

# Update on the determination of rust (*Puccinia helianthi*) prevalence and virulence in the Northern Great Plains

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Zachary Ittel, Brandt Berghuis, Jessica Scherer, Kaylie Schlecht, Robert Harveson, Febina Mathew, Brent Hulke, Bryan Hanson, and Samuel Markell

# Take Home Message & Results

- Rust is important
- High Prevalence:
  - Prevalence = Does rust occur in a field? (Yes/Fields Surveyed)
  - 98% of fields over two years had rust

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- Virulence Progress:
  - Virulence = Can the pathogen overcome a resistance gene?
  - Over 200 bulk pathogen isolates collected
  - Will be evaluating virulence on many new resistance genes

# Objective 1

Determine the prevalence of *P. helianthi* in the Northern Great Plains.

# Prevalence: Background

- 1.315 million acres of Sunflower were planted in the USA in 2023.
- Top 5 most destructive sunflower diseases.
- Prevalence (2002-2015)
  - Range approximately 20-80%
  - Mean of about 40-50%

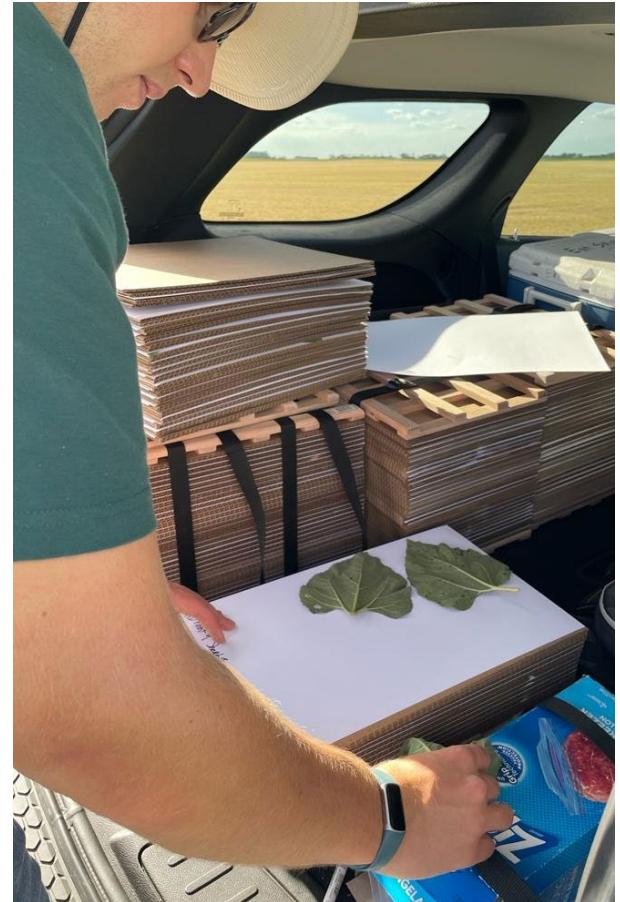


(Photo: Zachary Ittel)

