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

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

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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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  - Prevalence = Does rust occur in a field? (Yes/Fields Surveyed)
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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

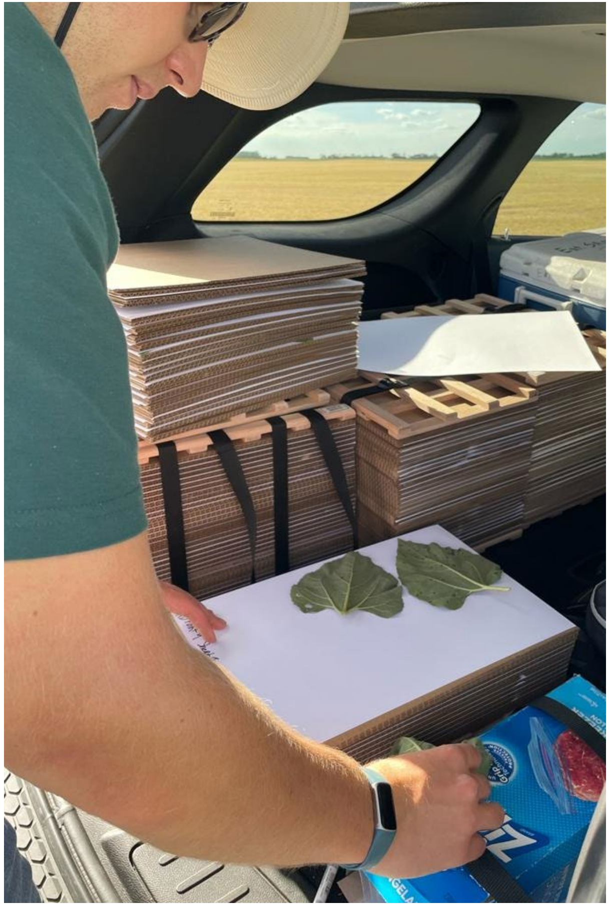
Determine the prevalence of *P. helianthi* in the Northern Great Plains.

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%

(Thorson 2024; Harveson et al. 2016; Gulya et al. 2019)

