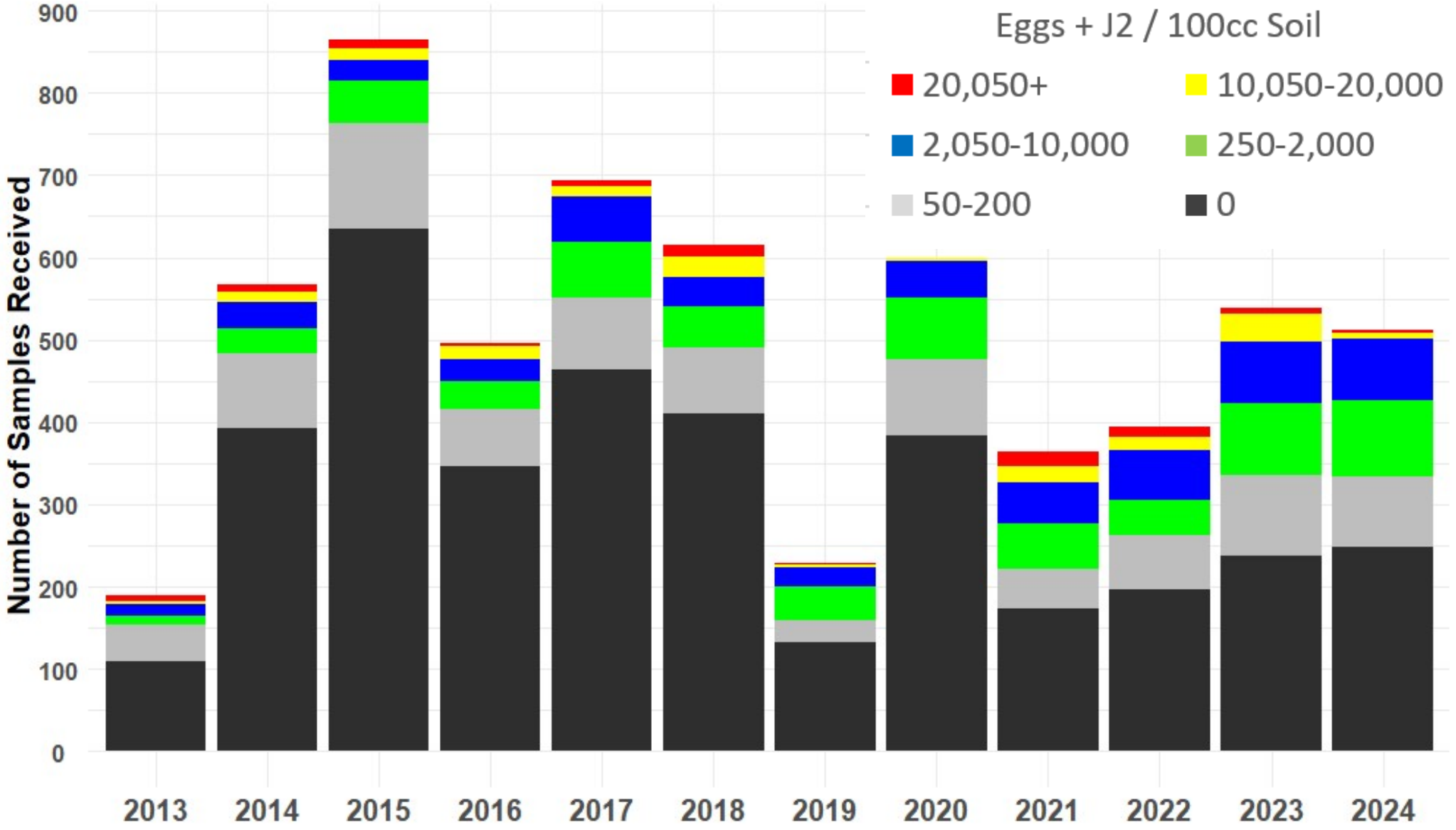

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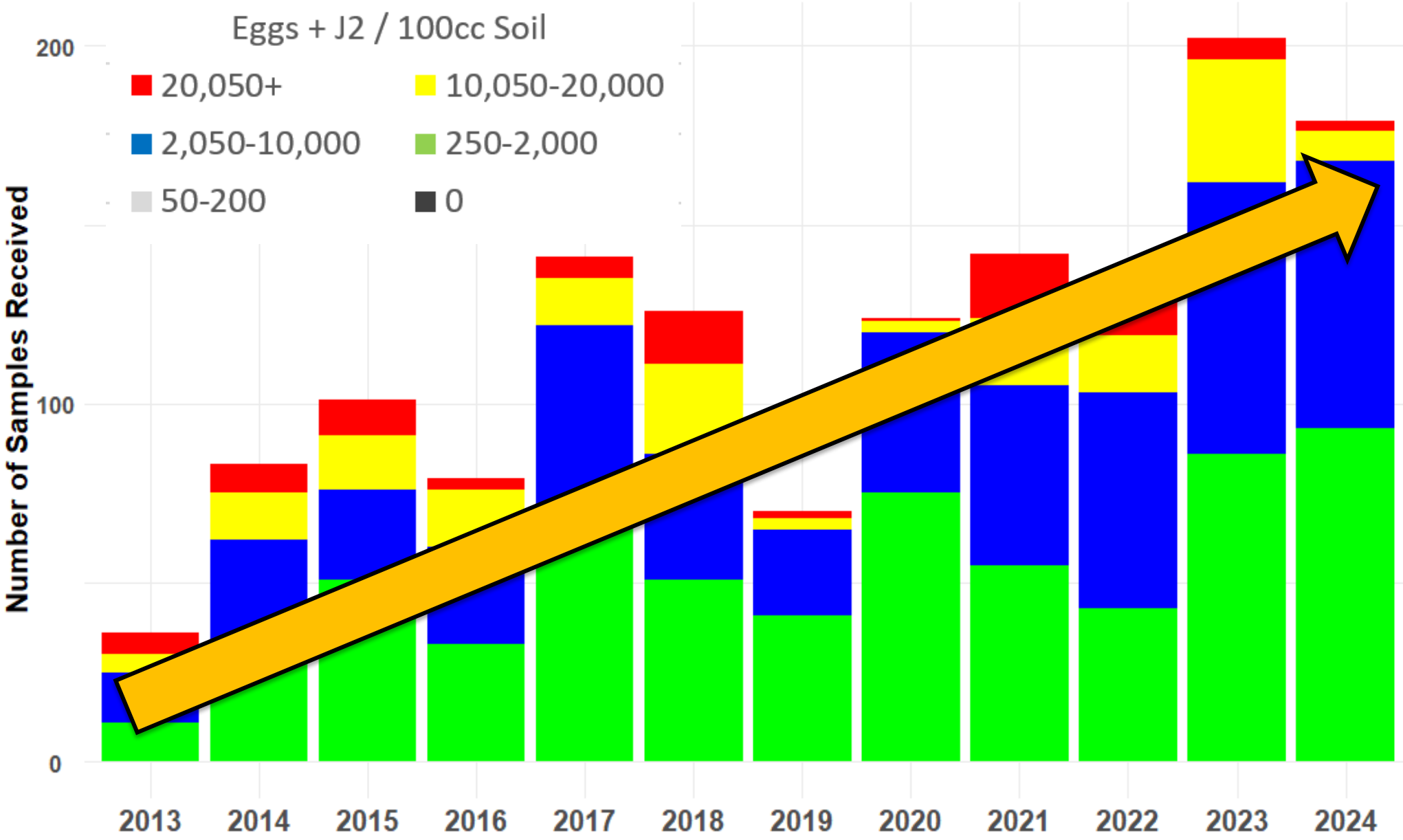

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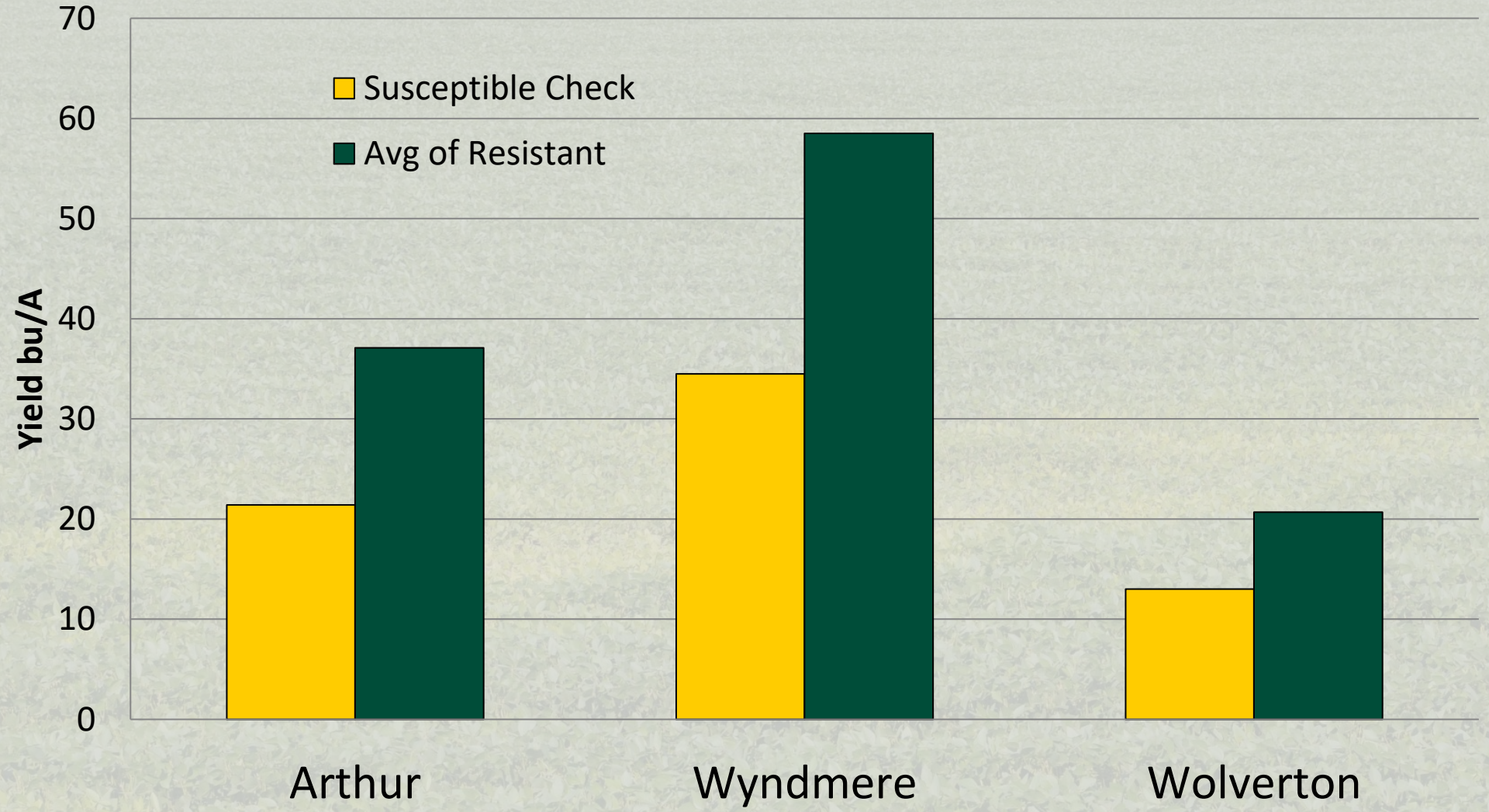
SCN Symptoms