# Prevalence: Materials & Methods



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STATE UNIVERSITY

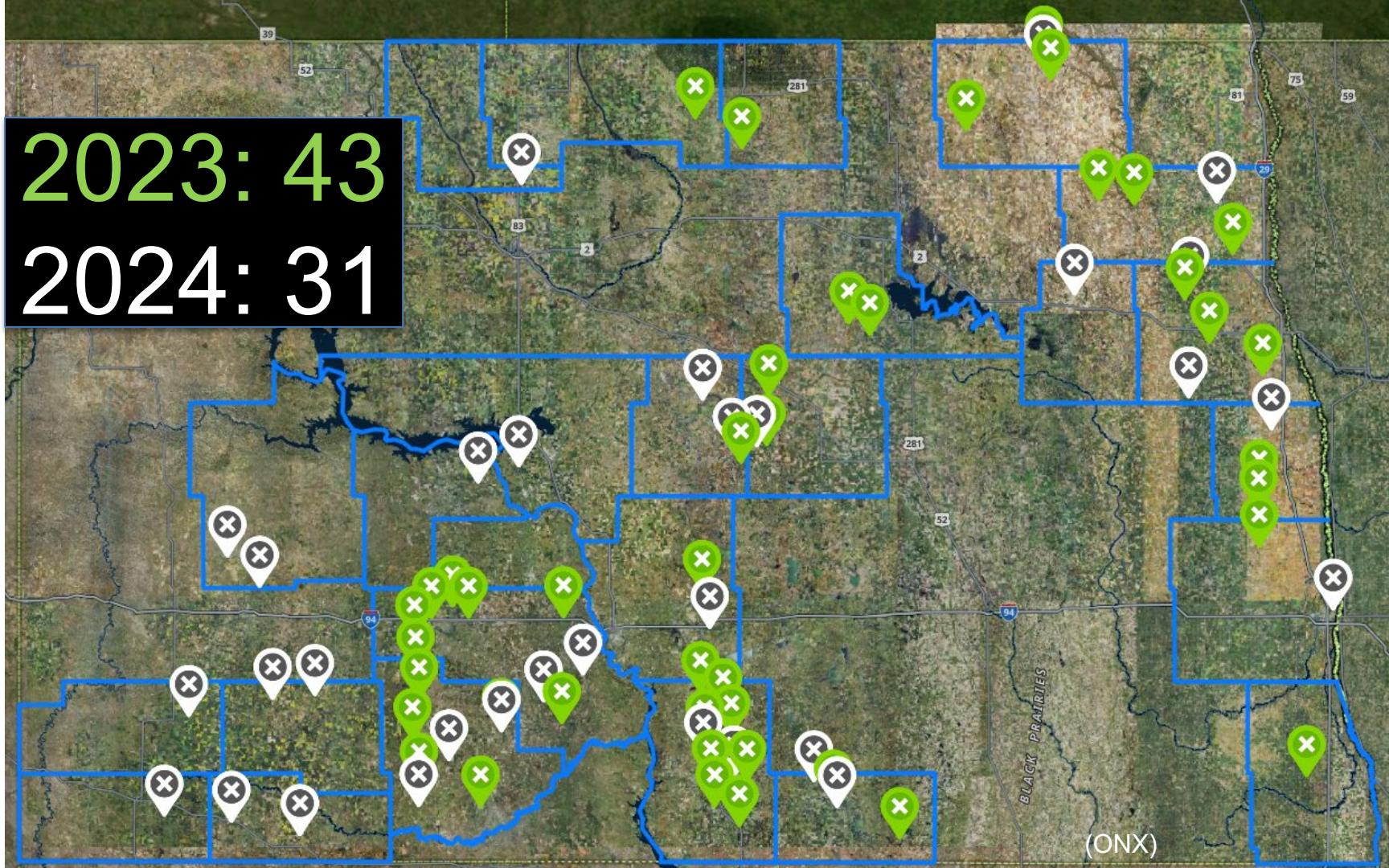


# ND Survey Map

## 2023-2024

2023: 43

2024: 31

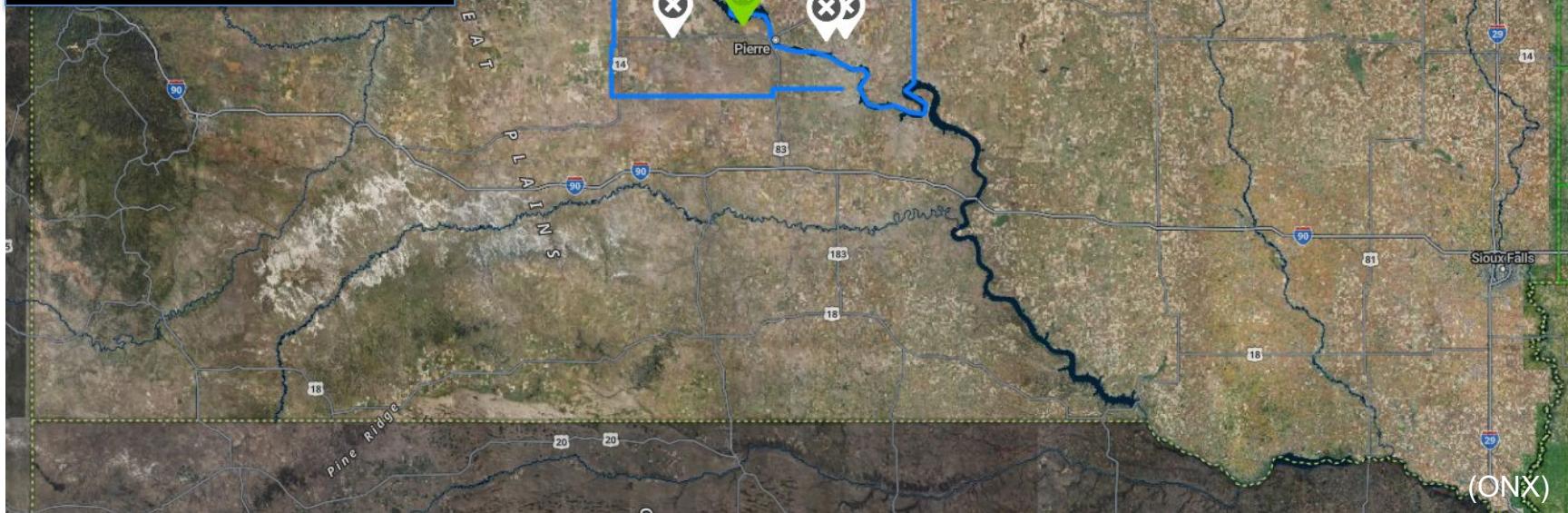