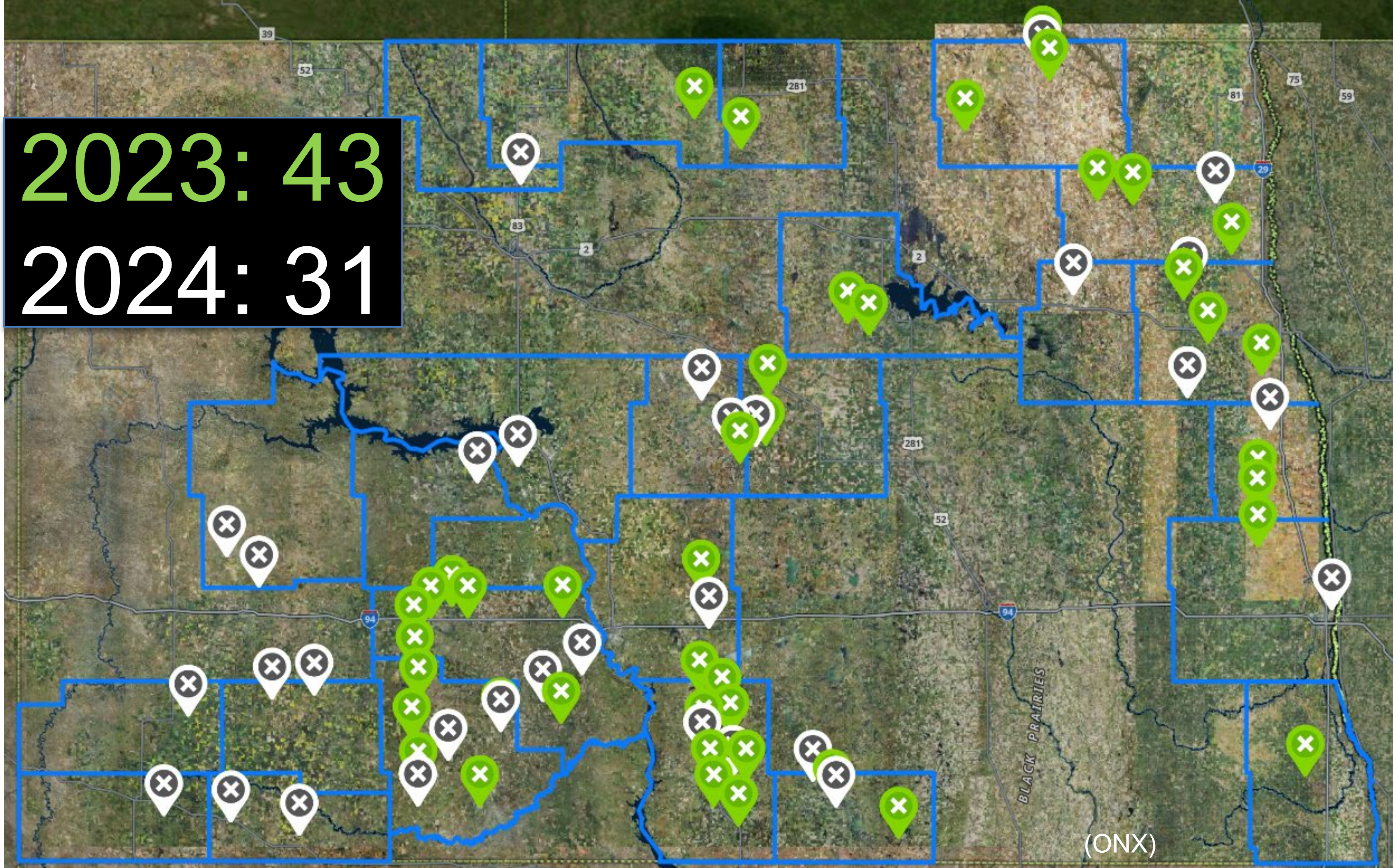
Prevalence: Materials & Methods



ND Survey Map 2023-2024

2023: 43

2024: 31



SD Survey Map 2023-2024