Photo: Sam Markell

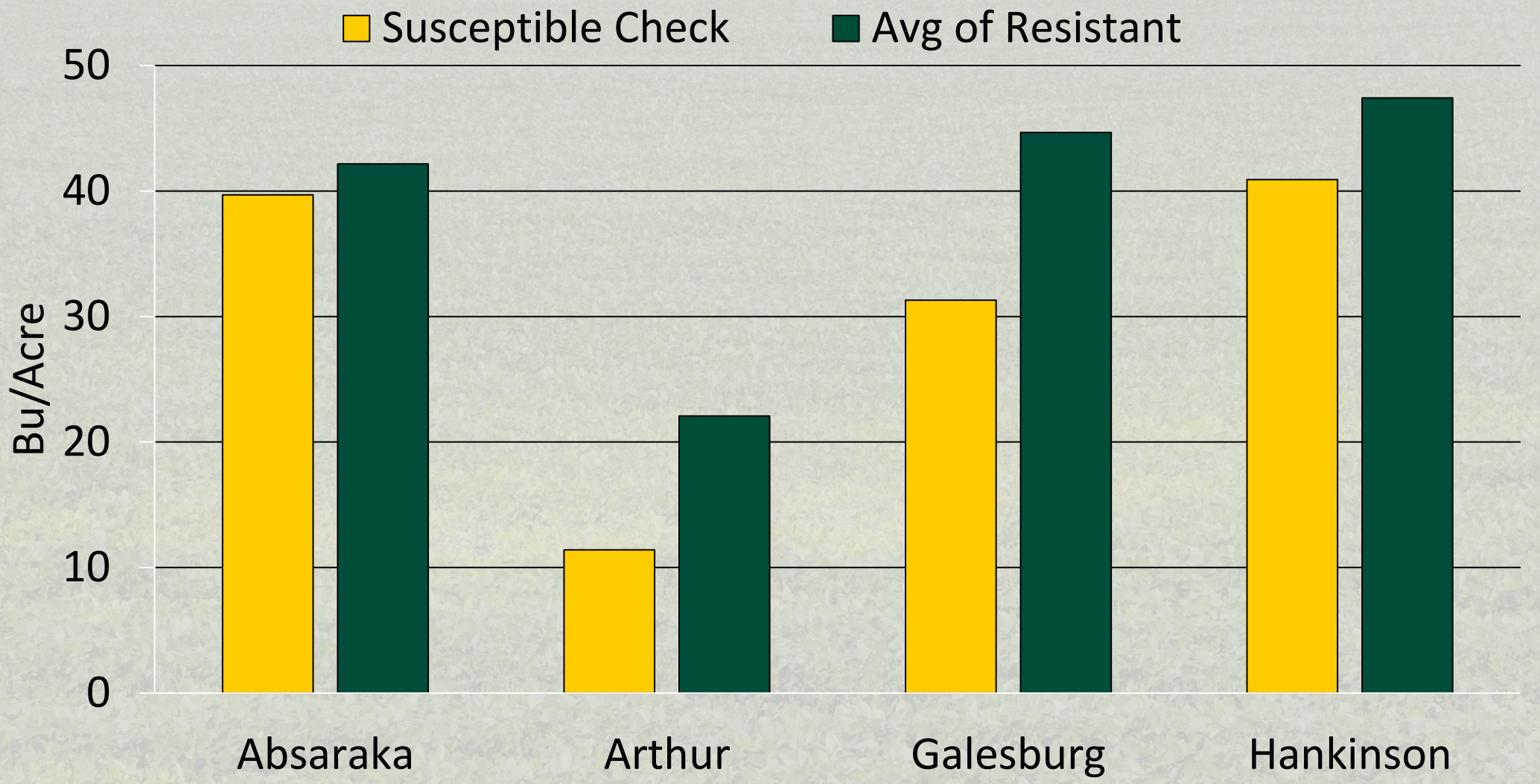

Richland County, ND
B. D. Nelson

2012 SCN Variety Trials



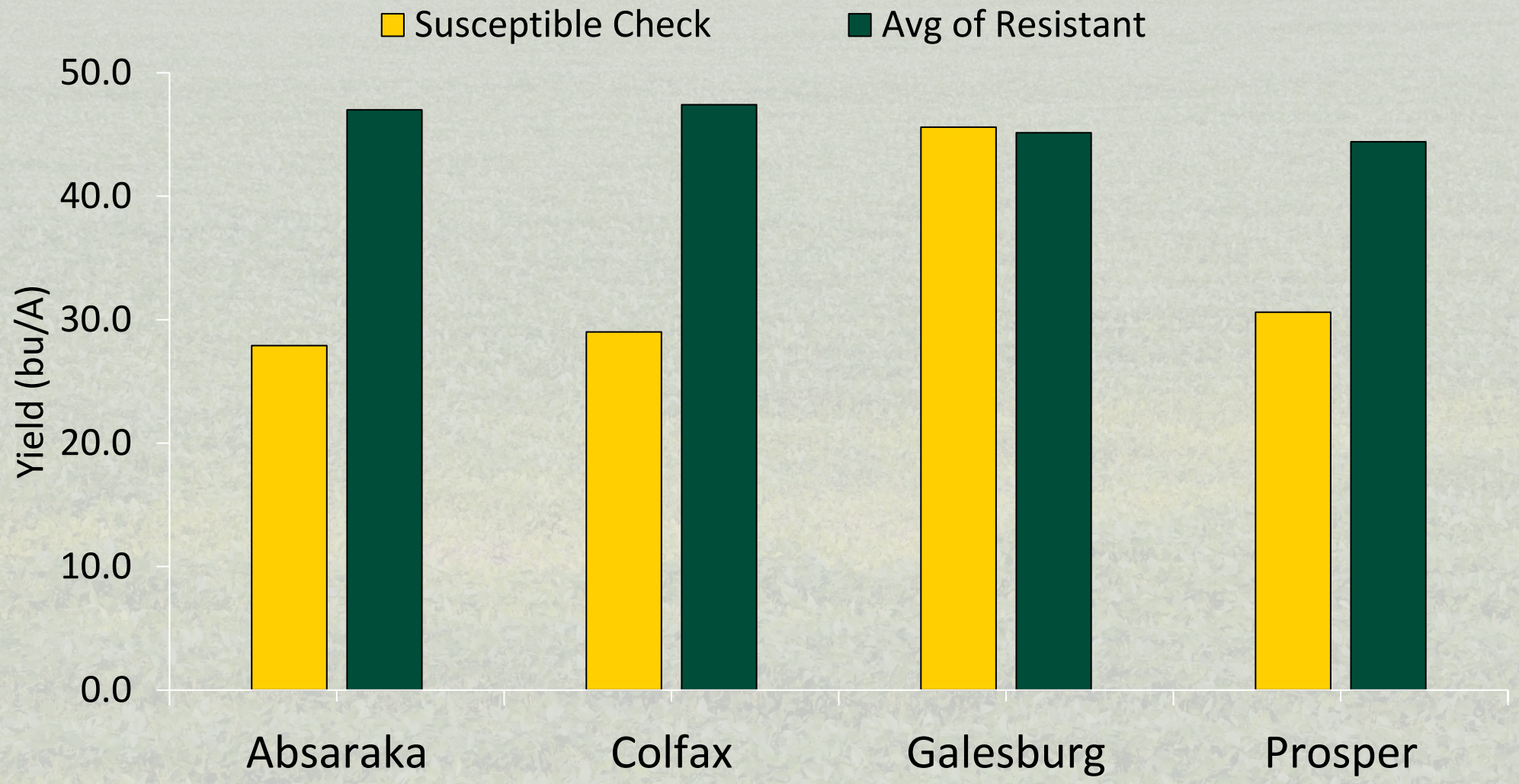
Adapted from Ted Helms

2015 SCN Variety Trials



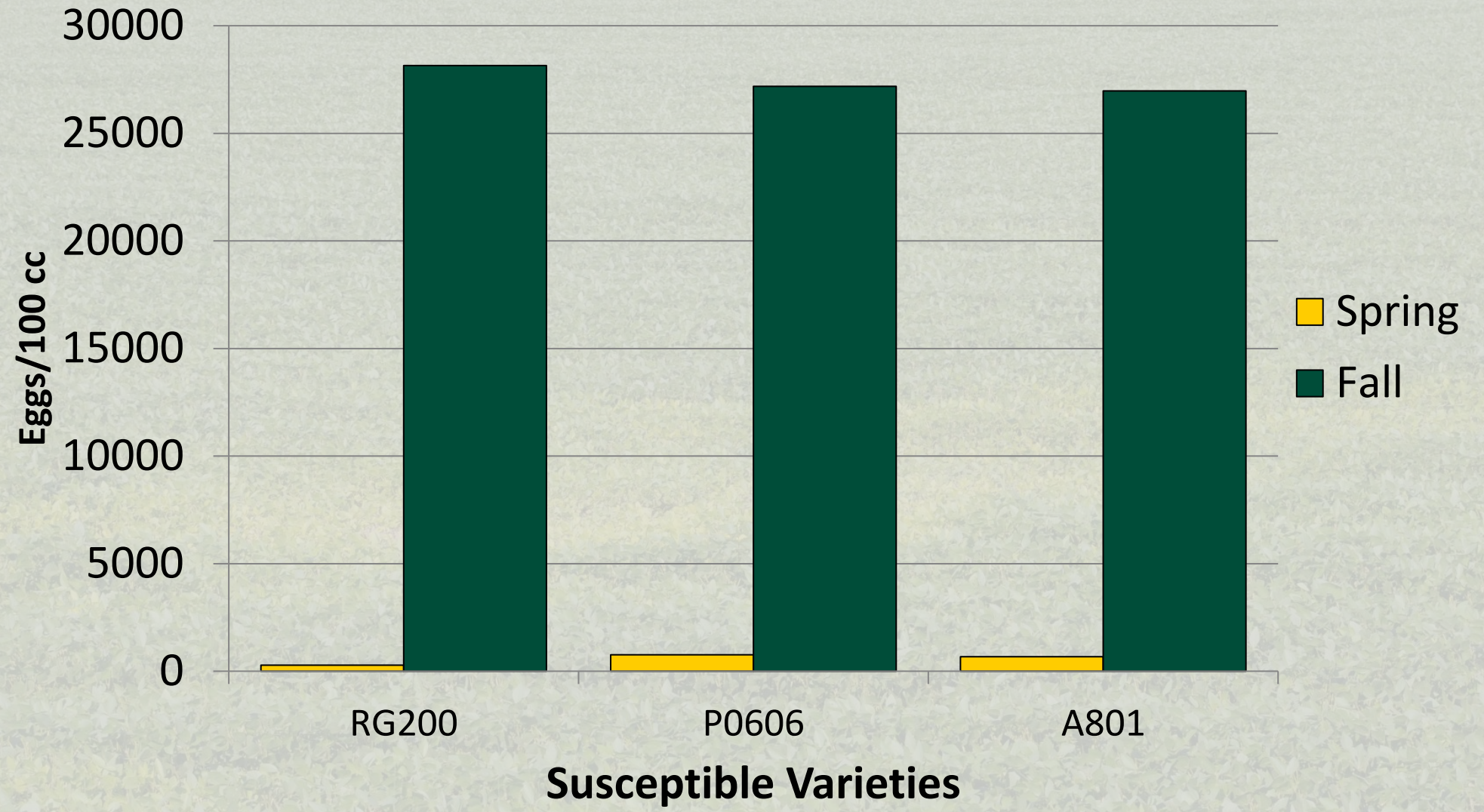
Adapted from Ted Helms

2017 SCN Yield Trial



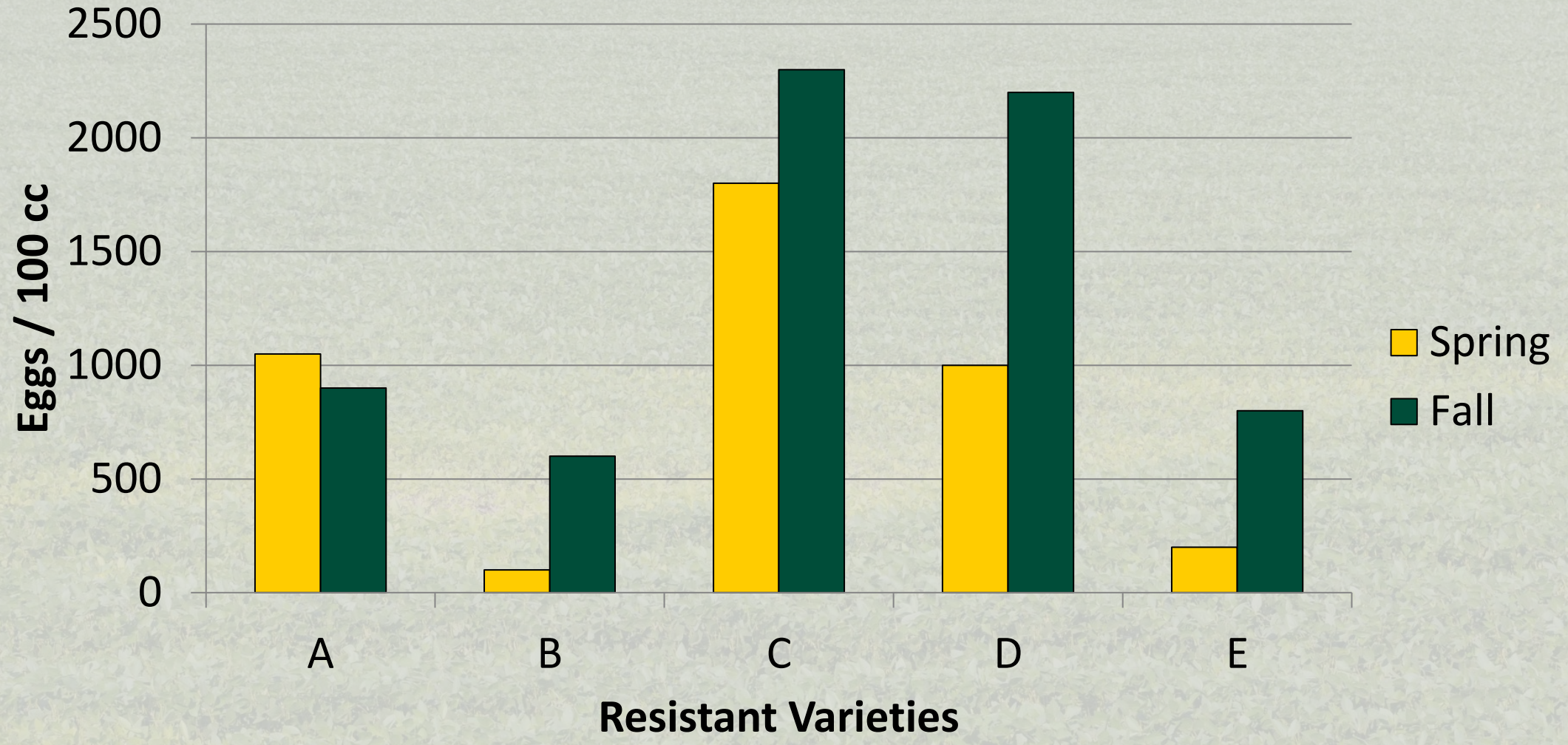
Adapted from Ted Helms

How Fast Can SCN Increase?