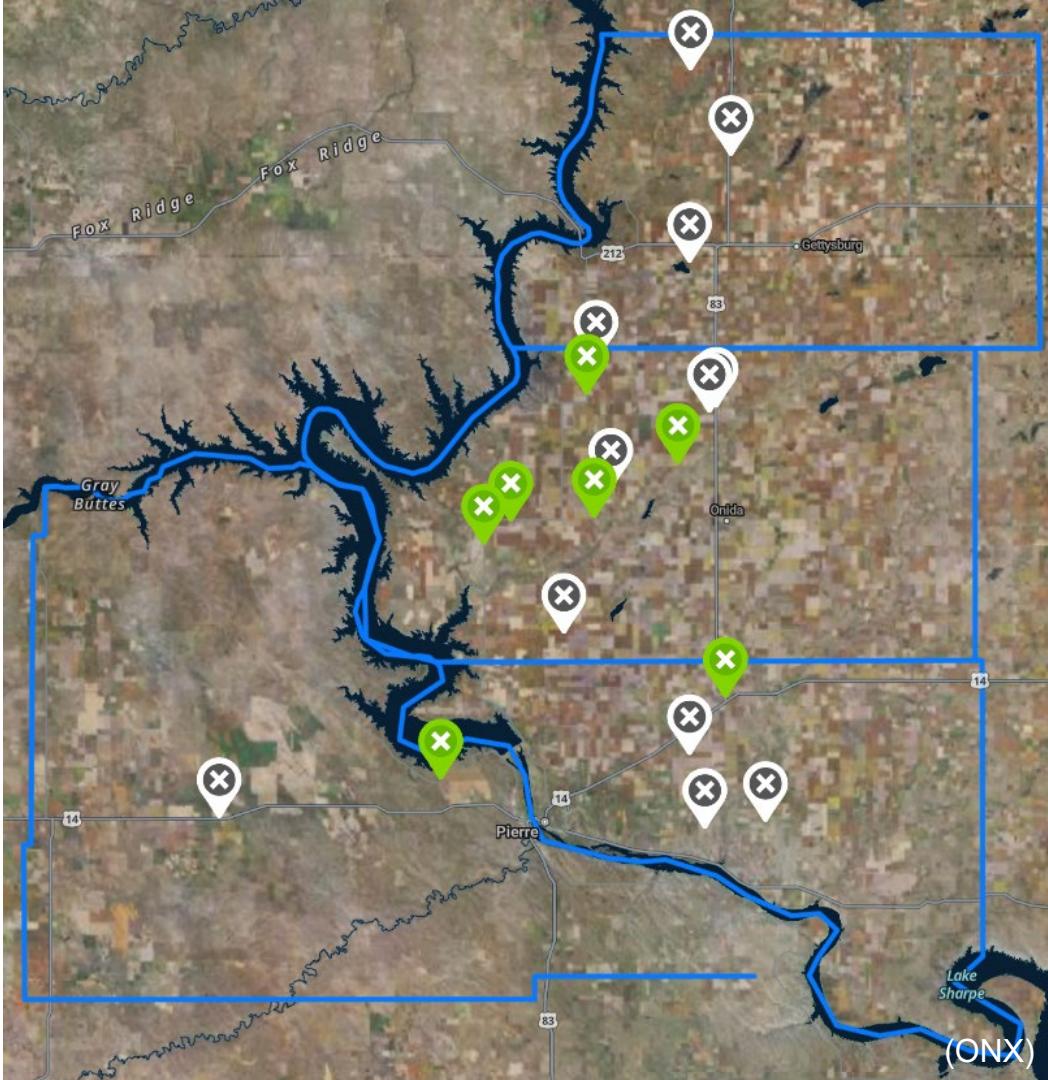
# SD Survey Map

## 2023-2024

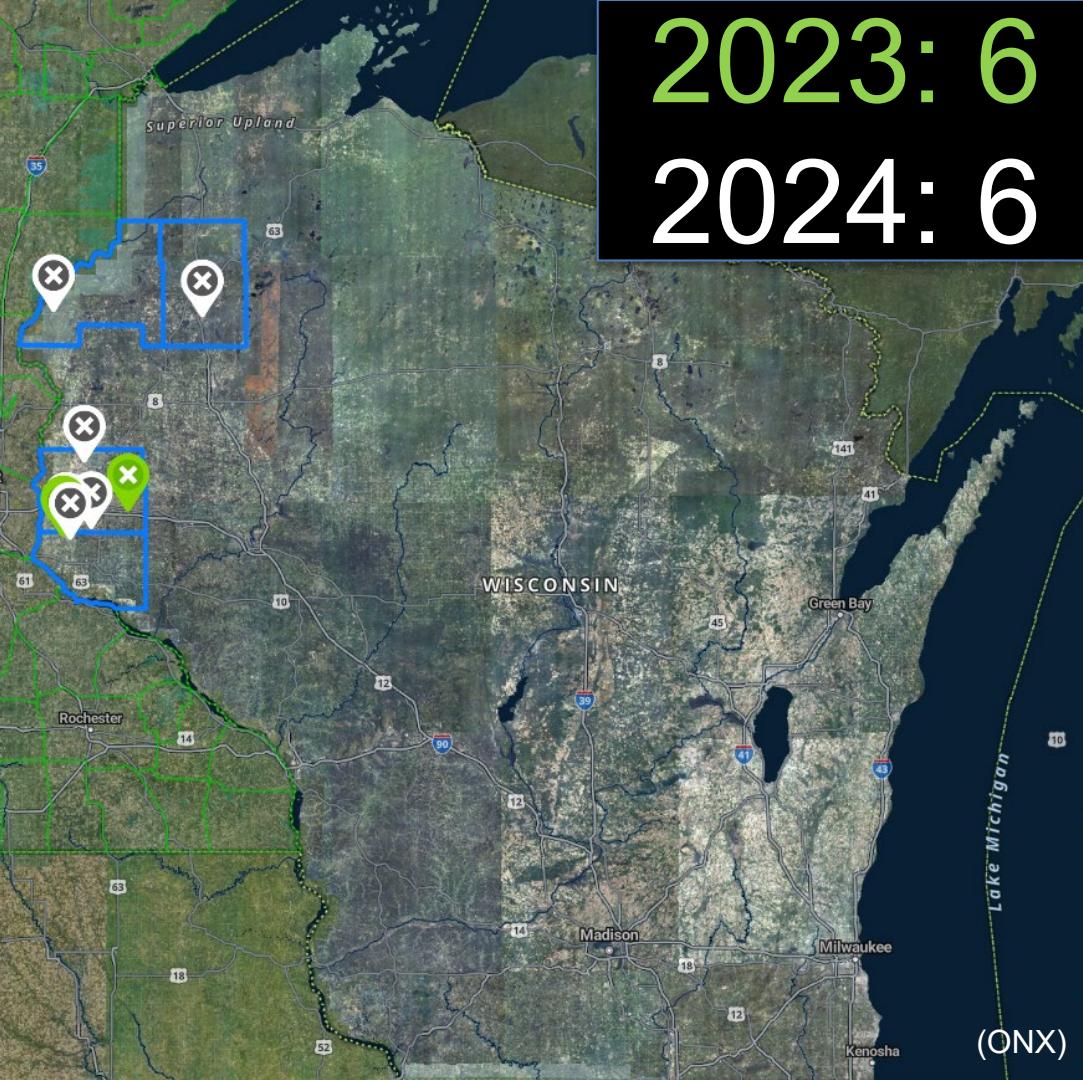
2023: 8

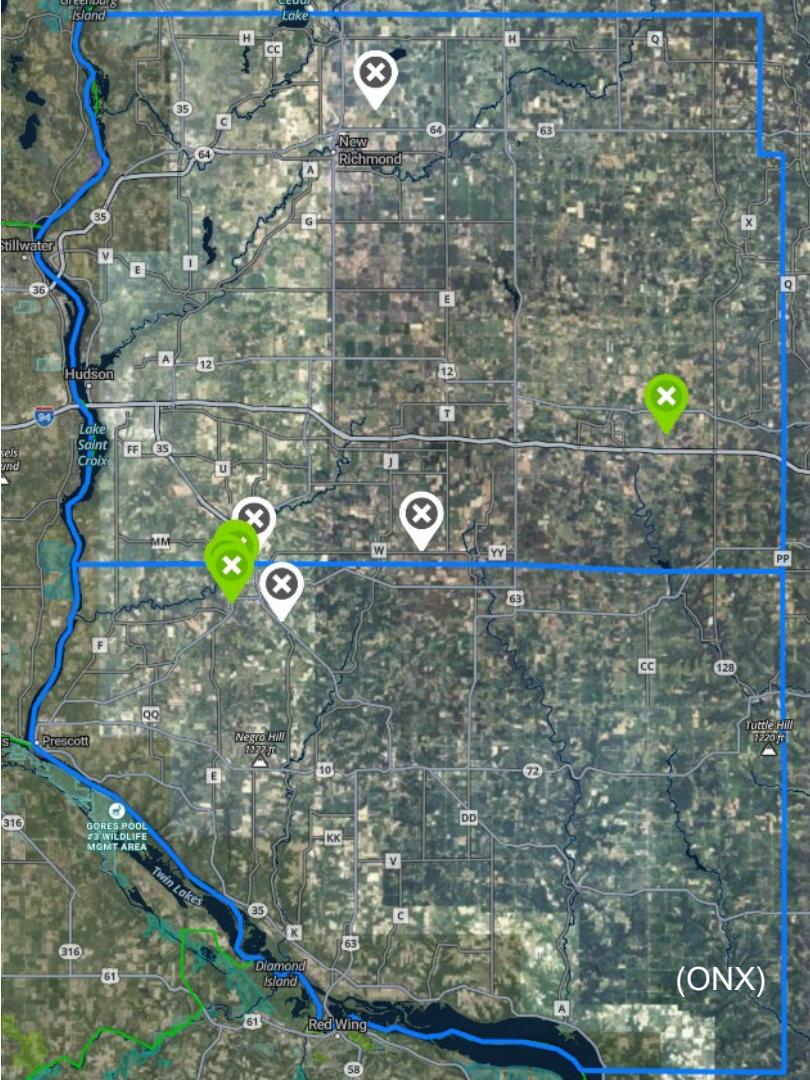
2024: 15



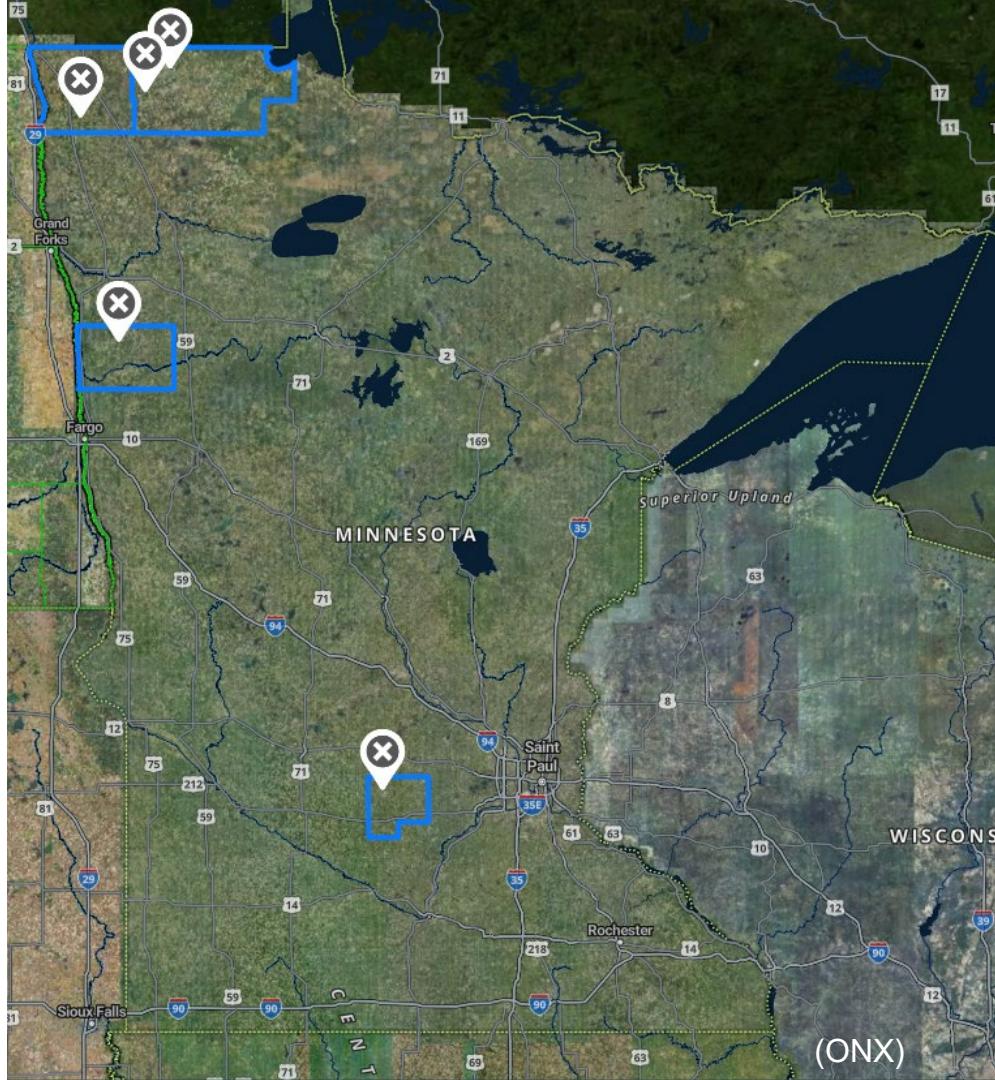