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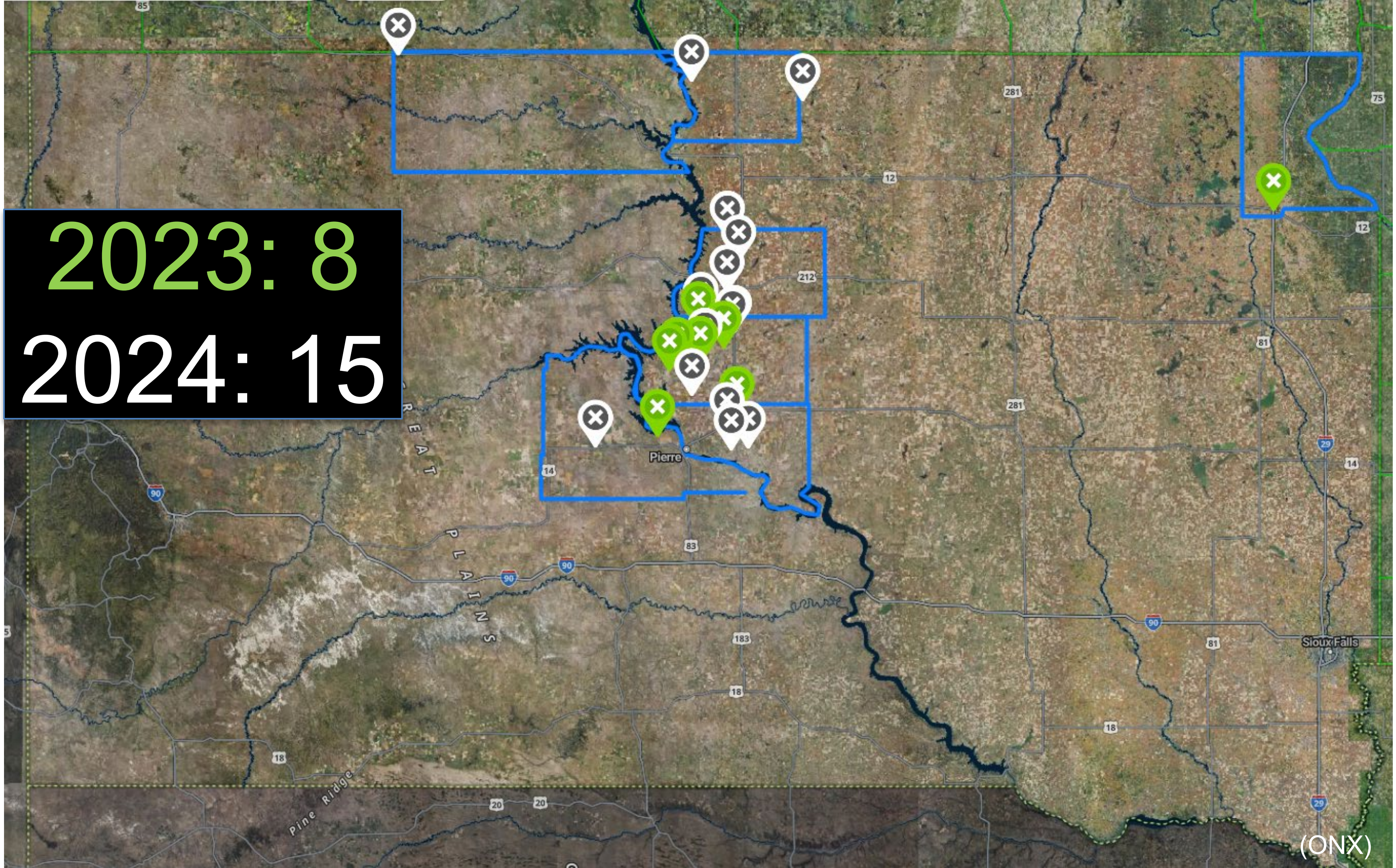
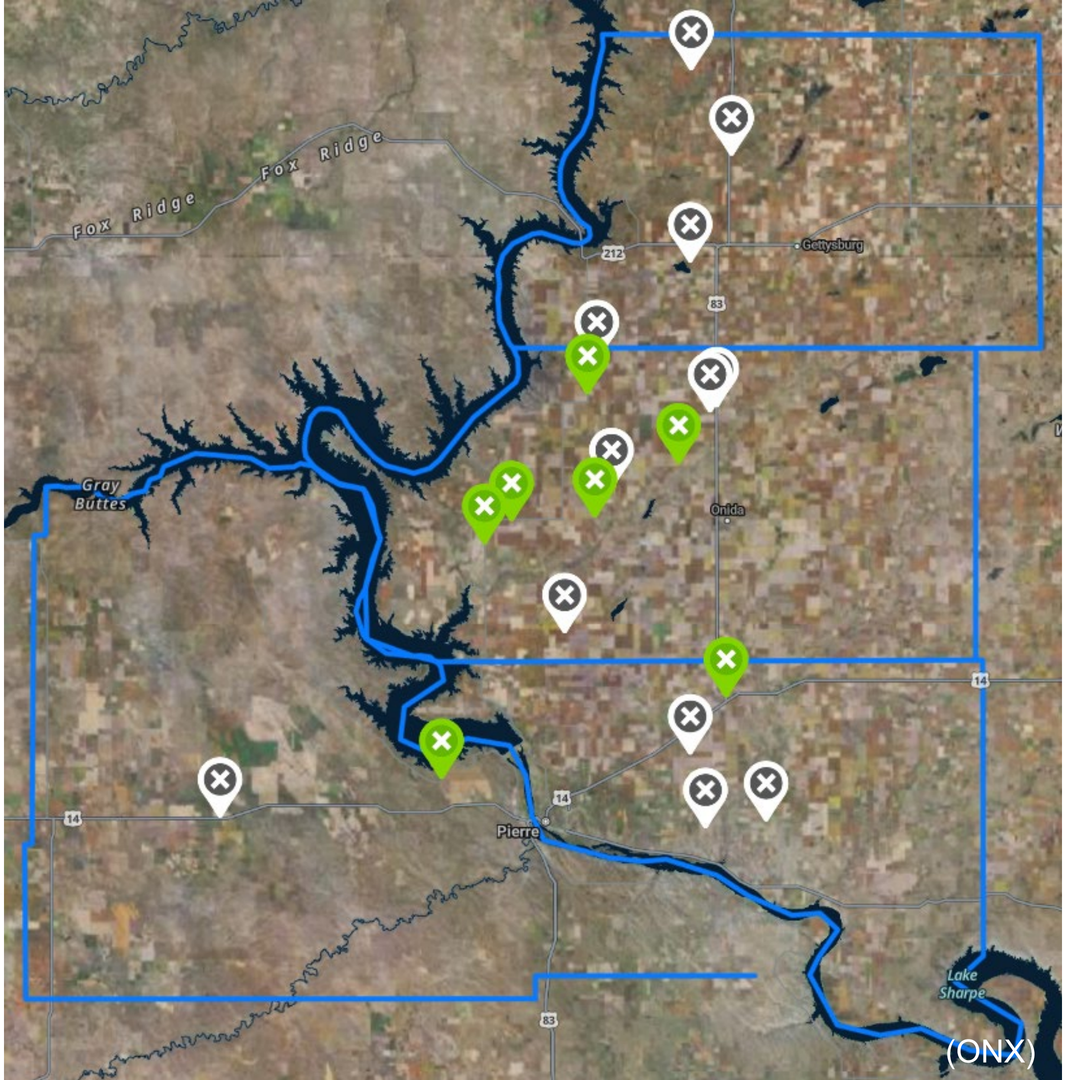
2023: 8