Adapted from Ted Helms

Resistance pays Twice – Egg levels

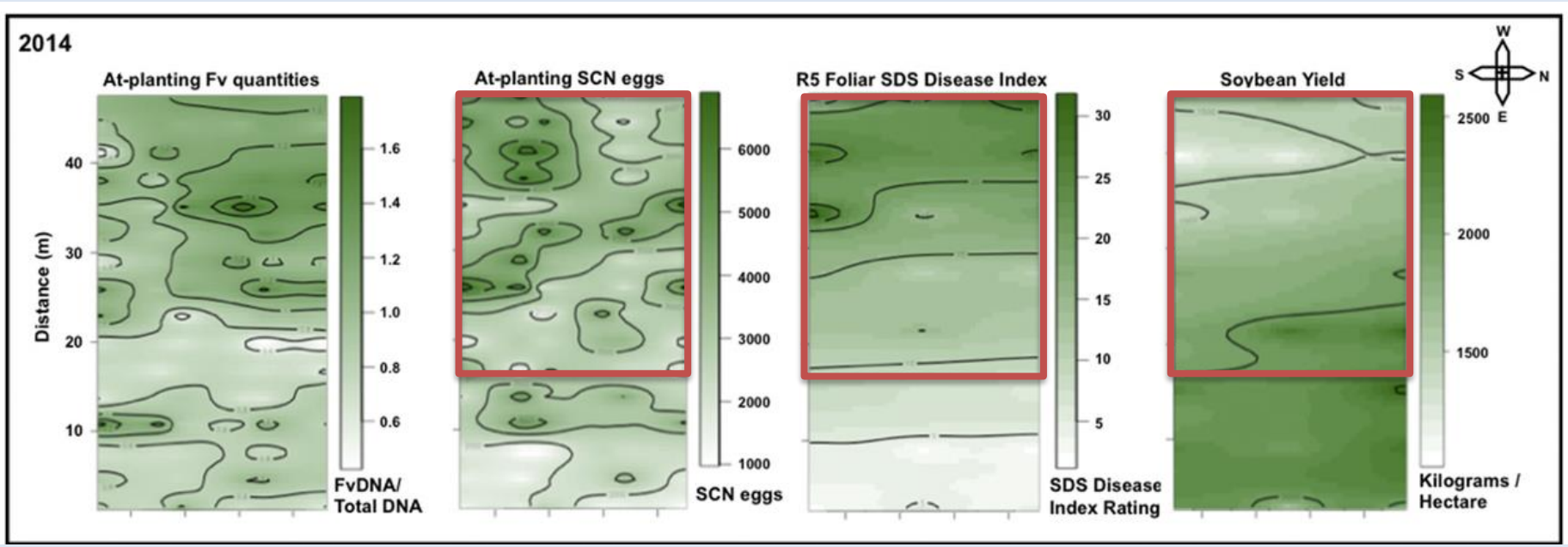


Adapted from Ted Helms

SCN Interactions

Sudden Death Syndrome Short Course

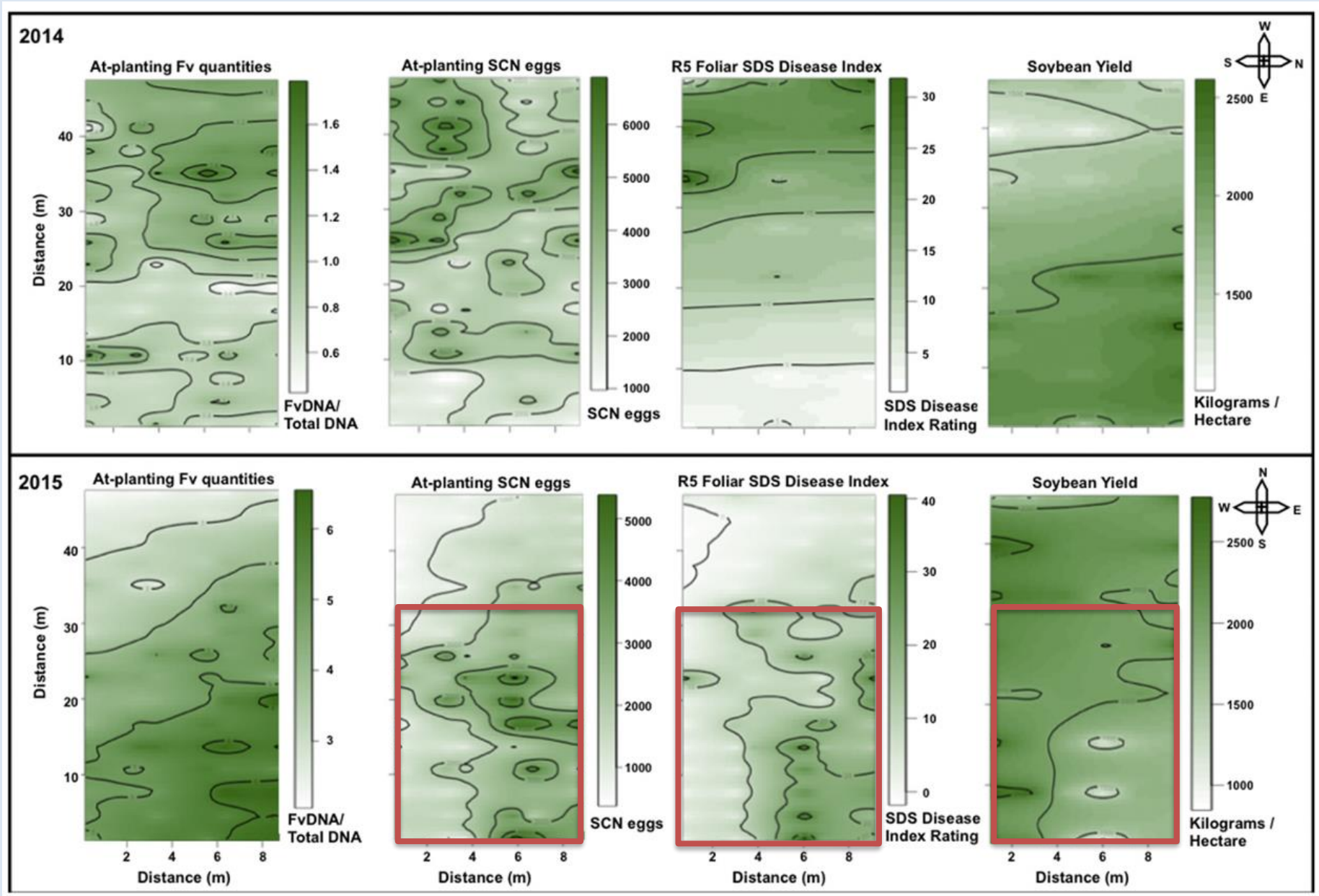
Association of SCN and SDS



Roth et al. 2019, Phytopathology

MICHIGAN STATE UNIVERSITY

Association of SCN and SDS



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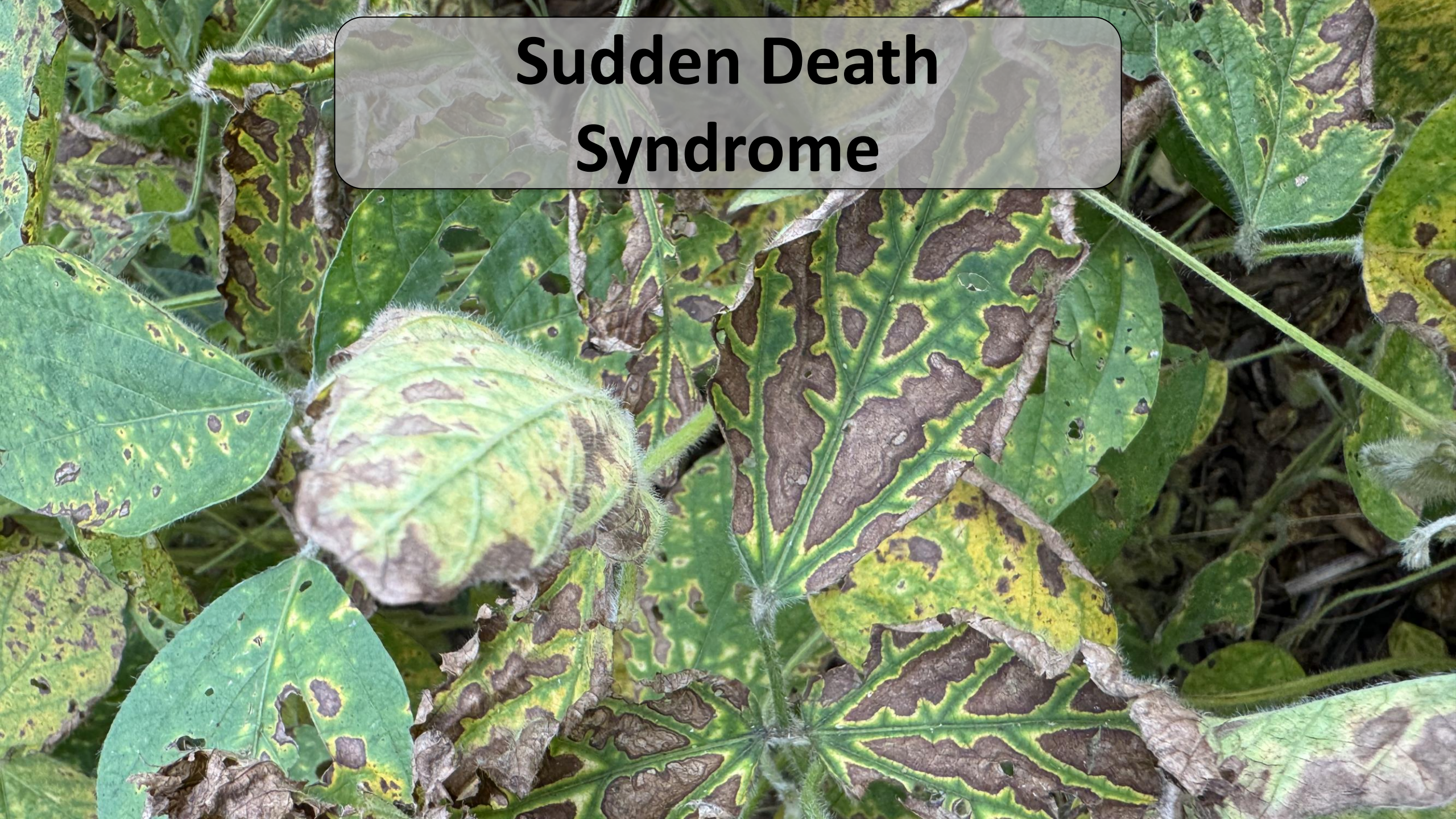
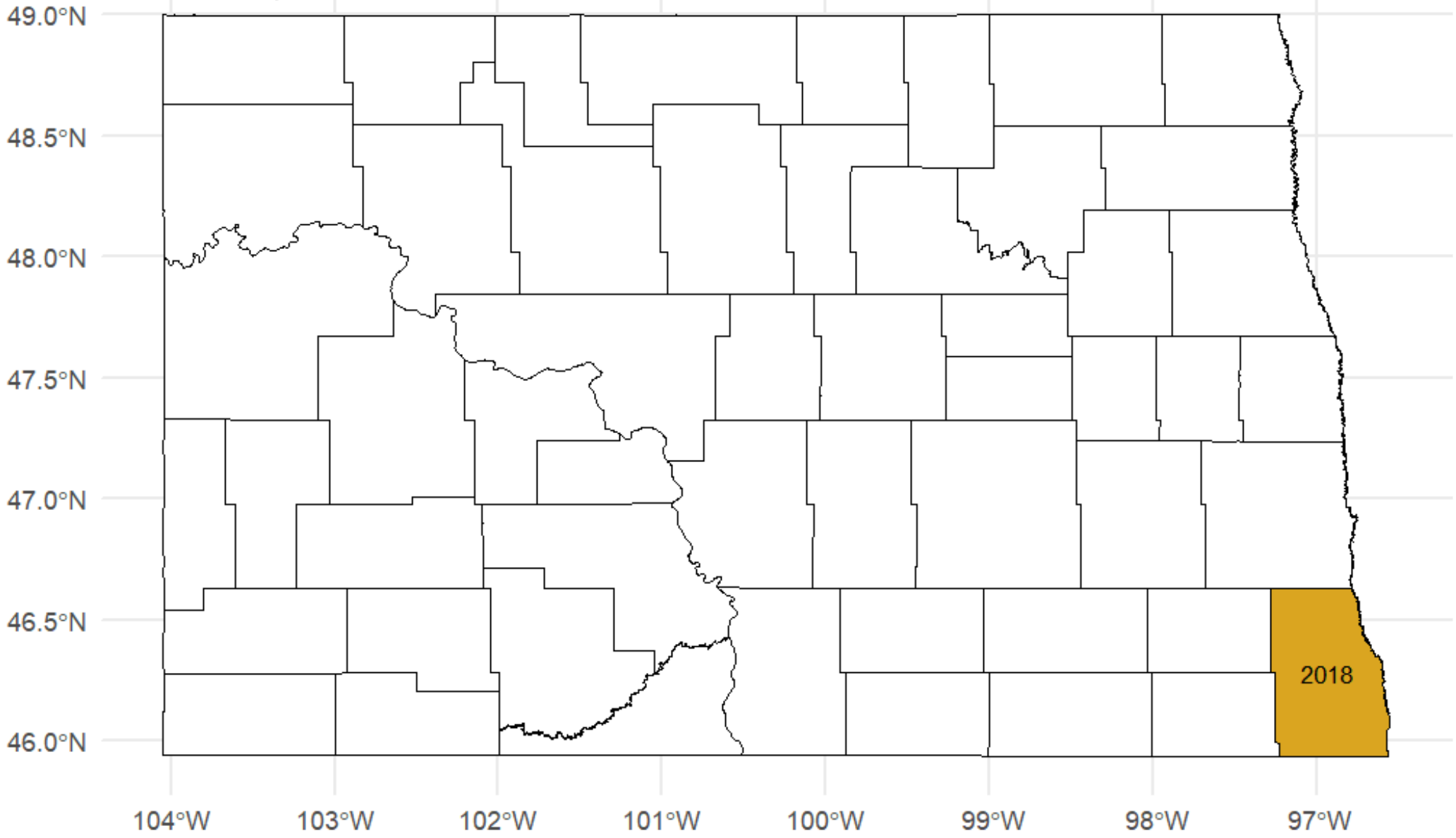
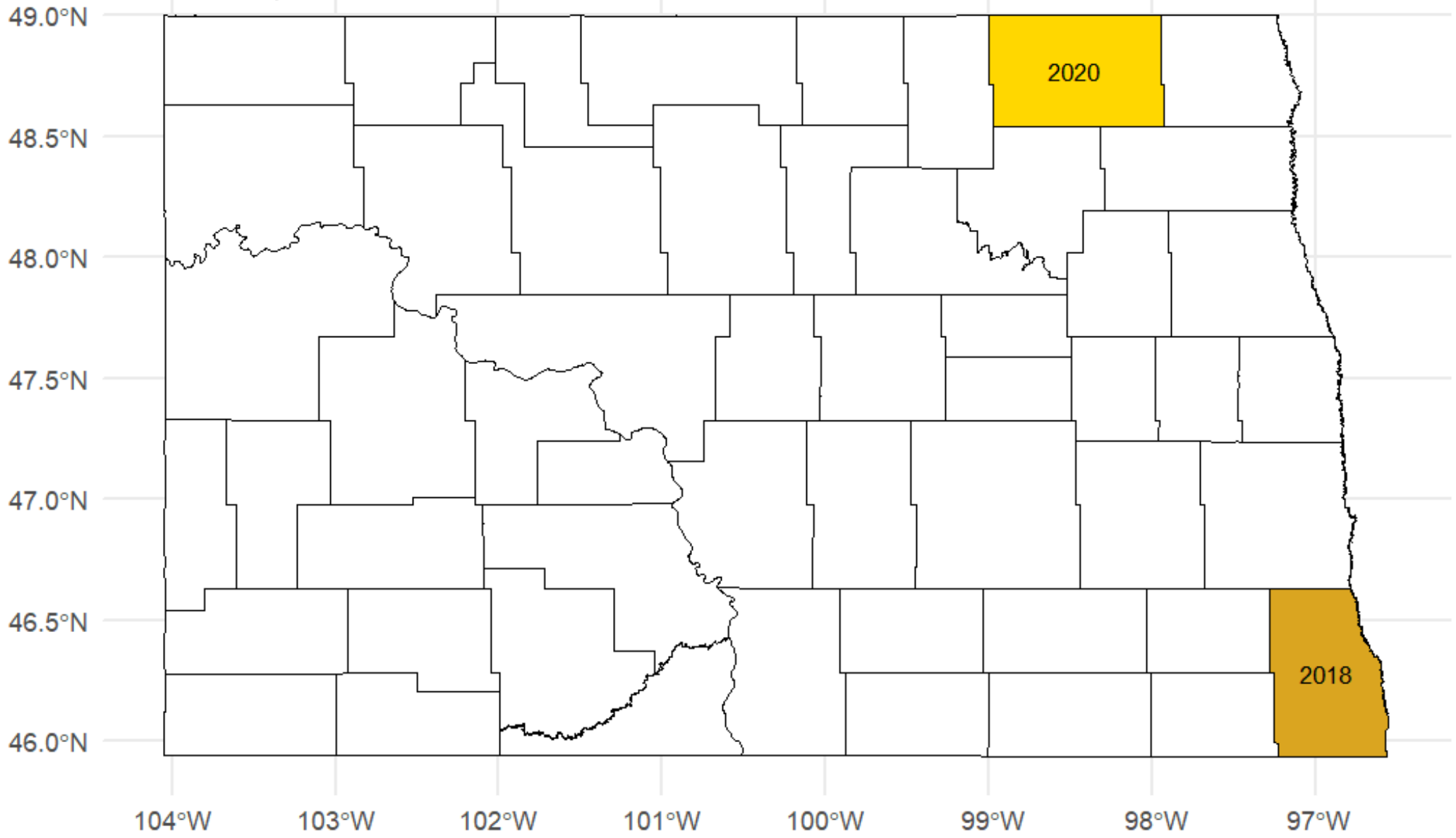
Sudden Death Syndrome