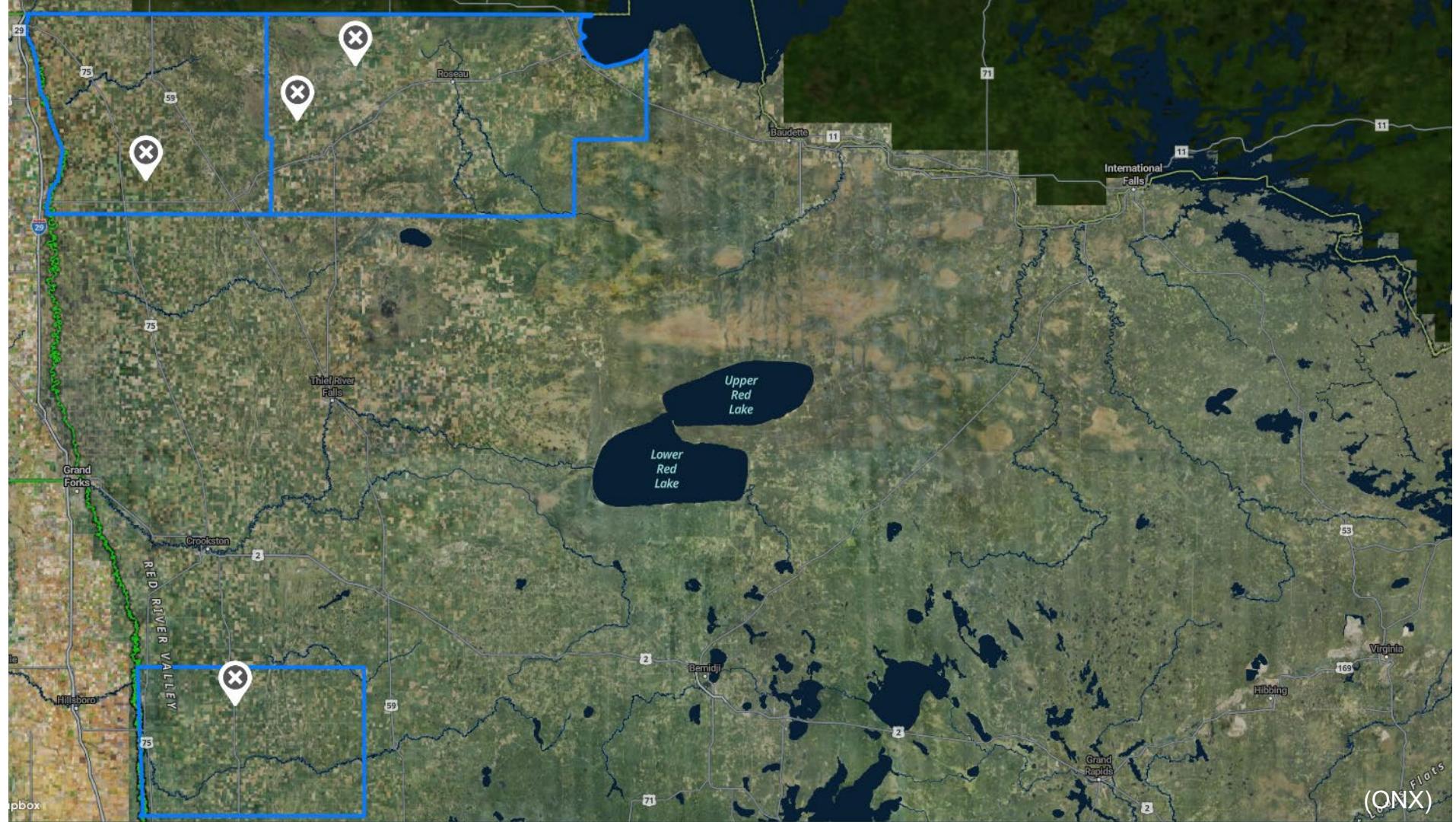
# WI Survey Map 2023-2024



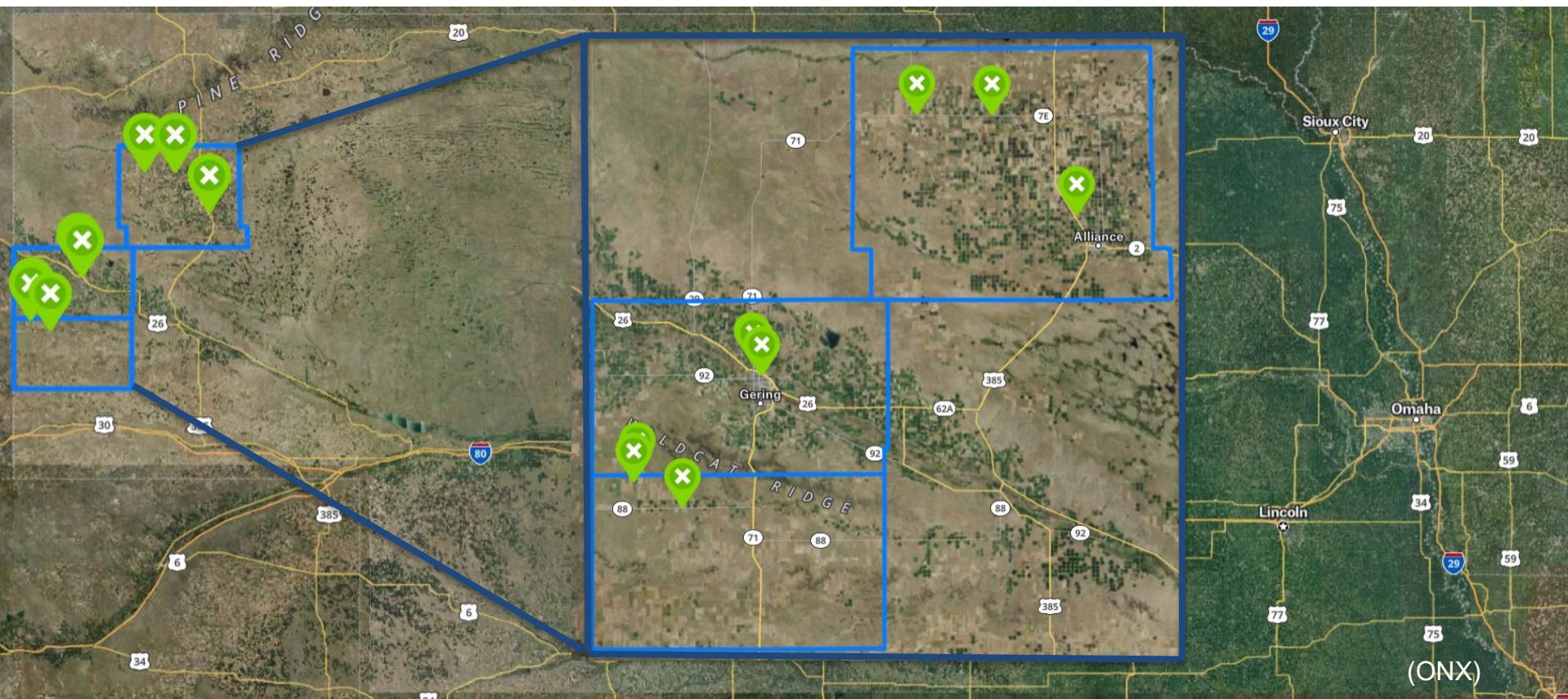


# MN Survey Map 2024





# NE Survey Map 2023



# Prevalence: Results

	2023			
North Dakota	41/43			
South Dakota	8/8			
Wisconsin	6/6			
Nebraska	10/10			
Minnesota	...			
Totals	65/67			

# Prevalence: Results

	2023	2024		
North Dakota	41/43	31/31		
South Dakota	8/8	15/15		
Wisconsin	6/6	6/6		
Nebraska	10/10	...		
Minnesota	...	5/5		
Totals	65/67	57/57		