2024: 15





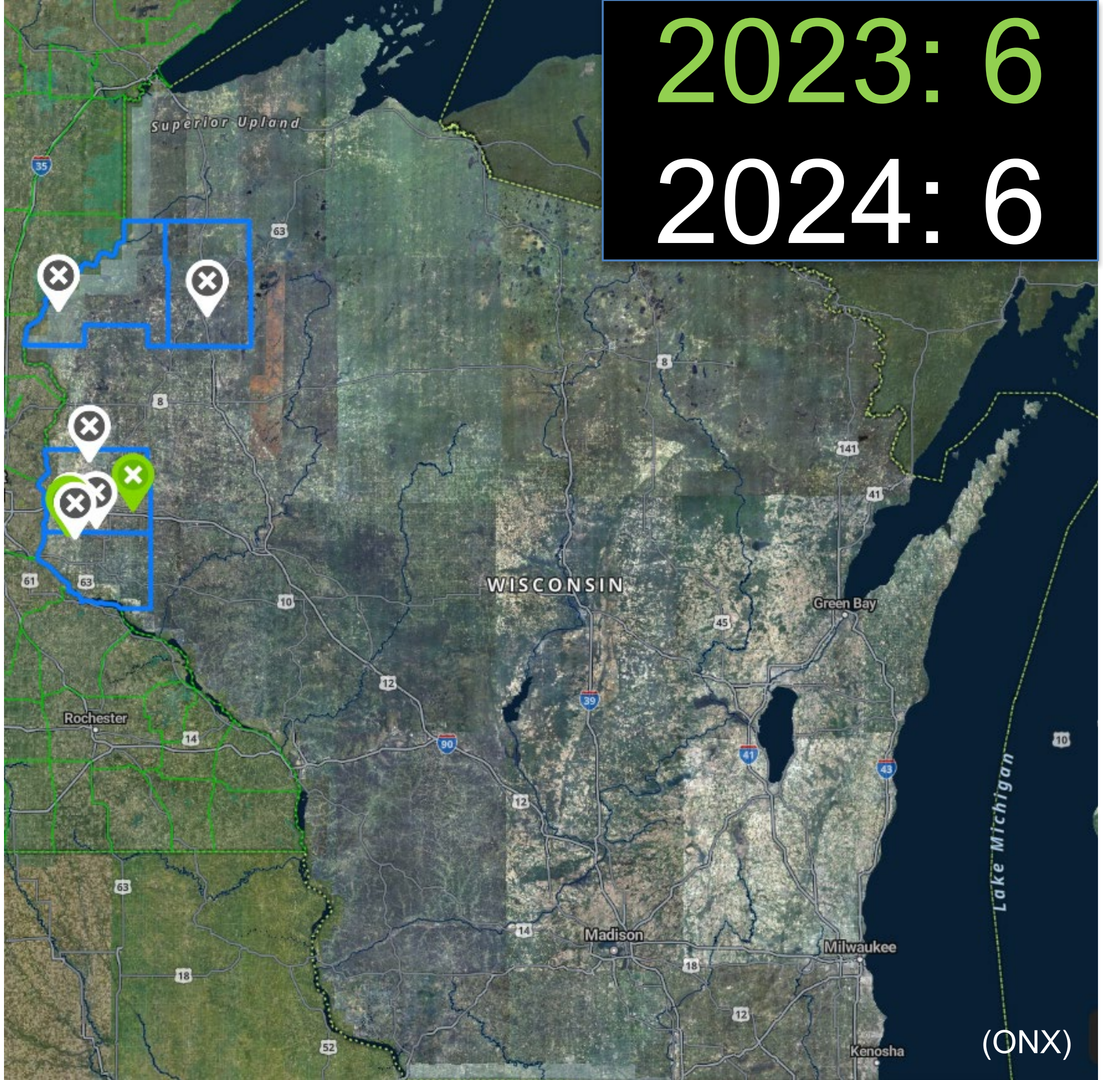
Fox Ridge
Fox Ridge
212
Gettysburg
83
Gray Buttes
Onida
14
14
14
Pierre
83
Lake Sharpe

(ONX)

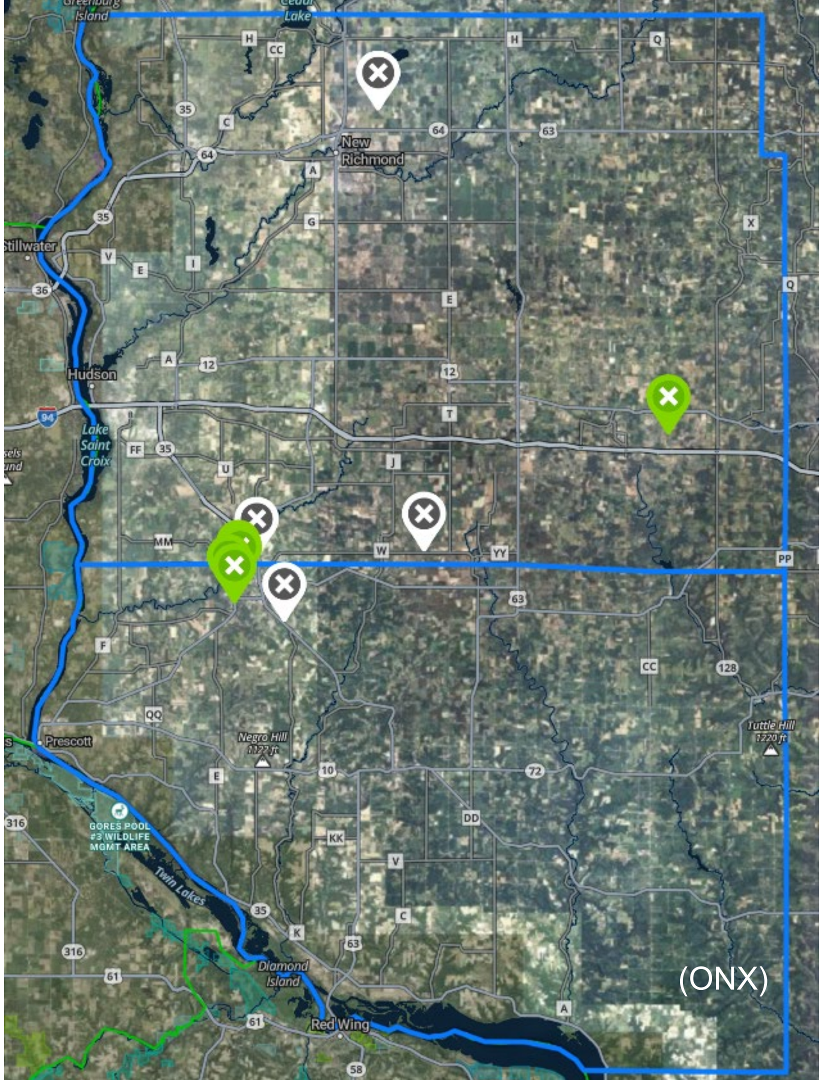
WI Survey Map 2023-2024

2023: 6

2024: 6



(ONX)