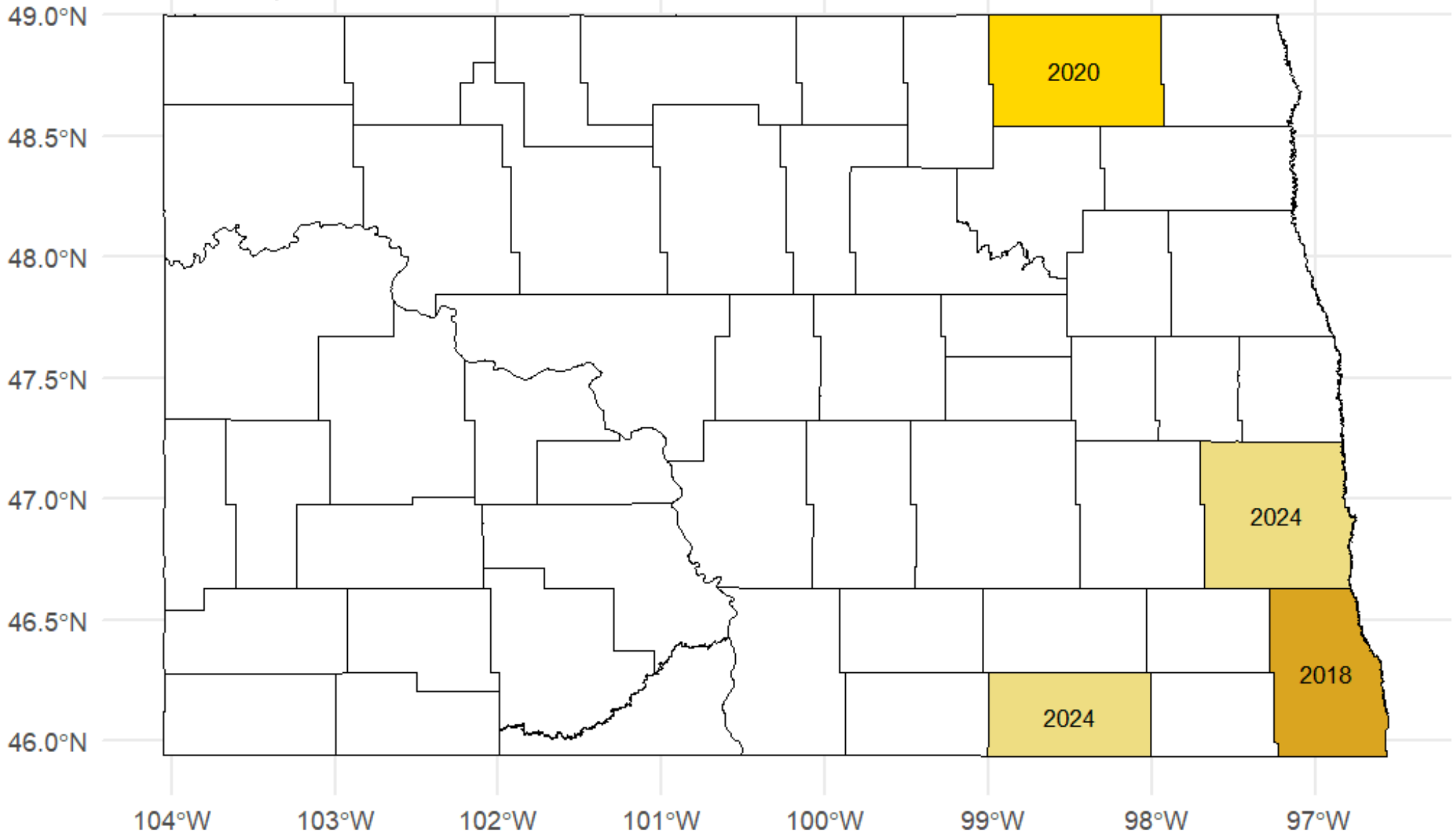
Progression of Sudden Death Syndrome



Progression of Sudden Death Syndrome

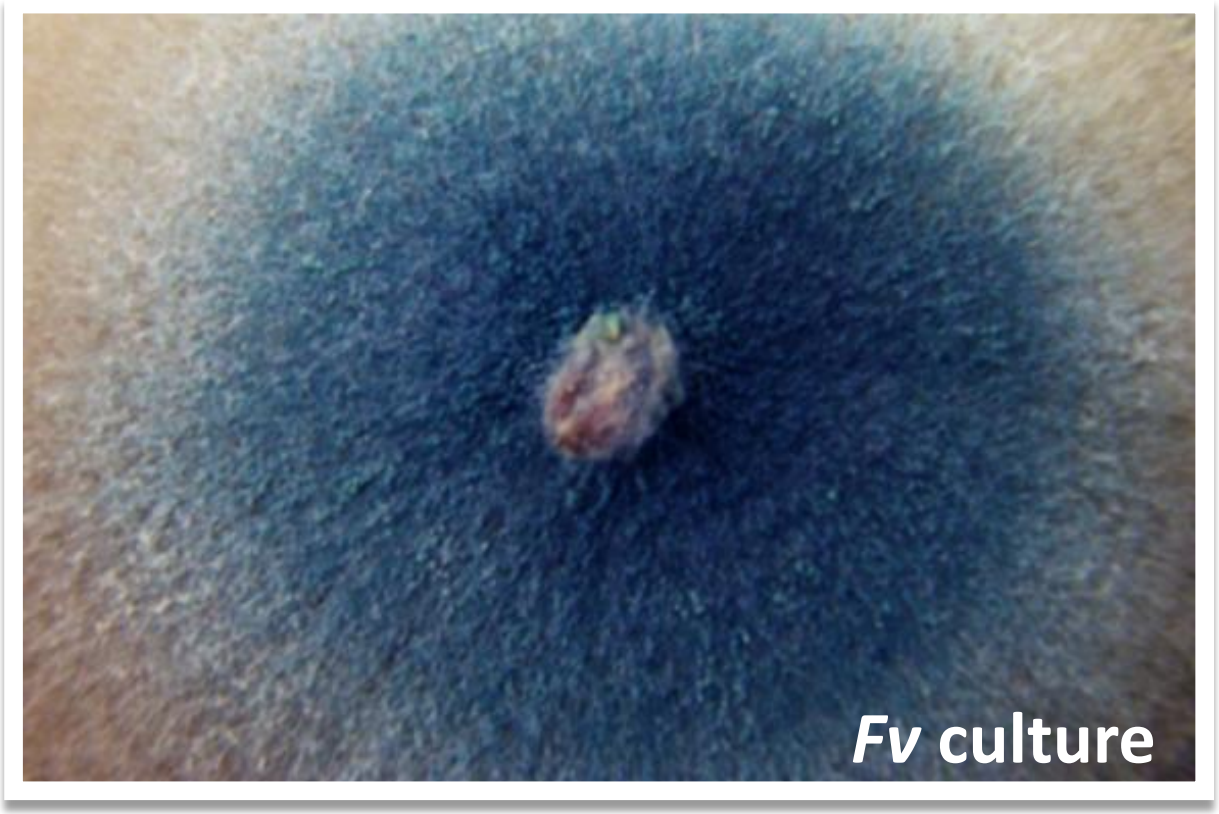


Progression of Sudden Death Syndrome



Sudden death syndrome

Soilborne pathogen – *Fusarium virguliforme*
Two phases – root rot, foliar symptoms



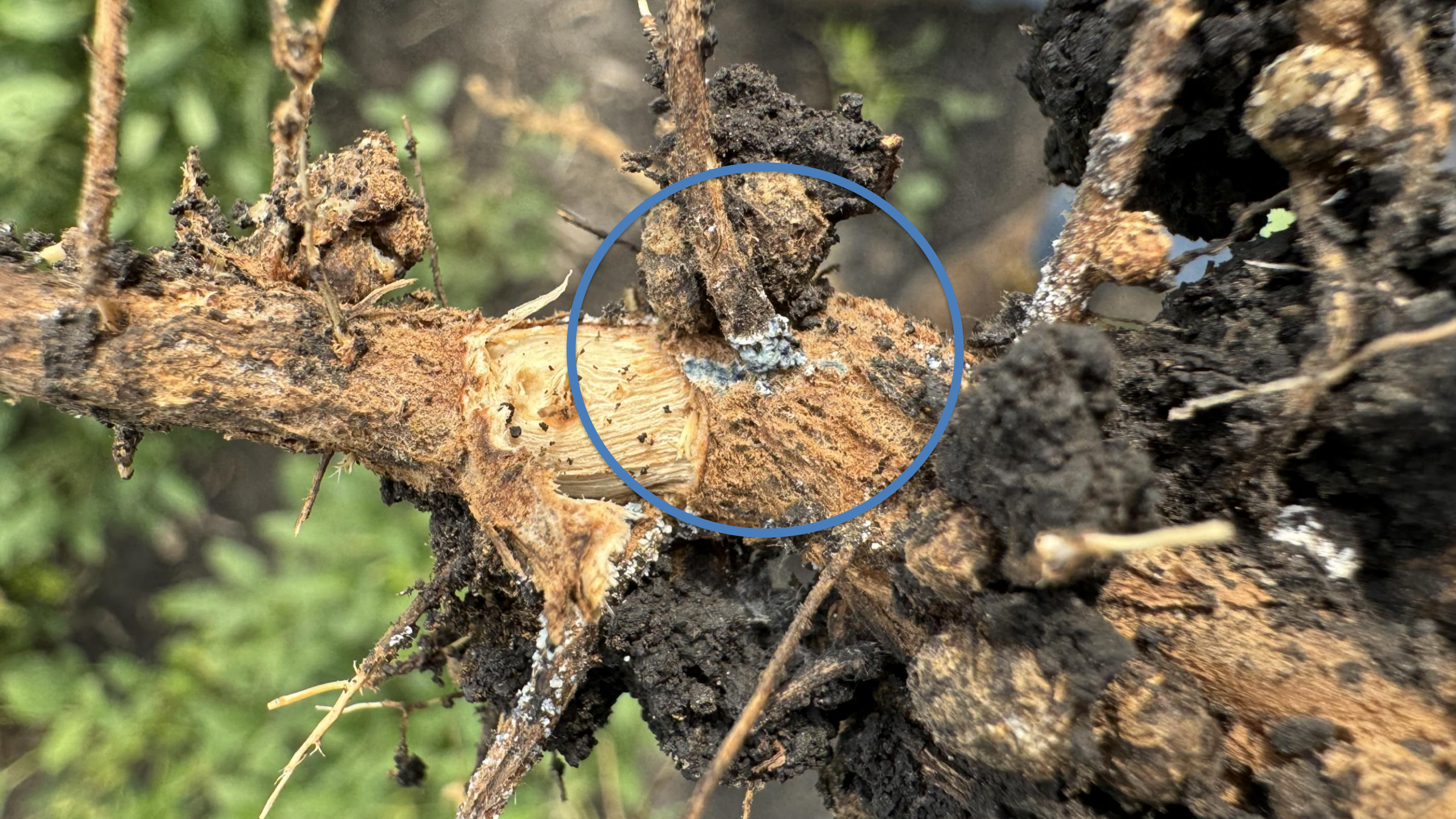


Photo: Sam Markell

Healthy Pith and Bruised Cortex

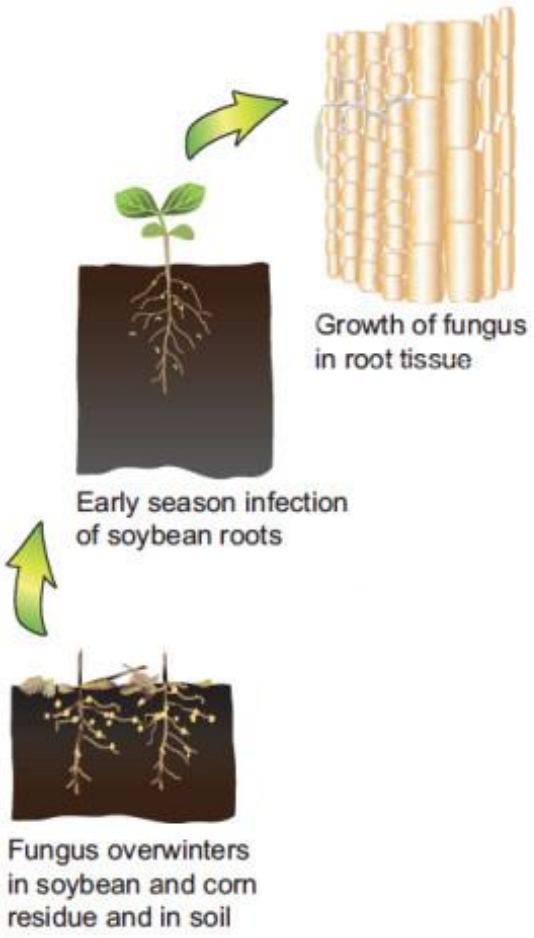
Brown Stem Rot

SDS Disease Cycle

Fungus overwinters in soybean and corn residue and in soil

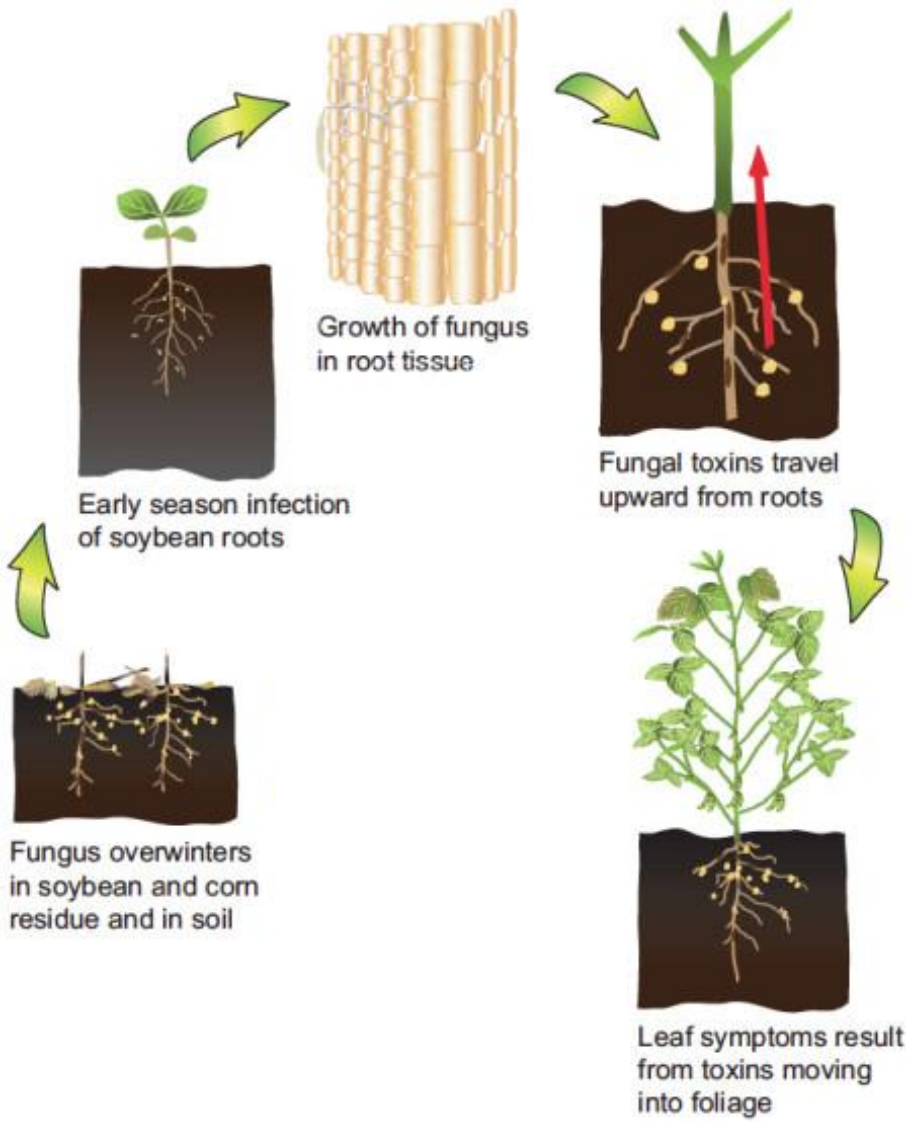
- **SDS pathogen is soilborne and can grow on corn residue**