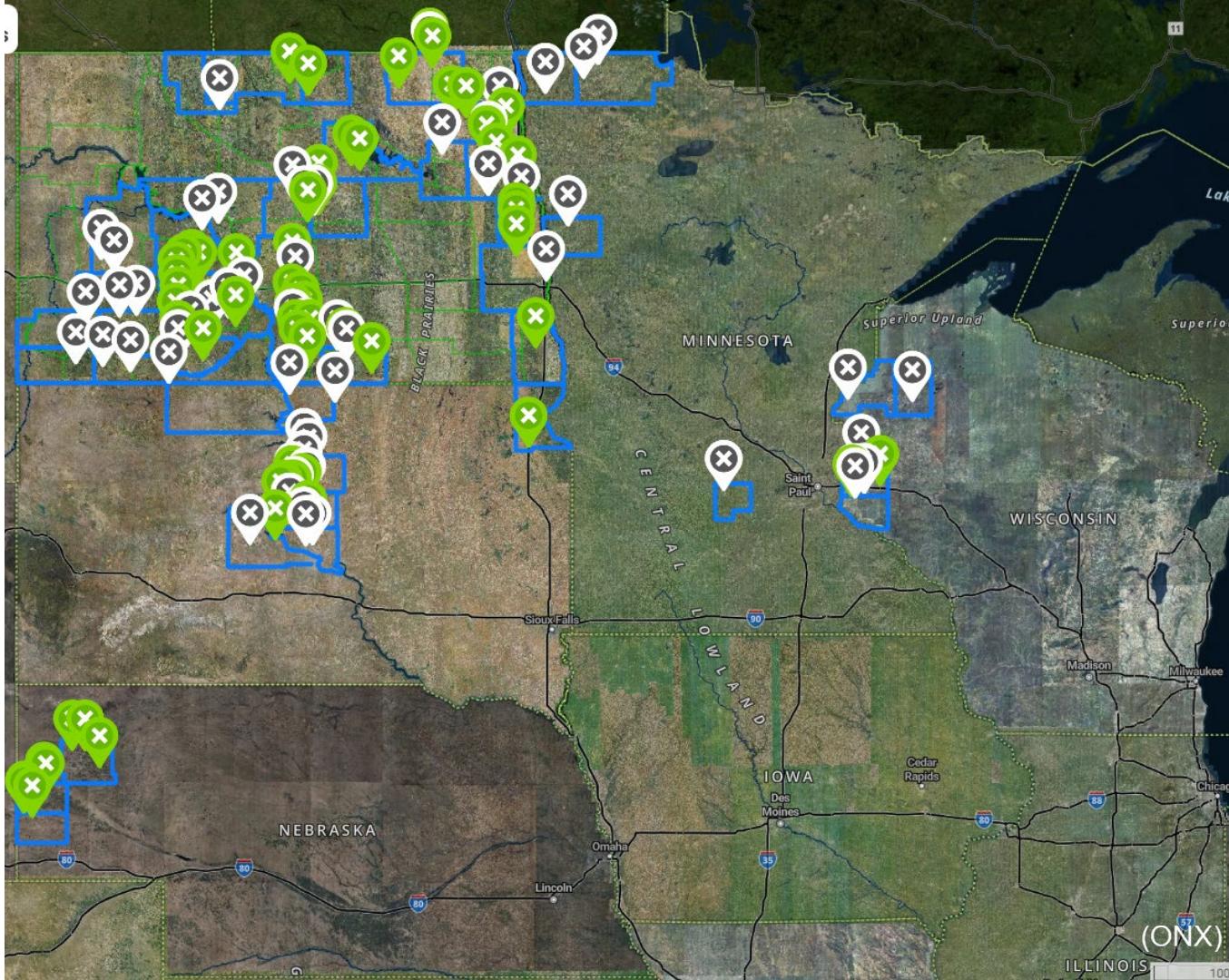
# Rust Prevalence 2023-2024

122/124  
Fields

>98%

# Objective 2

Determine the virulence phenotype  
of *P. helianthi* in the Northern Great  
Plains.



# Prevalence: Results

	2023	2024	Bulk Isolates	
North Dakota	41/43	31/31	123	
South Dakota	8/8	15/15	45	
Wisconsin	6/6	6/6	33	
Nebraska	10/10	...	30	
Minnesota	...	5/5	3	
Totals	65/67	57/57	234	

# Prevalence: Results

	2023	2024	Bulk Isolates	SPI's
North Dakota	41/43	31/31	123	3
South Dakota	8/8	15/15	45	22
Wisconsin	6/6	6/6	33	6
Nebraska	10/10	...	30	0
Minnesota	...	5/5	3	0
Totals	65/67	57/57	234	31

# Virulence: Background

- New races can overcome genetic resistance
- Management:
  - Genetic Resistance
  - Fungicides
  - Removal of volunteer plants



(Photo: Zachary Ittel)

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(Photo: Zachary Ittel)

# Virulence: Background

R genes



Hybrids

A race survey  
informs breeders

Reoccurring  
Rust  
Life Cycles

New races

~~R genes~~

# Virulence: Background



# *P. helianthi* Virulence in 2011-2012

- 238 single pustule isolates
  - 29 races
- States: NE, ND, SD, CA, IA, MN, TX, and MB.
- NE, ND, and MB each had rust that could overcome all known R genes



Dr. Andrew Friskop

# *P. helianthi* Virulence in CA in 2017-2018

- Production fields:
  - 2017 – 6 races (11 SPI)
  - 2018 – 8 races (13 SPI)
- Wild sunflower:
  - 2017 – 6 races (11 SPI)
  - 2018 – 16 races (20 SPI)
- CA had rust that could overcome all known R genes



Dr. Brandt Berghuis

# Virulence: Methods (Pathogen Recovery)



(Photo: Denis Colombo)



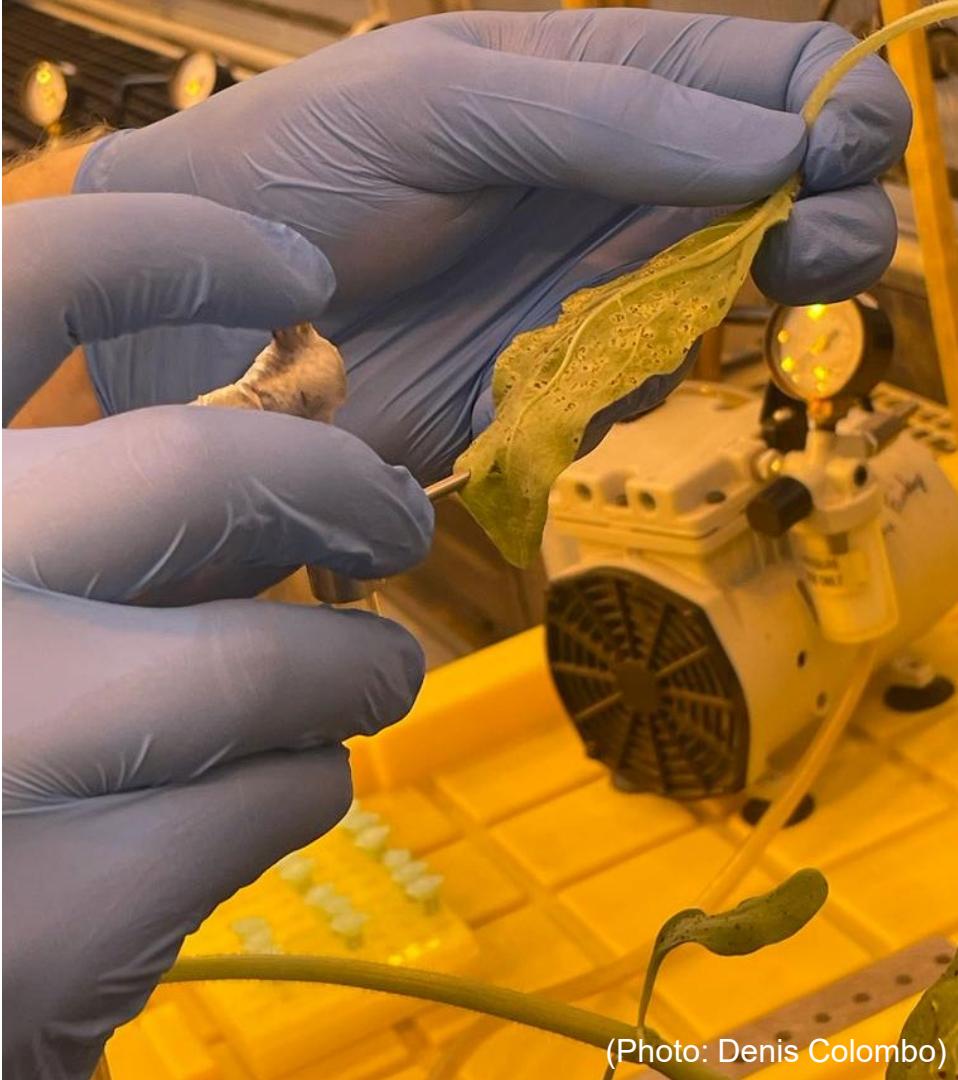
(Photo: Zachary Ittel)