Greenburg Island
Cedar Lake
New Richmond
Stillwater
Hudson
Lake Saint Croix
Prescott
Negro Hill 1127 ft
Tuttle Hill 1220 ft
GORES POOL #3 WILDLIFE MGMT AREA
Twin Lakes
Diamond Island
Red Wing
(ONX)

MN Survey Map 2024

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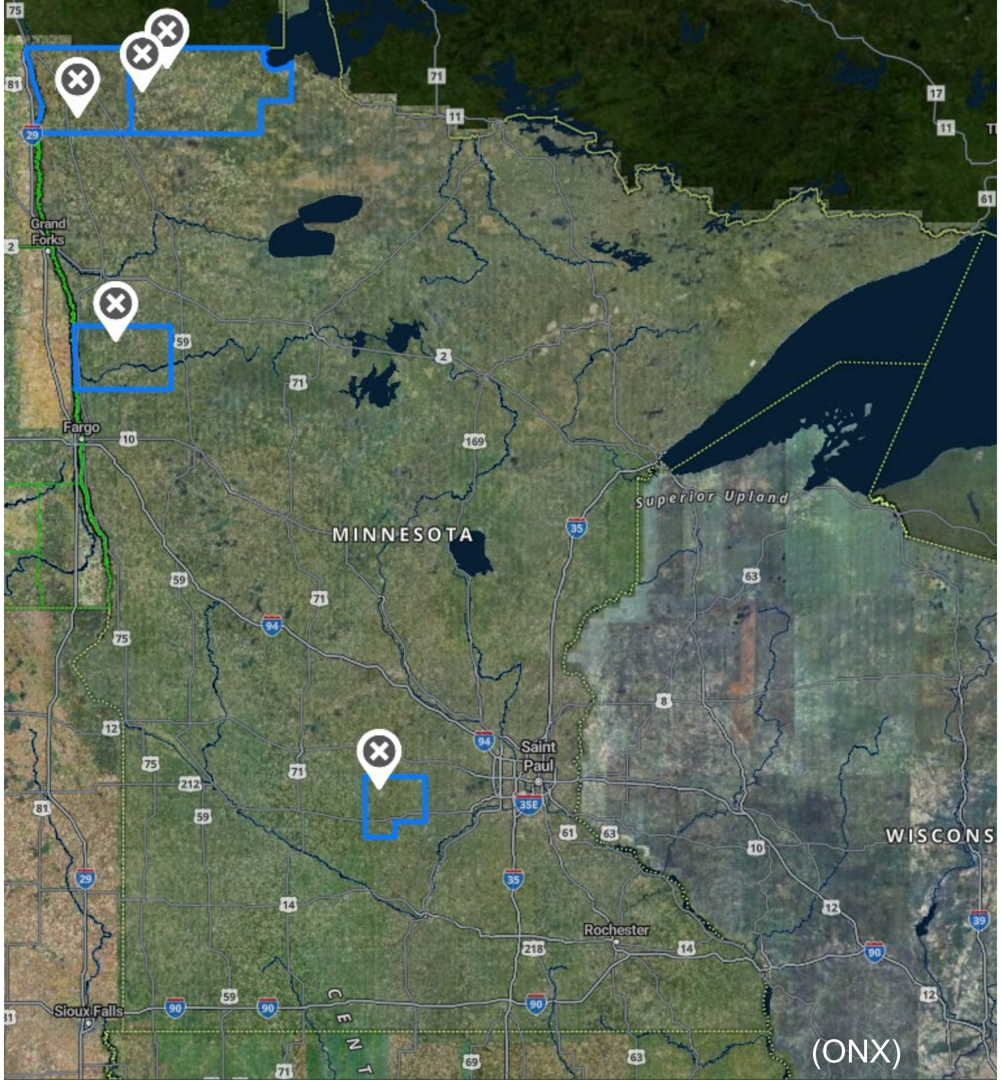
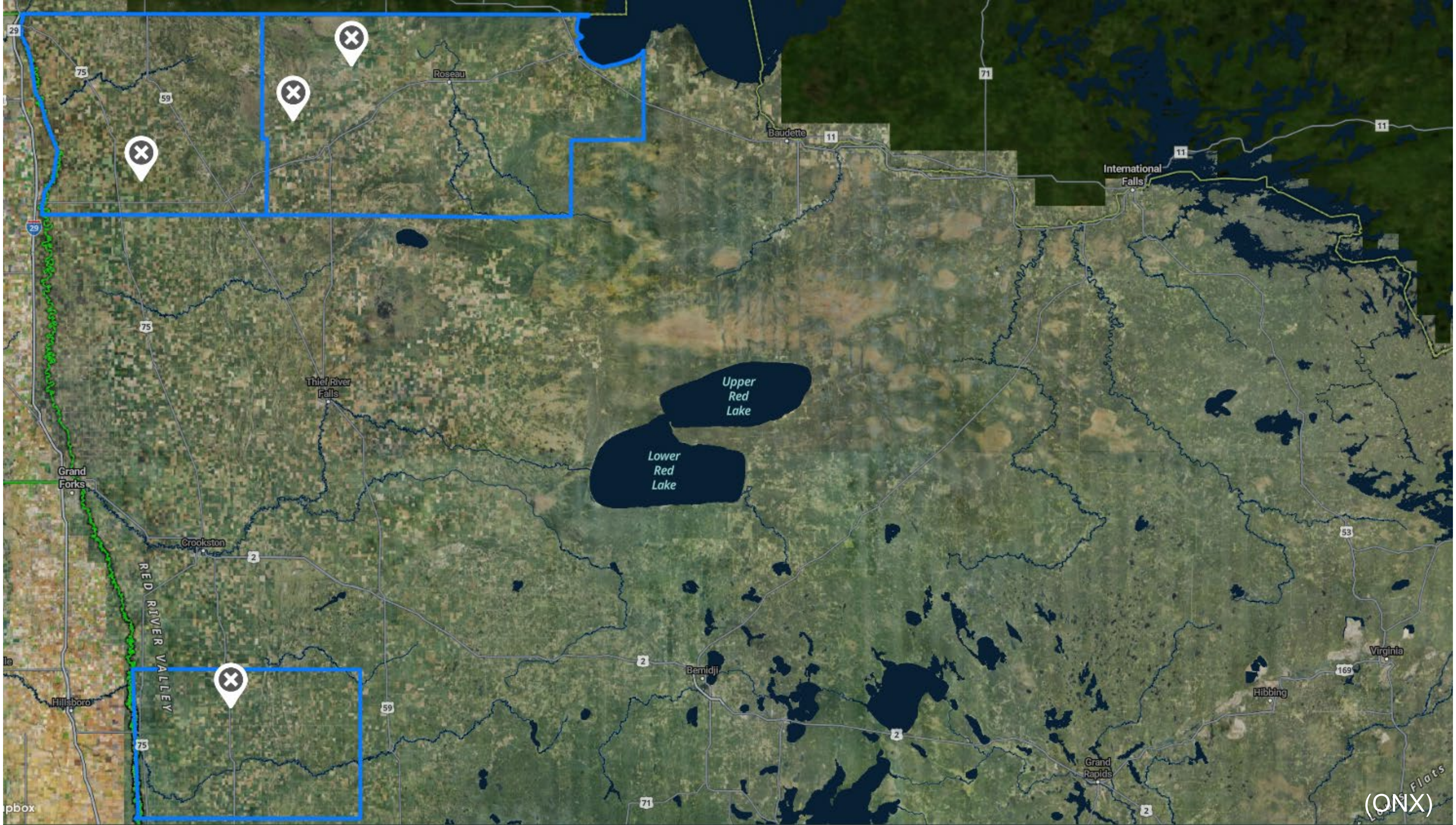
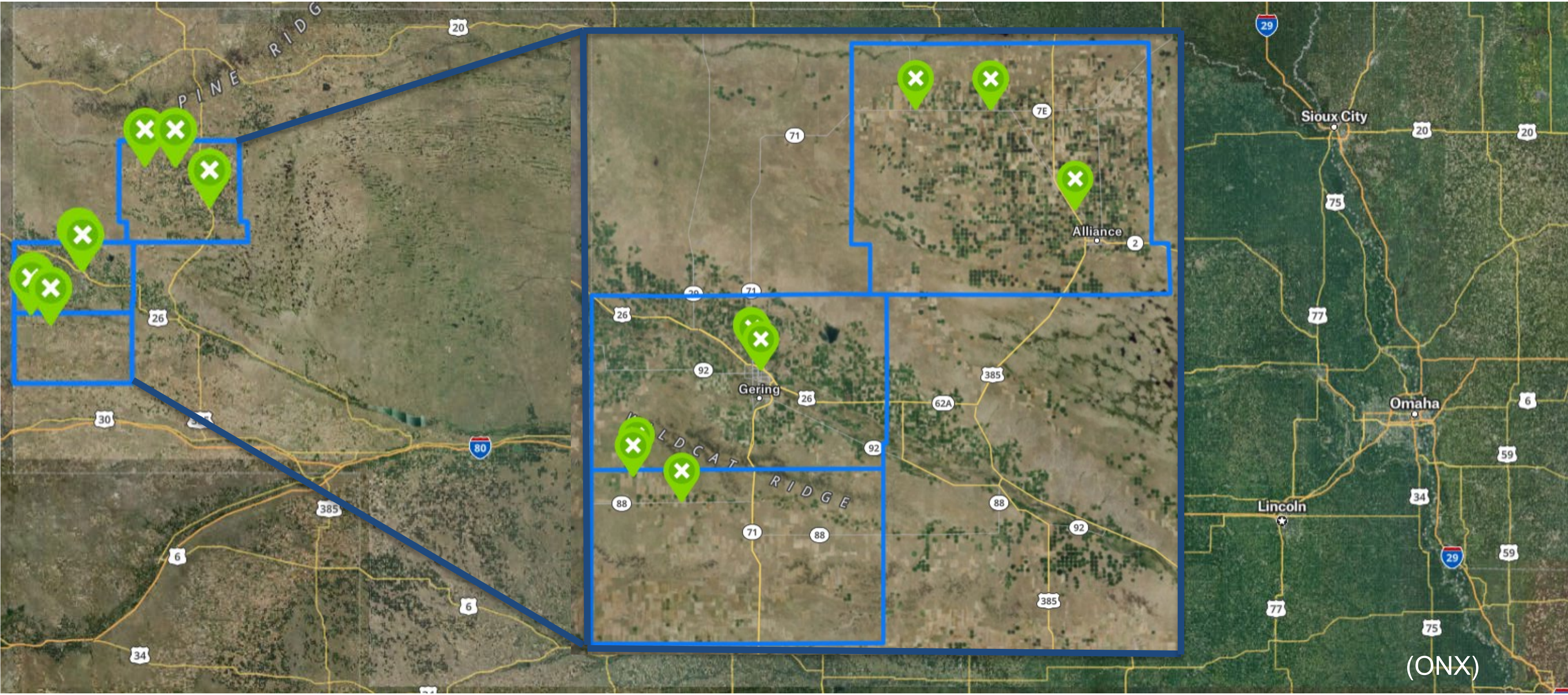