SDS Disease Cycle



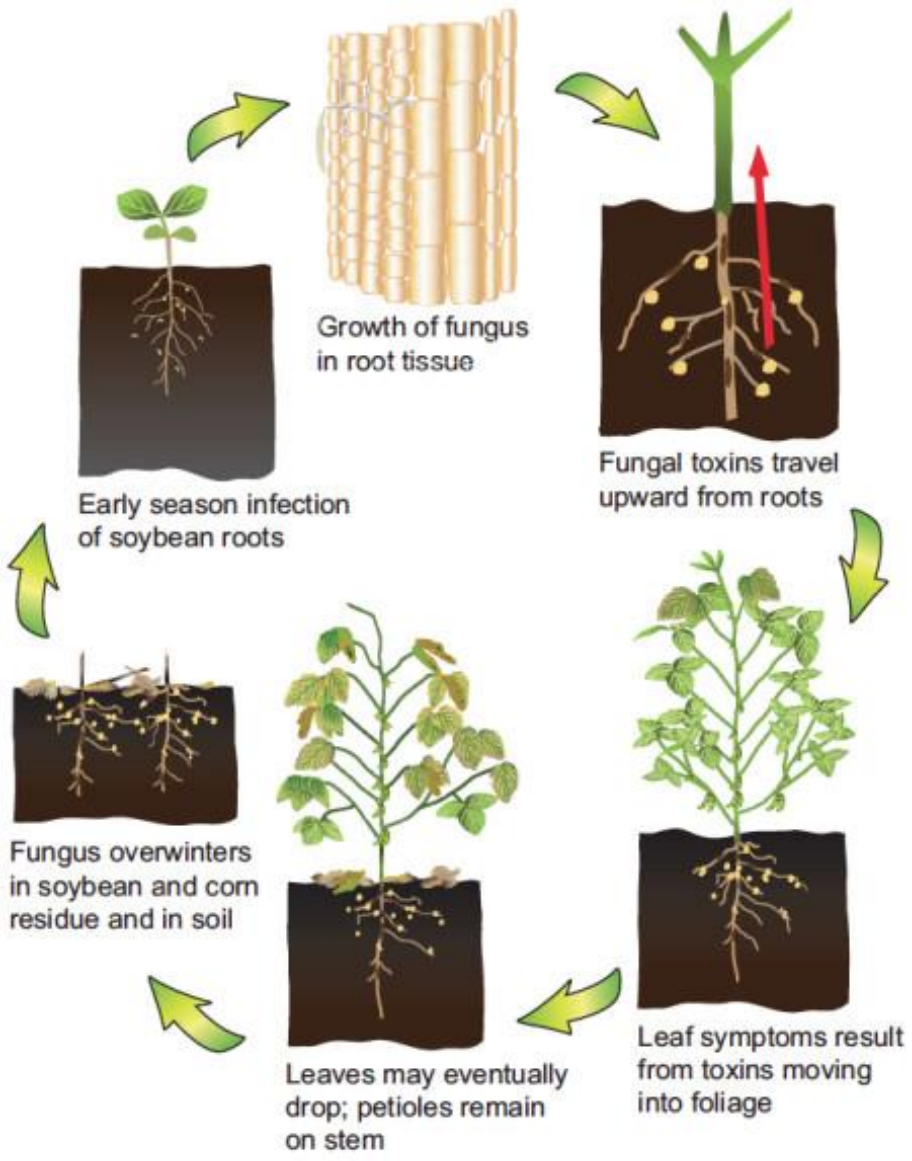
- **SDS pathogen is soilborne and can grow on corn residue**
- **Early season infection in root tissue**

SDS Disease Cycle

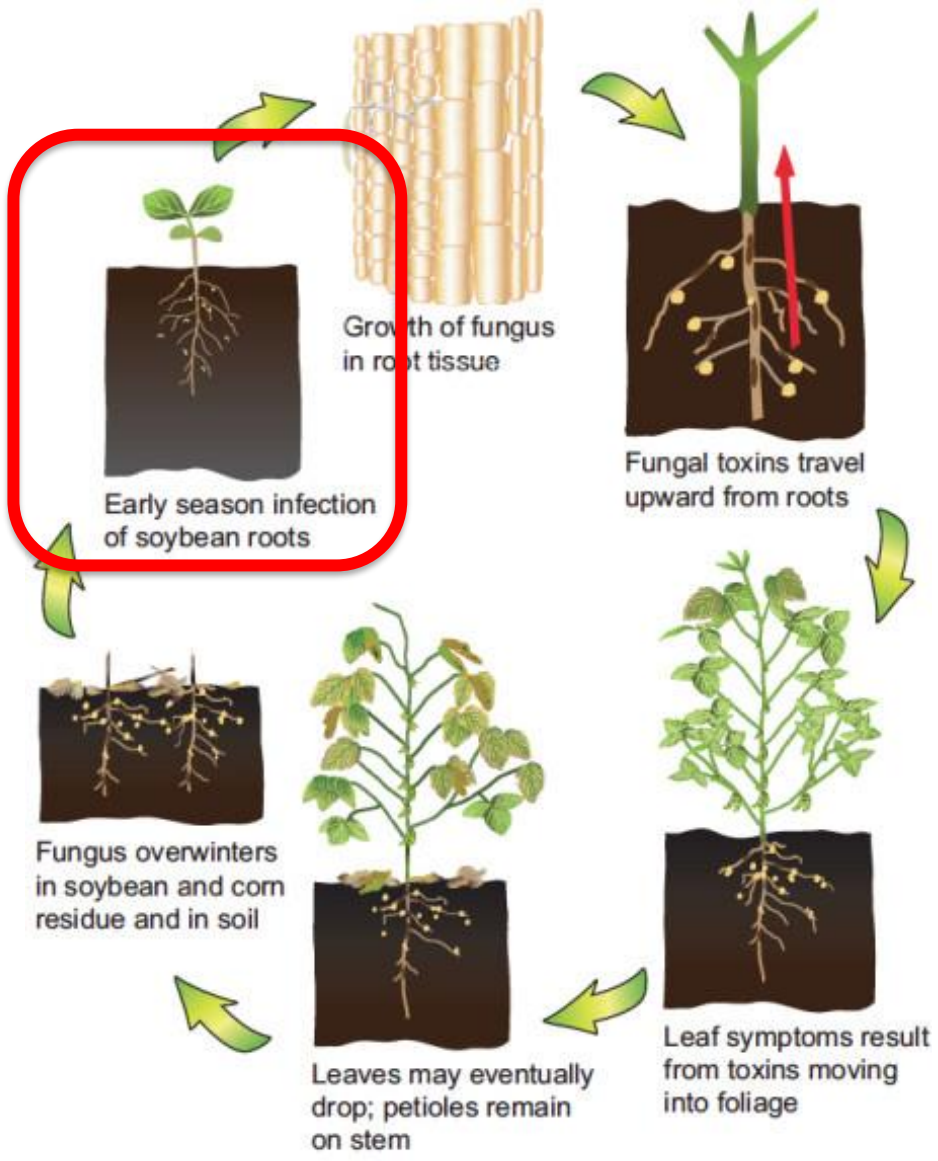


- **SDS pathogen is soilborne and can grow on corn residue**
- **Early season infection in root tissue**
- **Toxins are produced in the roots and move upward to leaves to cause interveinal chlorosis**

SDS Disease Cycle



- SDS pathogen is soilborne and can grow on corn residue
- Early season infection in root tissue
- Toxins are produced in the roots and move upward to leaves to cause interveinal chlorosis
- Susceptible varieties will drop leaves



SDS Disease Management

- **Genetic Resistance**
  - Limited selection for 00-1 MGs
  - Major breeding focus
- **Protecting against early-season infection**
  - Seeds treatments

Product evaluations

- Trials in Illinois, Indiana, Iowa, Michigan, Wisconsin and Ontario, Canada
- Each trial had susceptible and resistant varieties; some fields inoculated and/or irrigated
- Different seed treatments evaluated for foliar symptoms, root rot and yield

CROP PROTECTION NETWORK
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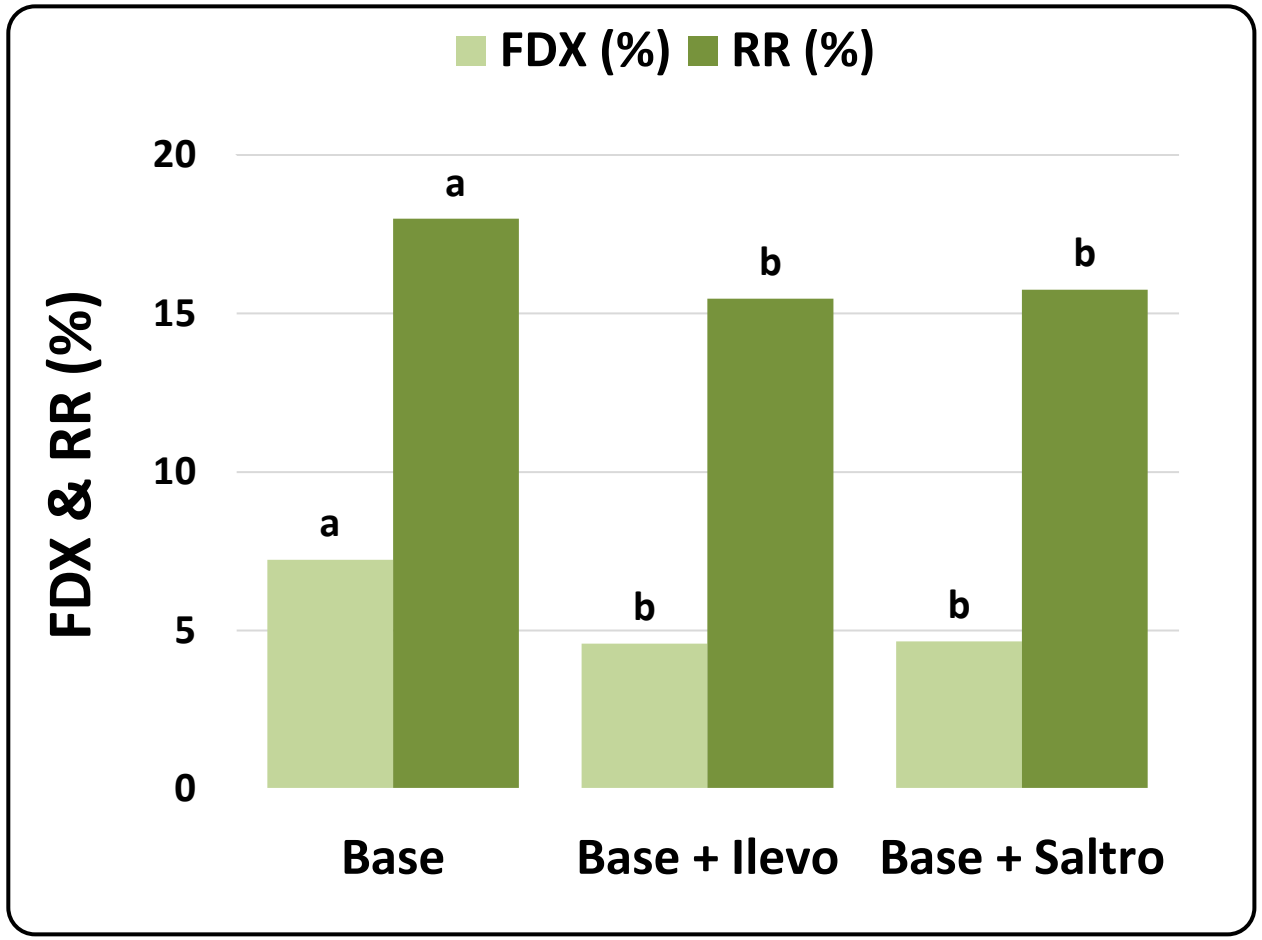
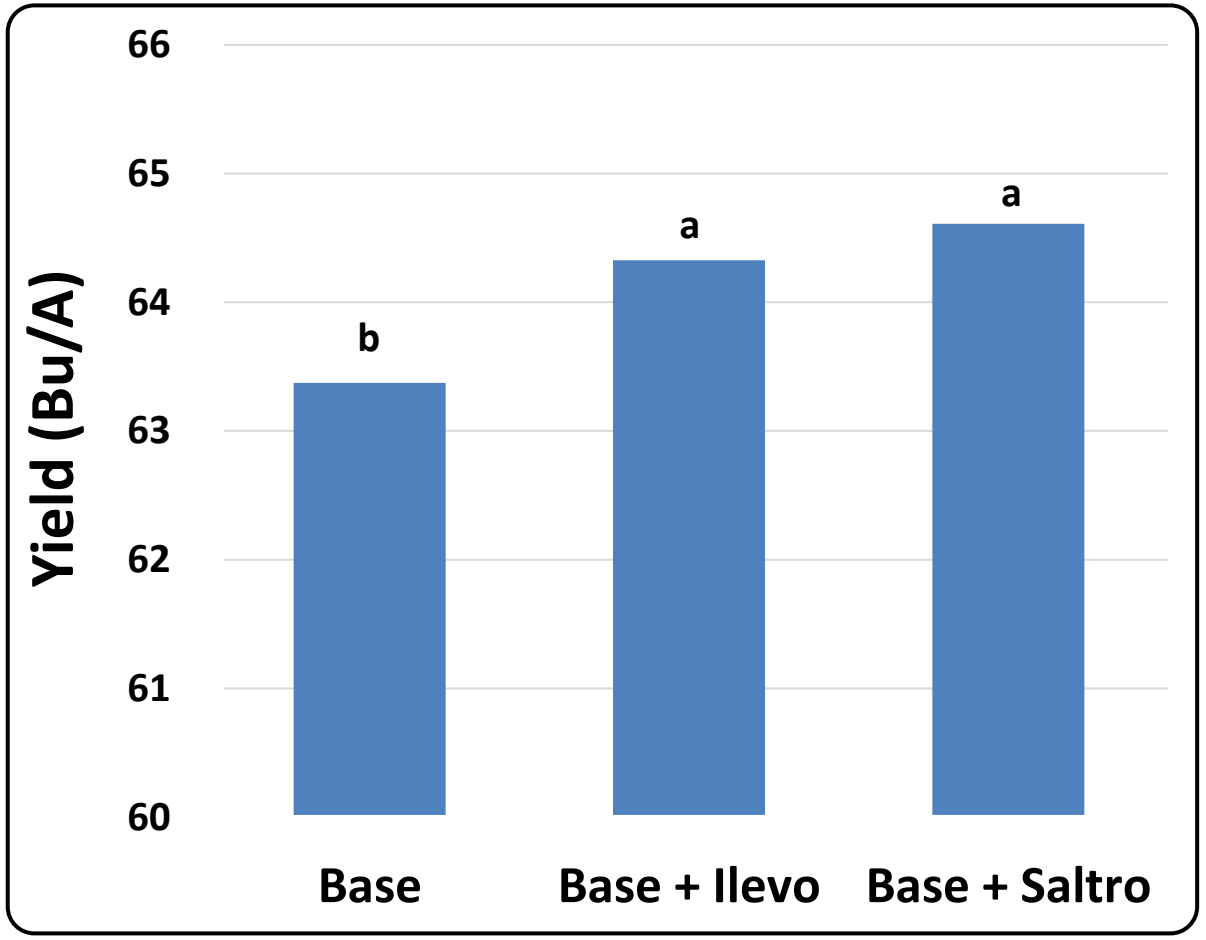
Seed Treatment – All Locations