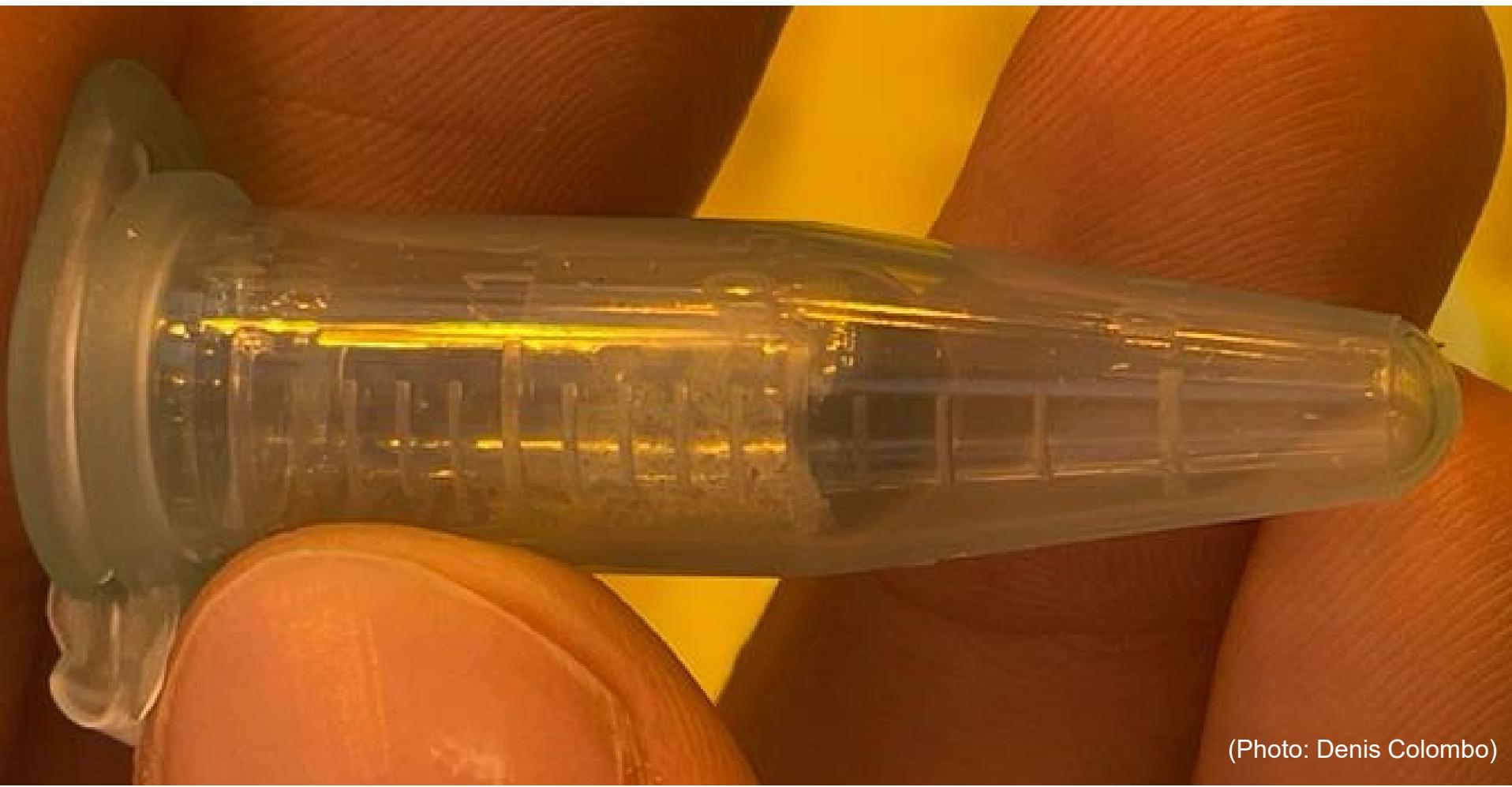
(Photo: Zachary Ittel)



(Photo: Denis Colombo)



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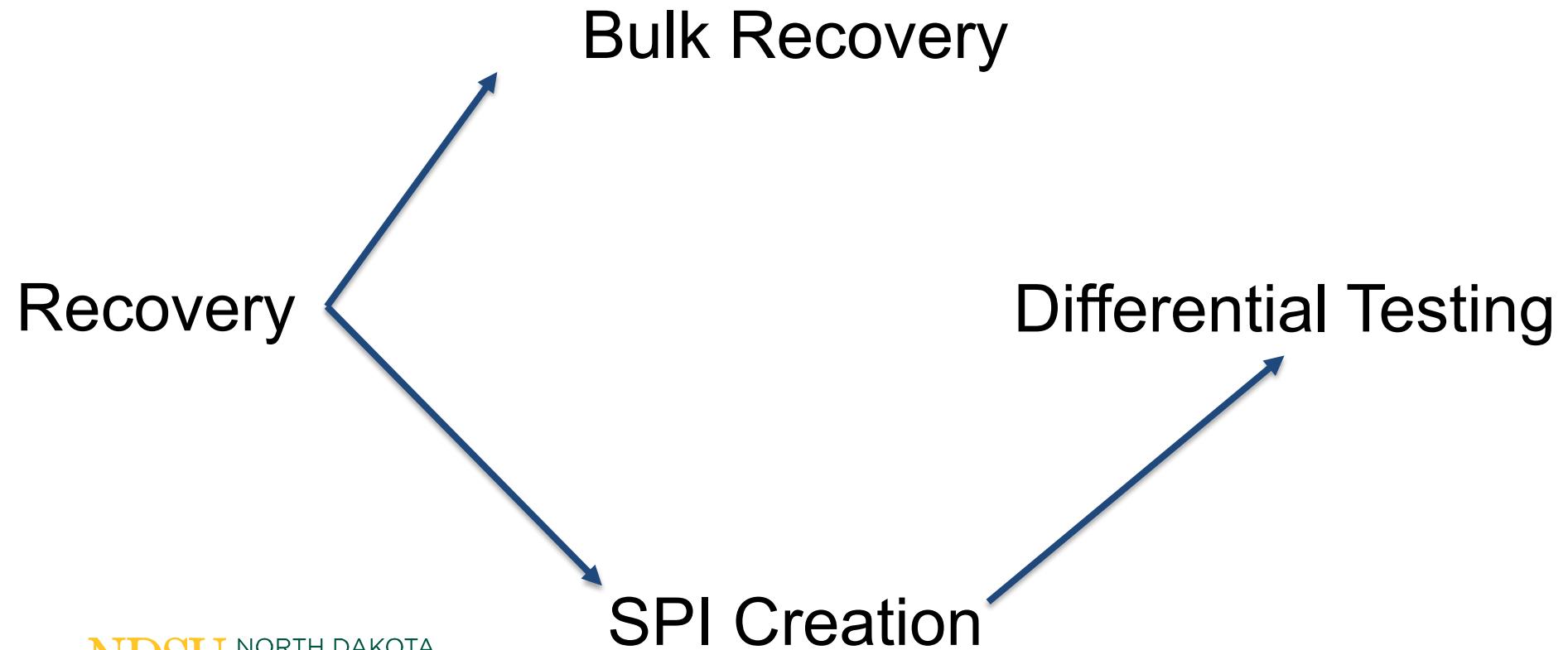


(Photo: Denis Colombo)



(Photo: Zachary Ittel)