MINNESOTA
WISCONS
Grand Forks
Fargo
Saint Paul
Rochester
Sioux Falls
Superior Upland

(ONX)


Roseau
Baudette
International Falls
Thief River Falls
Upper Red Lake
Lower Red Lake
Grand Forks
Crookston
RED RIVER VALLEY
Hillsboro
Bemidji
Virginia
Hibbing
Grand Rapids
(ONX)

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		

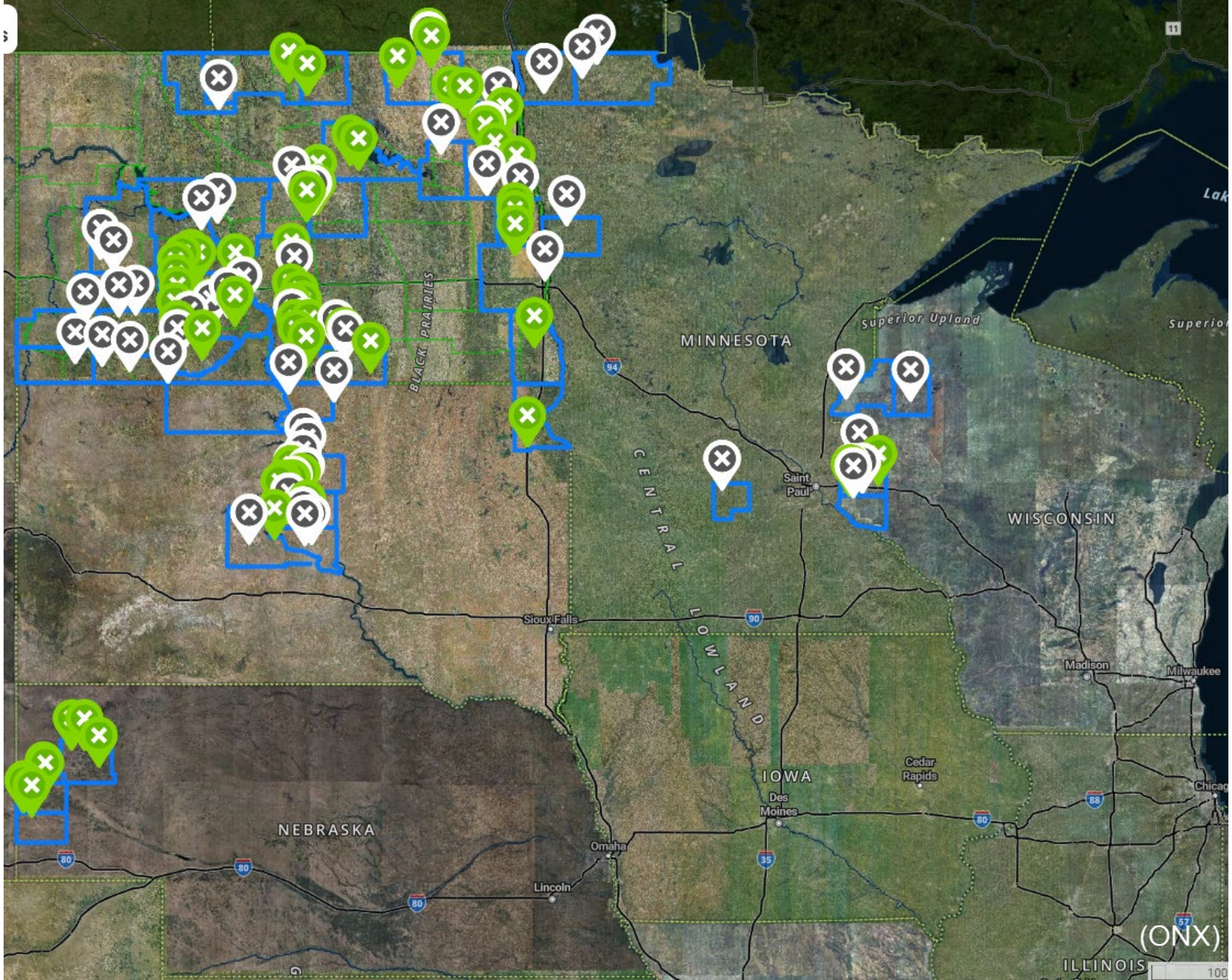
Rust Prevalence 2023-2024

122/124 Fields

>98%

Objective 2

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



Superior Upland
Lake
Superior
MINNESOTA
BLACK PRAIRIES
CENTRAL LOWLAND
Saint Paul
WISCONSIN
Madison
Milwaukee
Sioux Falls
IOWA
Des Moines
Cedar Rapids
Chicago
NEBRASKA
Omaha
Lincoln
ILLINOIS
(ONX)

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)