Yield increased 1.4% (ILEVO) and 1.9% (Saltro)
FDX was reduced 36.7% (ILEVO) and 35.6% (Saltro)
RR was reduced 14% (ILEVO) and 12.4% (Saltro)

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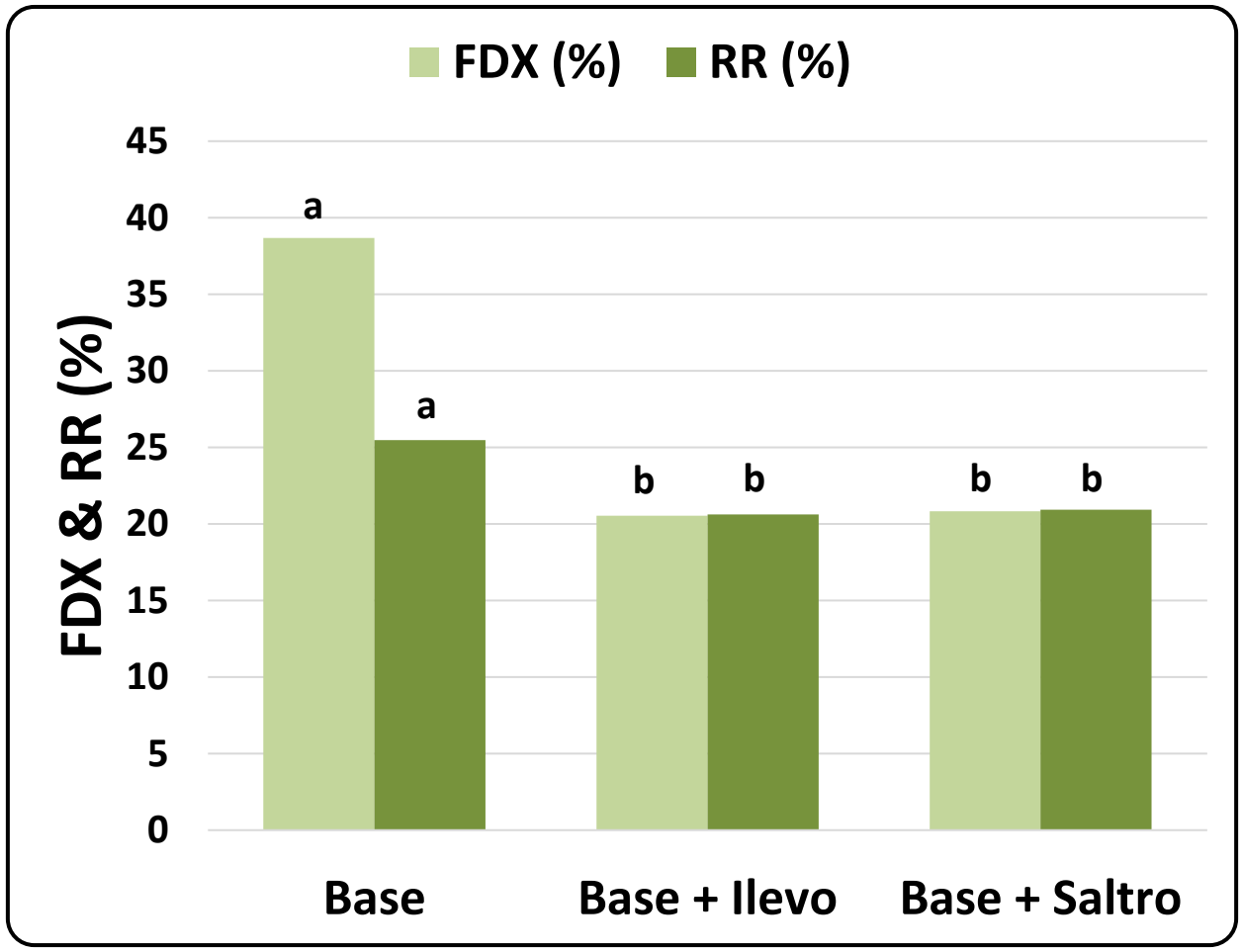
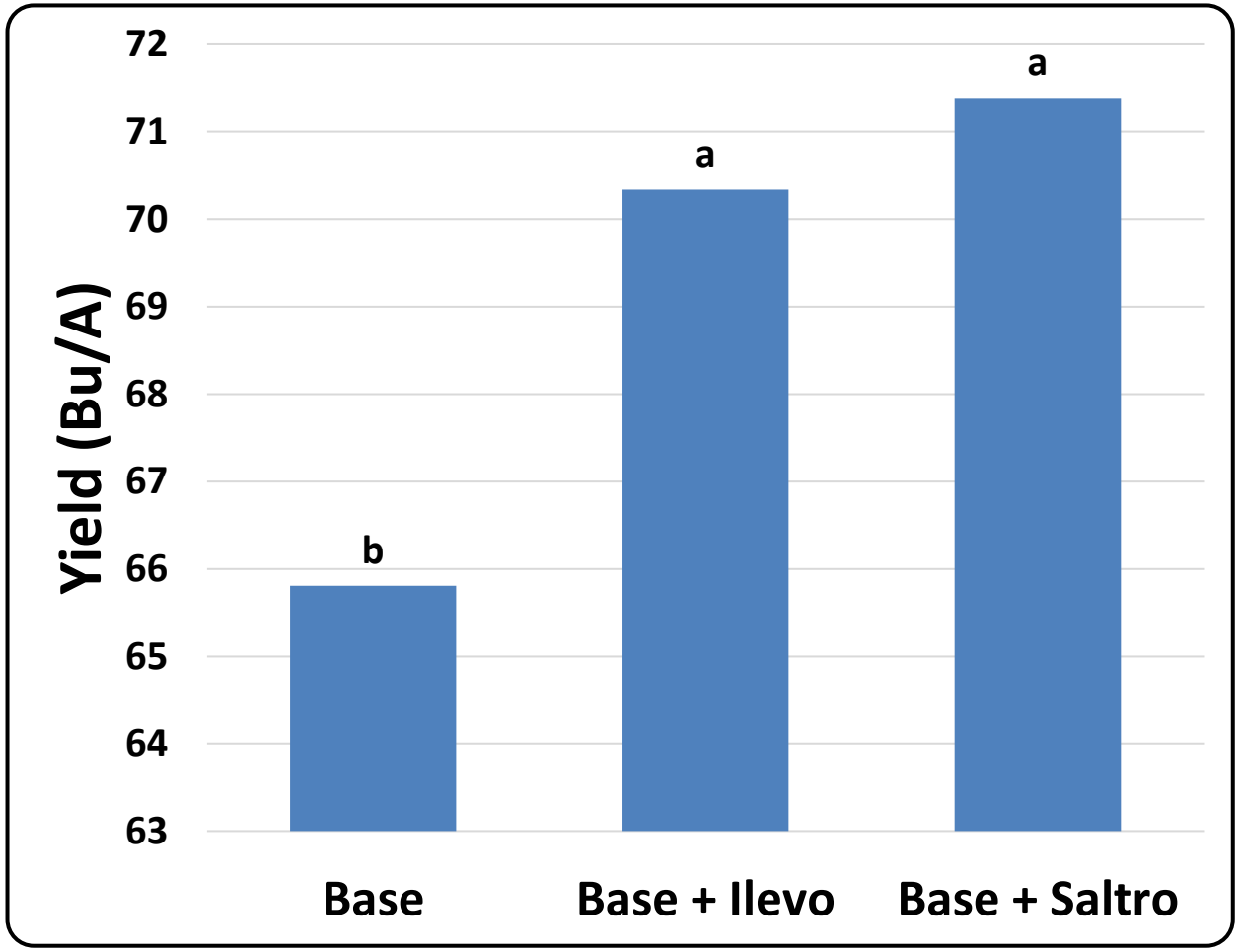
Locations with > 10 % FDX (16 locations)





Yield increased 6.9% (Ilevo) and 8.5% (Saltro)
FDX was reduced 46.9% (Ilevo) and 46.2% (Saltro)
RR was reduced 19.1% (Ilevo) and 17.8% (Saltro)

CROP PROTECTION NETWORK
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White Mold

White Mold Sclerotia

- **Survival:** pathogen hibernation
- **Longevity:** 5-10 years
- **Larger sclerotia produce a greater number of apothecia**

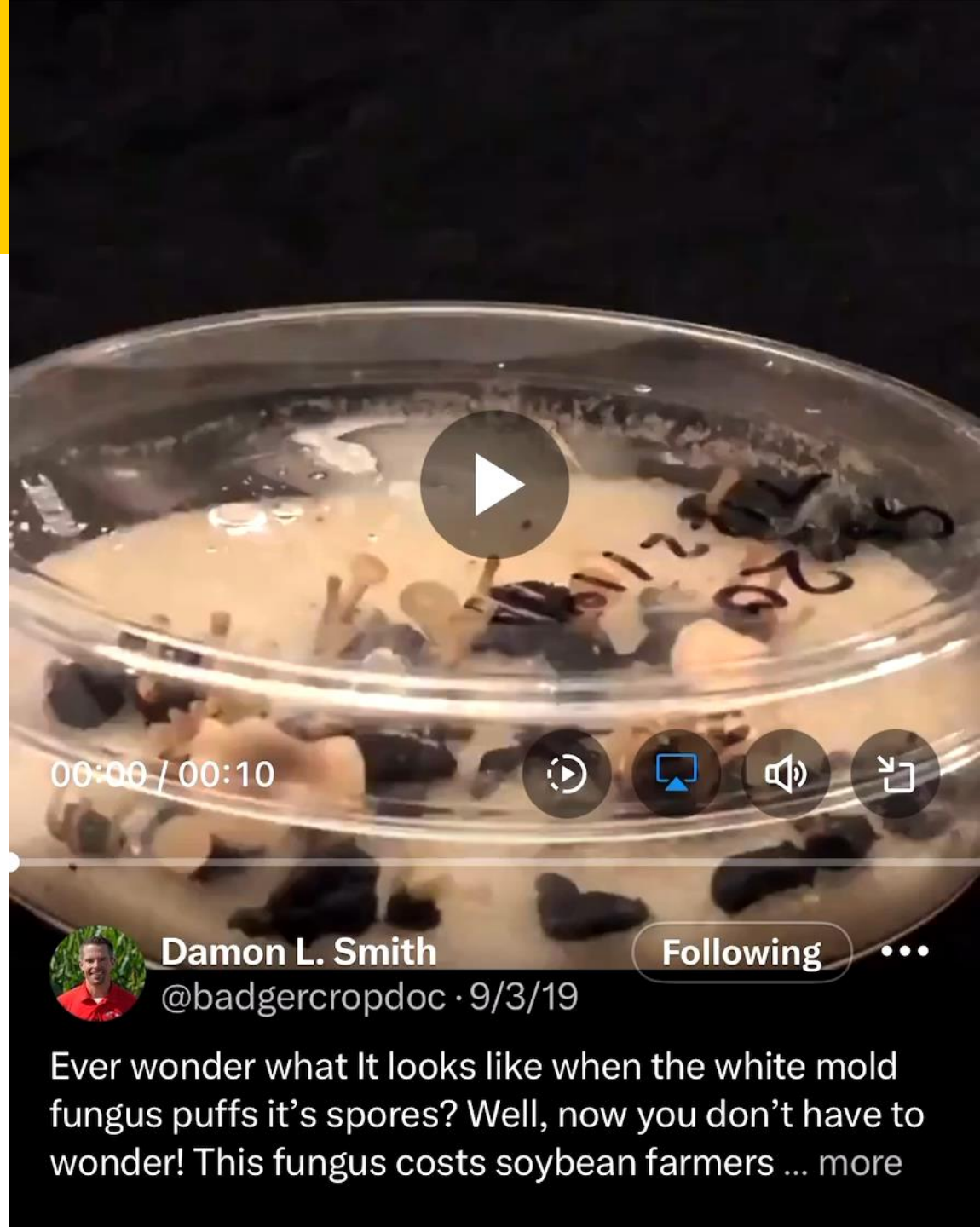
Apothecia Production

- **Environmental Conditions**
  - **Cool Temps:** 54-70 ºF
  - **High Moisture:** moist soil surface 1-2 weeks
  - **Shade:** specific light conditions (canopy closure)