# Virulence: Next Steps



# Determining Virulence Phenotype (Race)

# Universal Differential Set

Triplet	Differential	Resistance Gene	coding value
One	7350	...	996
	MC90	$R_{10}$	2
	MC29	$R_2 + R_{10}$	4
Two	P386	$R_{4e}$	1
	HA-R1	$R_{4a}$	2
	HA-R2	$R_5$	4
Three	HA-R3	$R_{4b}$	1
	HA-R4	$R_{4c}$	2
	HA-R5	$R_{4d}$	4

(Friskop et al. 2015; Gulya and Masirevic 1996)

Triplet	Differential	Resistance Gene	Scoring Value	Code
One	7350	...	1	
	MC90	$R_1$	2	
	MC29	$R_2 + R_{10}$	4	

Triplet	Differential	Resistance Gene	Scoring Value	Code
One	7350	...	1	3
	MC90	$R_1$	2	
	MC29	$R_2 + R_{10}$	4	

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	HA-R1	$R_{4a}$	2	
	HA-R2	$R_5$	4	
Three	HA-R3	$R_{4b}$	1	6
	HA-R4	$R_{4c}$	2	
	HA-R5	$R_{4d}$	4	

Race Name =  
346

Triplet	Differential	Resistance Gene	Scoring Value	Code
One	7350	...	1	
	MC90	$R_1$	2	
	MC29	$R_2 + R_{10}$	4	
Two	P386	$R_{4e}$	1	
	HA-R1	$R_{4a}$	2	
	HA-R2	$R_5$	4	
Three	HA-R3	$R_{4b}$	1	
	HA-R4	$R_{4c}$	2	
	HA-R5	$R_{4d}$	4	
Four	?	?	?	?
	?	?	?	
	?	?	?	



# Differential Additions

Differential Name	Pedigree	Gene	Year Released
HAR-9	Selection of Rf ANN 1742	$R_{11}$	2013
RHA 464	Selection of PI 413047	$R_{12}$	2013
HAR-6	(R702CLPlus/HAR6-1)F2	$R_{13a}$	2013
HAR-8	Selection of PI 432512	$R_{15}$	2018
HAR-18	Selection of South Africa line KP193	$R_{17}$	2020
HAR-19	Selection of South Africa line KP193	$R_{18}$	2020

Triplet	Differential	Resistance Gene	Scoring Value
One	7350	...	1
	MC90	$R_1$	2
	MC29	$R_2 + R_{10}$	4
Two	P386	$R_{4e}$	1
	HA-R1	$R_{4a}$	2
	HA-R2	$R_5$	4
Three	HA-R3	$R_{4b}$	1
	HA-R4	$R_{4c}$	2
	HA-R5	$R_{4d}$	4
Four	HAR-9	$R_{11}$	1
	RHA 464	$R_{12}$	2
	HAR-6	$R_{13a}$	4
Five	HAR-8	$R_{15}$	1
	HAR-18	$R_{17}$	2
	HAR-19	$R_{18}$	4

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# Future Objectives

- Whole Genome Pathogen Sequencing
- *Puccinia helianthi* population genetic analysis
- SAM pop experiment
- Fungicide evaluation



**Evaluation of Fungicides for Sunflower Rust Management**  
Zachary Ittel<sup>1</sup>, Gabriel Drusek<sup>1</sup>, Bryan Hansen<sup>2</sup>, Jess Scherer<sup>2</sup>, Brent Hulke<sup>2</sup>, Sam Markell<sup>1</sup>  
<sup>1</sup>North Dakota State University – Department of Plant Pathology, Valente Hall, Fargo, ND  
<sup>2</sup>USDA-ARS Sunflower Research Unit, 1307 10th Street N, Fargo, ND

**Introduction**

This trial was conducted in Casselton, ND in a Randomized Block Design with six replicates per treatment. Labeled fungicides were chosen based on product availability to growers and diversity of mode of action (Table 1). The trial was conducted on CHS R3-609 CLP planted into four-row plots spaced 30 inches and 20 feet long.

The experiment was inoculated withuredospores at canopy closure with a fungicide solution containing 100 g of conidia/ml of water and 0.2% Tween 80 in a soil/suspension using a leaf blower.

Fungicides were applied at R5 (two weeks after pathogen inoculation) using a hand sprayer with a flat fan nozzle to sunflower heads with flat fan nozzles at a rate of 20 gallons/acre. A Non-ionic surfactant was included in all treatments.

The severity of rust was evaluated by randomly selecting 10 leaves from 10 arbitrarily selected leaves from the upper canopy in each plot using the severity scale (Figure 3). Evaluation was conducted three times, beginning two weeks after fungicide application. Only R5 and final evaluations are reported.

Yield data was not collected due to a late planting date of mid June.

**Materials & Methods**

Figure 1. a. Planting site  
b. Pathogen increase  
c. Collected pathogen for inoculation

Figure 2. a. Trial at canopy closure  
b. Inoculation equipment

Figure 3. Sunflower rust severity reference rating chart (Friskop et al. 2011)

Figure 4. Mean rust severity of 10 leaves by fungicide treatment at Growth Stage R5

Figure 5. Mean rust severity of 10 leaves by fungicide treatment at Growth Stage R8.5

**Results**

**Table 1.** Treatment number, treatment name, active ingredient, mode of action and rate utilized for this study are displayed below

Treatment Name	Active Ingredient	Mode of Action and Group	Rate & Rate Unit
Non Treated Control (Check)	-	-	-
Quazip	Triadimenol	DMI(3)	8 fl oz/a
Quazip + Qo11	Qo11	8 fl oz/a	8 fl oz/a
Luna Experience	Flutriafol + Tebuconazole	SDHI (+) + DMI (3)	8 fl oz/a
Priaxor	Flutriafol + Pyraclostrobin	SDHI (+) + Qo11	8 fl oz/a
Headline	Pyraclostrobin	Qo11	8 fl oz/a

**Conclusion Summary**

- High disease severity occurred on the Non Treated Control, indicating the need for fungicide application.
- Rust severity on all treatment was significantly lower than on the non-treated control, demonstrating that all fungicides tested were effective against sunflower rust.
- Statistical differences among treatments occurred at both the R5 and R8.5 ratings.
- Between R5 and R8.5, the non-treated control increased from approximately 4% to nearly 20% from R5 to R8.5.
- For all treatments, the mean rust severity at R8.5 was greater than at R5, indicating that the severity increases of treatments were relatively low in the same time frame (roughly 1 or 2% to 1.5 to 5%), demonstrating how effective the fungicides were.
- Yield could not be taken due to a late planting date of mid June.

**Acknowledgments:**  
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- SD (Mr. Weber, NSA Board members, Farmers, and Febina Mathew's Team)
- NE (Bob Harveson and his team)
- WI (Brandt Burghuis and his team)
- MN (Farmers)
- Scott Radi
- Bill Underwood
- Kaylie Schlecht
- John Sandbakken

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# Thank you Questions?