Spore Release

- **Each apothecia can contain over 1 million spores**
- **Slight decrease in moisture tension releases spores**

Image: Sarah Pethybridge



Infection

- **Ascospores need dead flower petals to grow**
- **Infection usually occurs at nodes**

R1

Reproductive Stage 1

One open flower at any node on the main stem

- Flowering begins on the 3rd to 6th nodes of the main stem
- Flowering on the branches begins after those on the main stem
- Flowers can be purple or white
- If a field has a history of white mold, this is the earliest growth stage to apply an effective fungicide

R2

Reproductive Stage 2

Open flower at one of the two uppermost nodes on the main stem with a fully developed leaf

- Flowering will continue for 3-5 weeks
- 20-80% of flowers produced will be aborted
- 50% defoliation can reduce yield by 6%
- 100% defoliation can reduce yield between 23-40%

Image: Cool Bean Team

Infection

- **Ascospores need dead flower petals to grow**
- **Infection usually occurs at nodes**

R3

Reproductive Stage 3

Pod is 3/16 inch long at one of the four uppermost nodes on the main stem with a fully developed leaf

- A plant can have all of the following: developing pods, withering flowers, new open flowers and flower buds
- Potassium uptake rates peak shortly after R2, ranging between 3.5-5.2 lb K_2O /acre/day
- Last growth stage to treat for white mold

R4

Reproductive Stage 4

Pod is 3/4 inch long at one of the four uppermost nodes on the main stem with a fully developed leaf

- At this stage, rapid pod growth is occurring and seeds are starting to develop
- Flowering continues on the upper branch nodes
- Peak nitrogen uptake rates occur between R4-R5, ranging between 3.0-4.0 lb N /acre/day

Image: Cool Bean Team

Symptom Development

- **Signs and Symptoms appear 2-3 weeks after infection**
  - **White fluffy fungal growth**
  - **Bleaching of stem tissue**
  - **Development of new sclerotia**
  - **Severe infections can cause premature wilting**

Symptom Development

- **Signs and Symptoms appear 2-3 weeks after infection**
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  - **Development of new sclerotia**
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New Sclerotia Development

How Do We Manage White Mold?

1. Crop Rotation
2. Cultural Practices
   - Wide Rows
   - Low Planting Pops
3. Chemical Control
   - Good products available
   - Apply at R2 or Full Canopy Closure
4. Predictive Models
5. Biological Control
6. Tillage
7. Genetic Resistance

Commercial Varieties Are Susceptible

Photo: Damon Smith

Genetic Resistance

- **Limited highly resistant varieties commercially**
- **Lower maturity groups may result in lower white mold**
  - **Less time with flowers present**
- **Highly resistant varieties may reduce the need for fungicide applications**

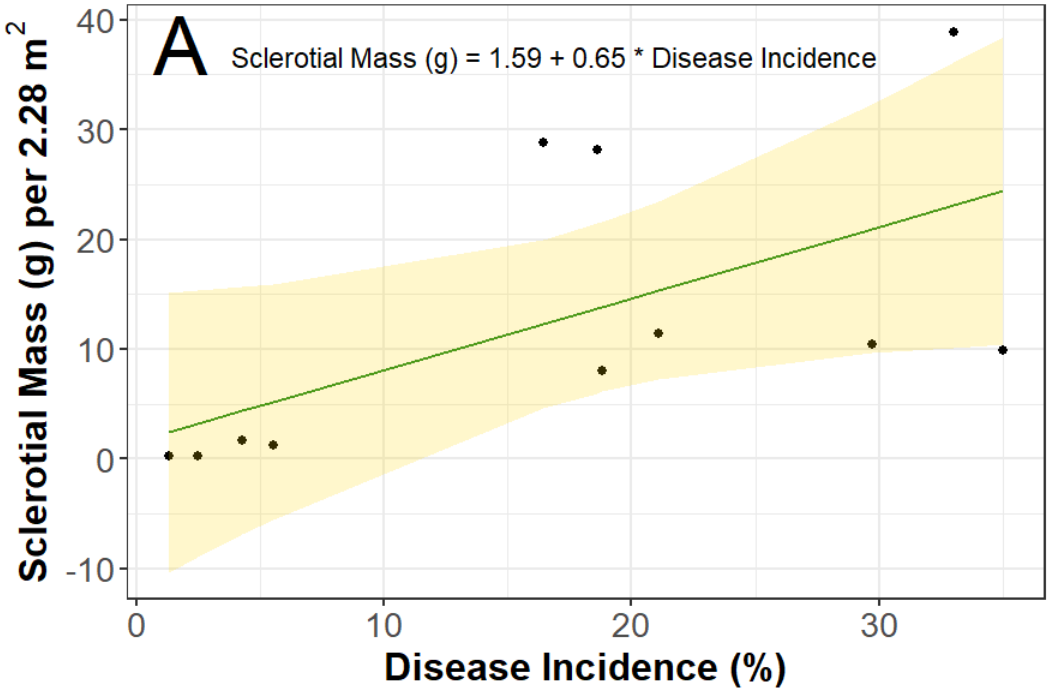
Sclerotial Production is Influenced by Variety Resistance

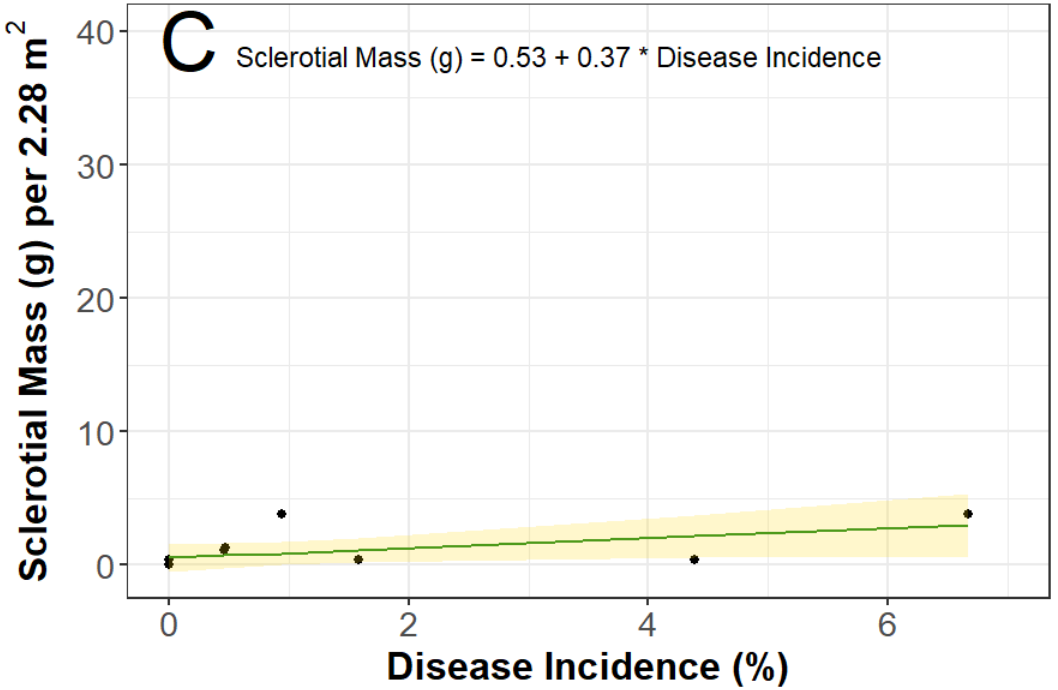
	Location	91-44 (Susceptible)	91-145 (Resistant)
Disease Severity Index (%)	Arlington, WI	23.3 a	2.3 b
	Hancock, WI	2.2 a	0.1 b
	Oakes, ND	22.3 a	0.5 b
Sclerotial Production (lb ac^{-1})	Arlington, WI	38.7 a	6.4 b
	Hancock, WI	3.7 a	0.0 b
	Oakes, ND	124.4 a	5.9 b

- **91-44** (susceptible) **produced higher quantity of sclerotia**
- **91-145** (resistant) **produced lower quantity of sclerotia**
- **Resistant genotypes reduce the production of new inoculum**
- **Susceptible produced a mean 8.7 lb/ac of new sclerotia at Oakes, ND in 2023**

Sclerotial Production Under Field Conditions

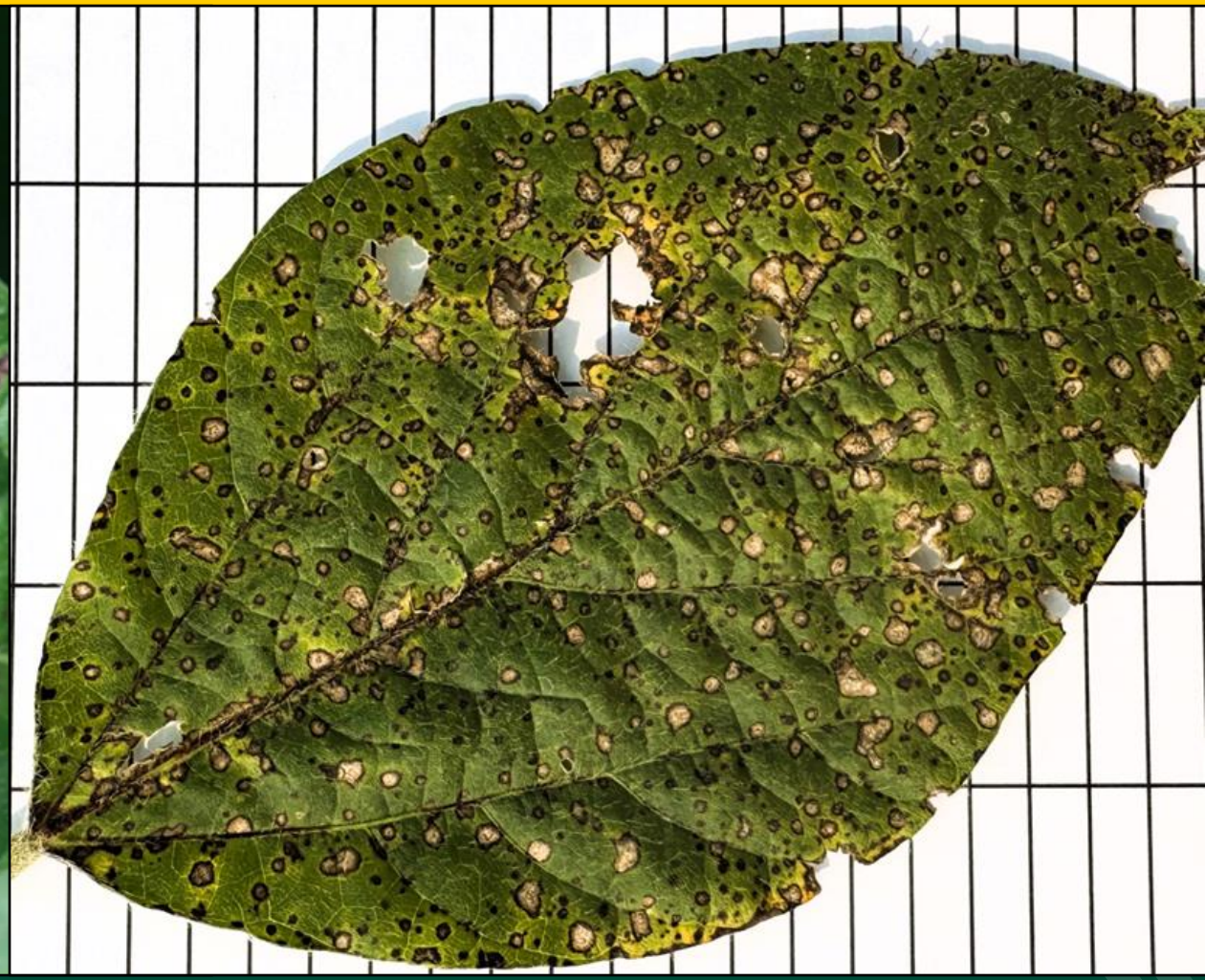
- **Susceptible Variety:** 25.4 lb/ac of new sclerotia production for every 10% increase in disease incidence
- **Resistant Variety:** 14.4 lb/ac of new sclerotia production for every 10% increase in disease incidence



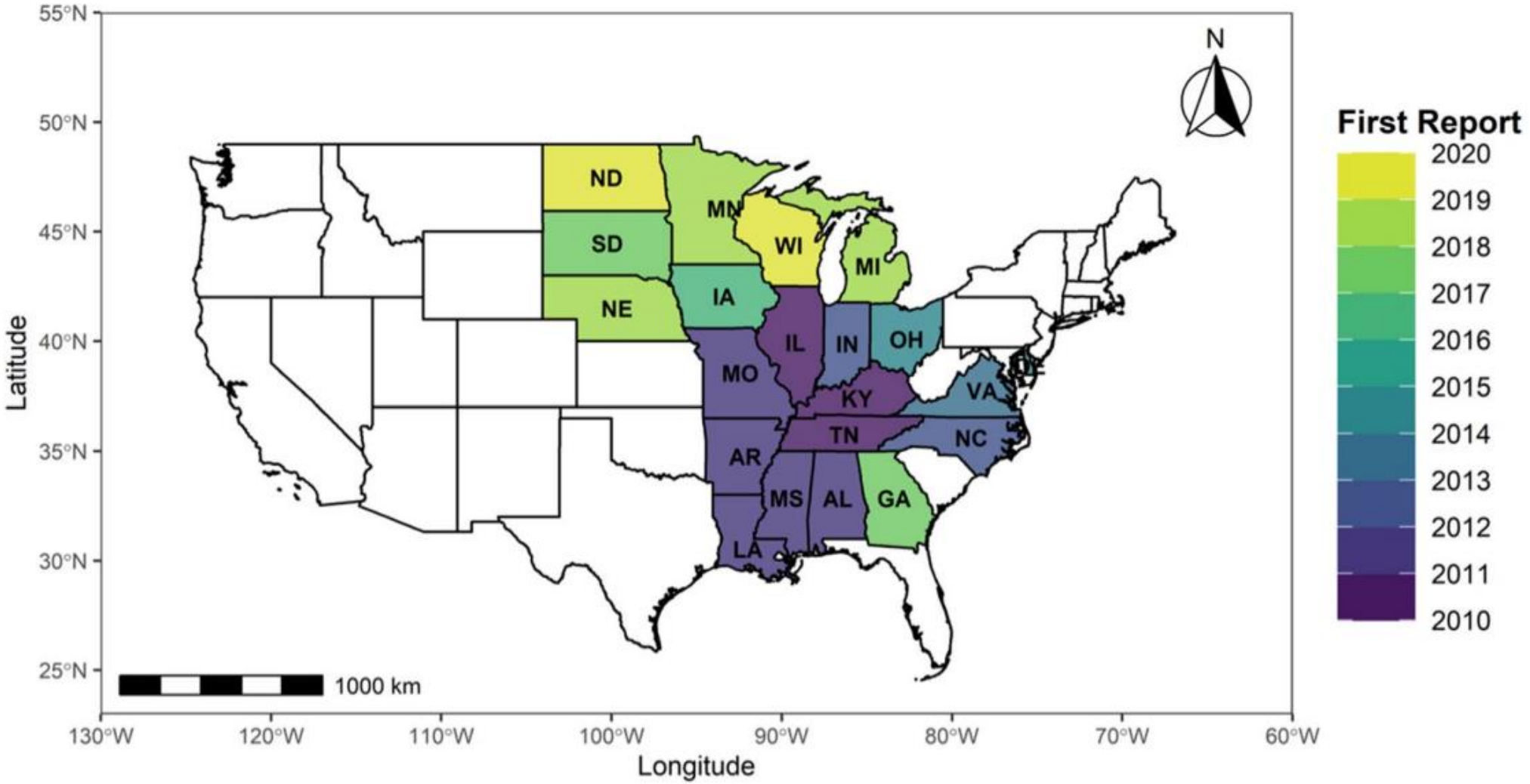


Frogeye Leaf Spot

Image: Crop Protection Network



Frogeye's Northward March



Barro et al 2023, Tropical Plant Pathology

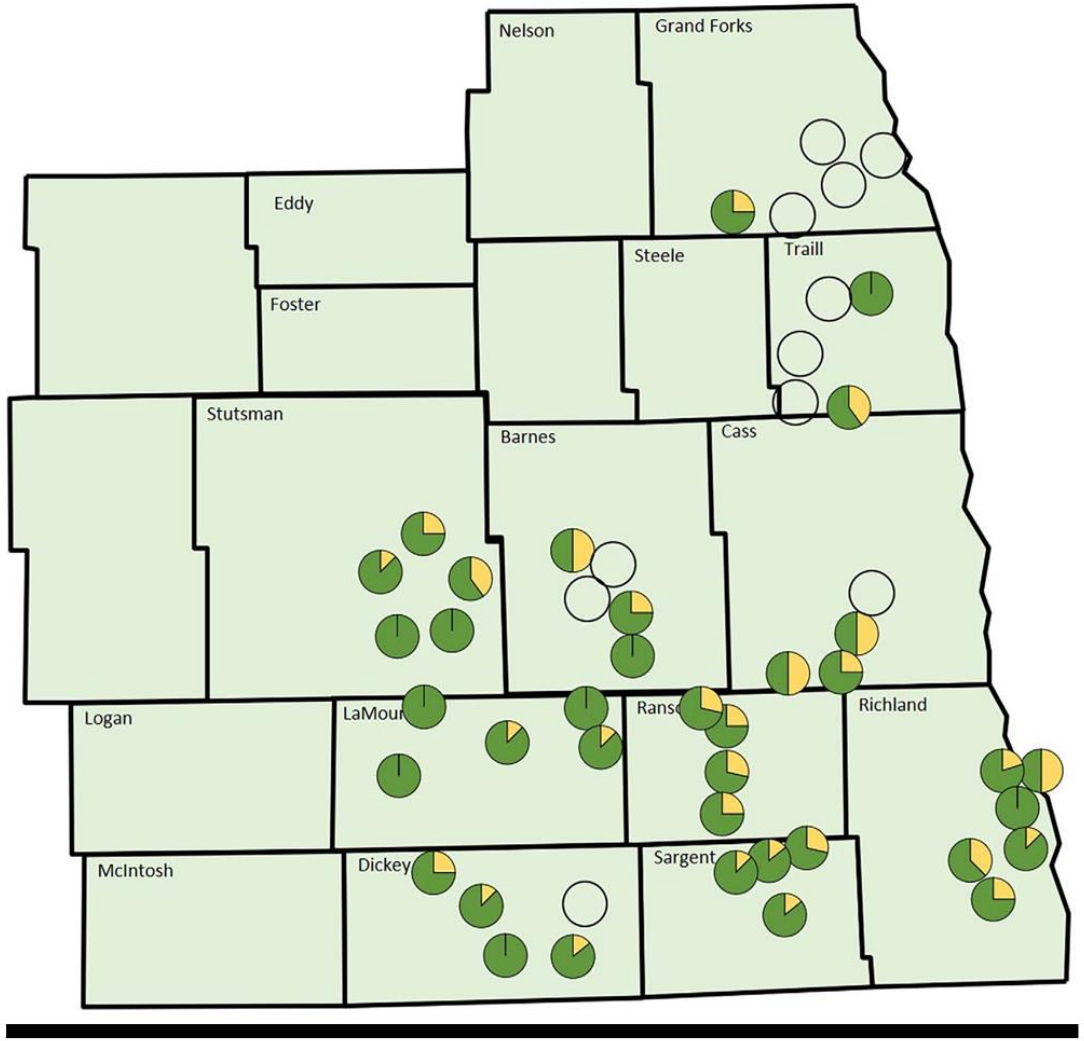


FIGURE 1

Distribution of frogeye leaf spot among surveyed counties in North Dakota. Circles indicate approximate locations of fields surveyed and sampled, with color of closed circles proportionate to QoI-sensitive (green) and -resistant (yellow) *Cercospora sojina* isolates identified. Open circles indicate frogeye leaf spot was not observed.

Neves et al. 2022, Plant Health Progress

23% of North Dakota isolates are resistant to QoI fungicides

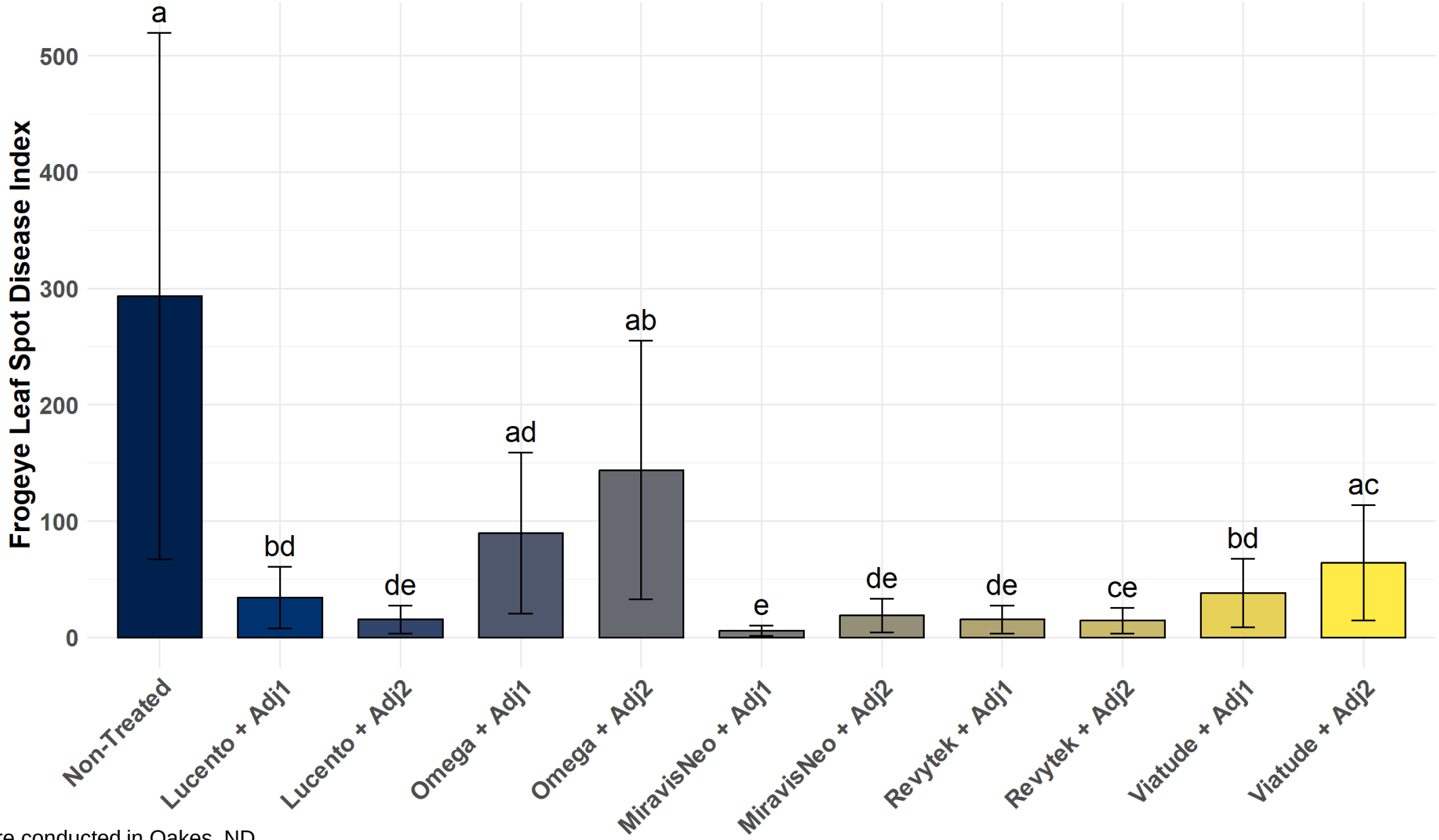
Management in southern states influences our control programs

Image: Anna McConnell

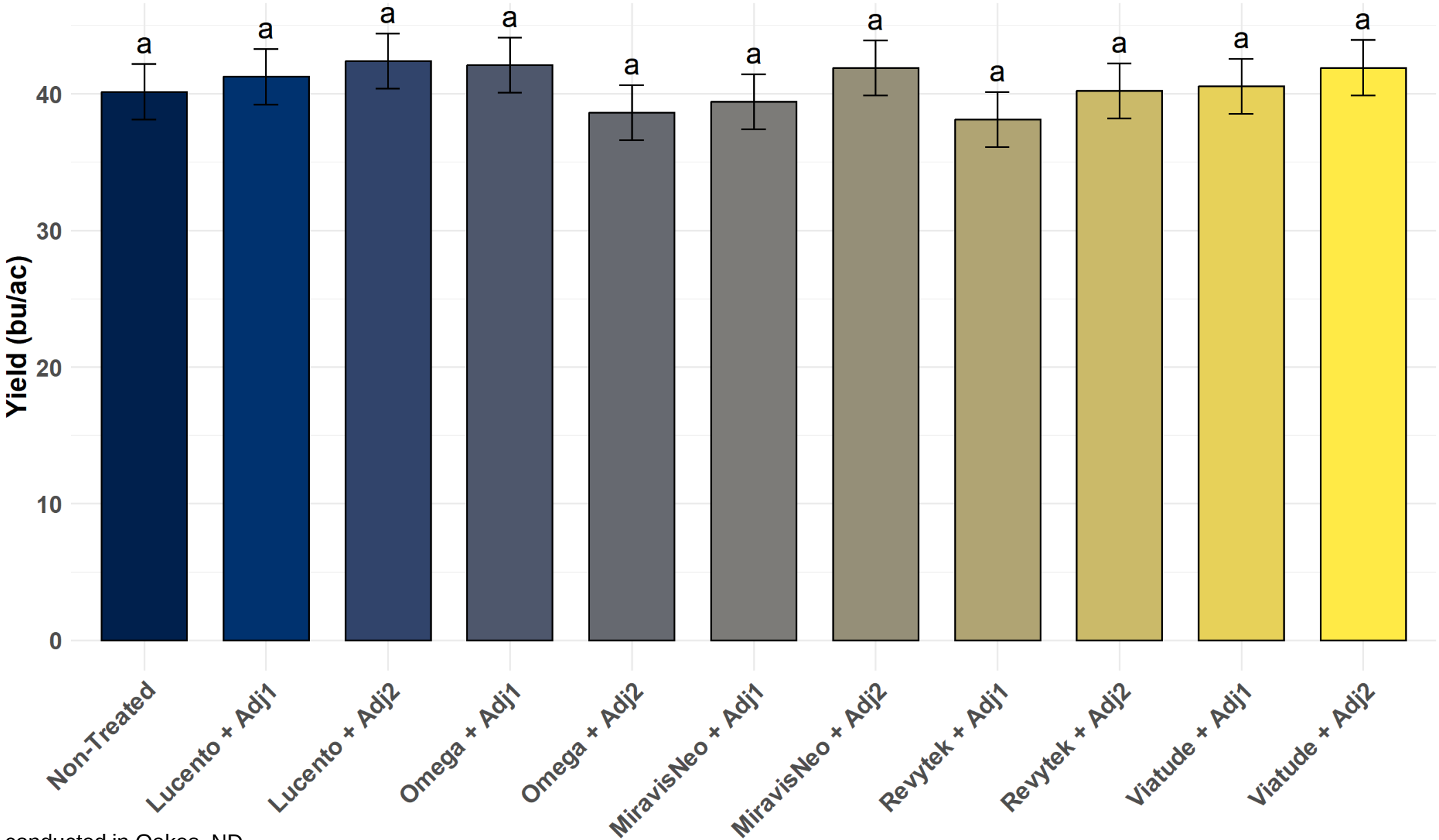
Frogeye Leaf Spot Foliar Trials

Program	Active Ingredient	Rate
Non-Treated	-	-
Omega	Fluazinam (FRAC 29)	12 floz/ac
Lucento	Bixafen and Flutriafol (FRAC 7 + 3)	5 floz/ac
Miravis Neo	Pydiflumetofen, Azoxystrobin, and Propiconazole (FRAC 3, 7, 11)	13.7 floz/ac
Revytek	Mefentrifluconazole, Pyraclostrobin, and Fluxapyroxad (FRAC 3 + 7 + 11)	10 floz/ac
Viatude	Picoxystrobin and Prothiconazole (FRAC 3 + 11)	12 floz/ac

- **Conducted at Oakes, ND under irrigation**
- **Paired with two different NIS adjuvants**
- **All applied at R3 growth stage**



Trials were conducted in Oakes, ND
Seeding rate: 140,000 seeds/ac
$P < 0.01$
$\alpha = 0.05$



Trials were conducted in Oakes, ND
Seeding rate: 140,000 seeds/ac
P = 0.35
α = 0.05

Take Home Points

- **Seedling Diseases**
  - Proper seed treatments protect yield losses if stacked appropriately
- **Soybean Cyst Nematode**
  - Continue sampling!
  - Rotate resistant varieties
- **Sudden Death Syndrome**
  - Stay vigilant and report any suspected cases to NDSU Ext.
- **White Mold**
  - Combining multiple management strategies is effective in the long-term
  - Resistant varieties can reduce disease pressure in future years
- **Frogeye Leaf Spot**
  - Pay attention for this developing disease
  - No need to manage yet

Thank you!

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USDA NIFA
OHIO SOYBEAN COUNCIL
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