(Harveson et al. 2016)

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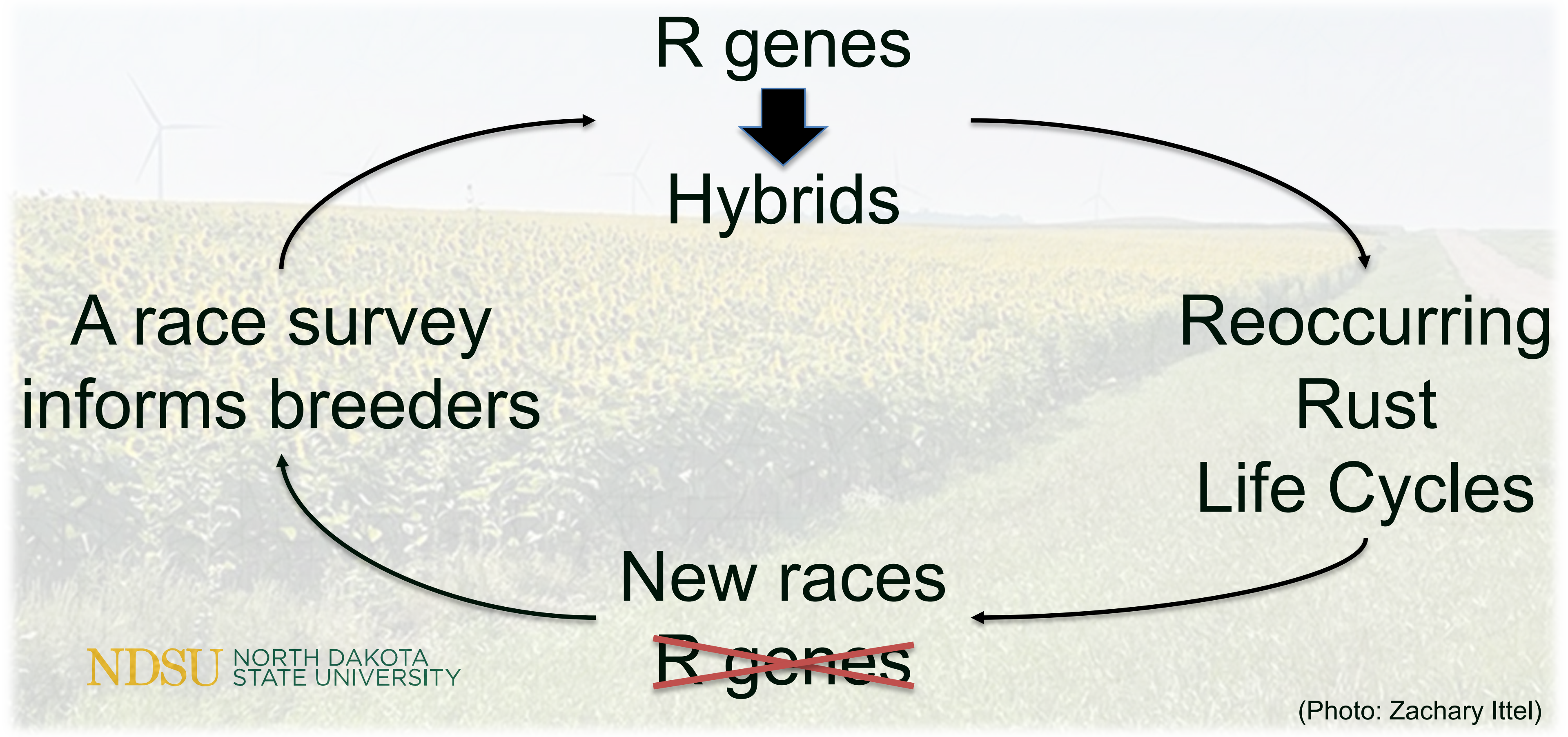

R genes

Hybrids

Reoccurring
Rust
Life Cycles

New races
~~R genes~~

A race survey
informs breeders

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(Photo: Zachary Ittel)

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

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National Sunflower ASSOCIATION

(Friskop et al. 2015)

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

(Berghuis et al. 2021)

National Sunflower Association

Virulence: Methods (Pathogen Recovery)


(Photo: Denis Colombo)

(Photo: Zachary Ittel)


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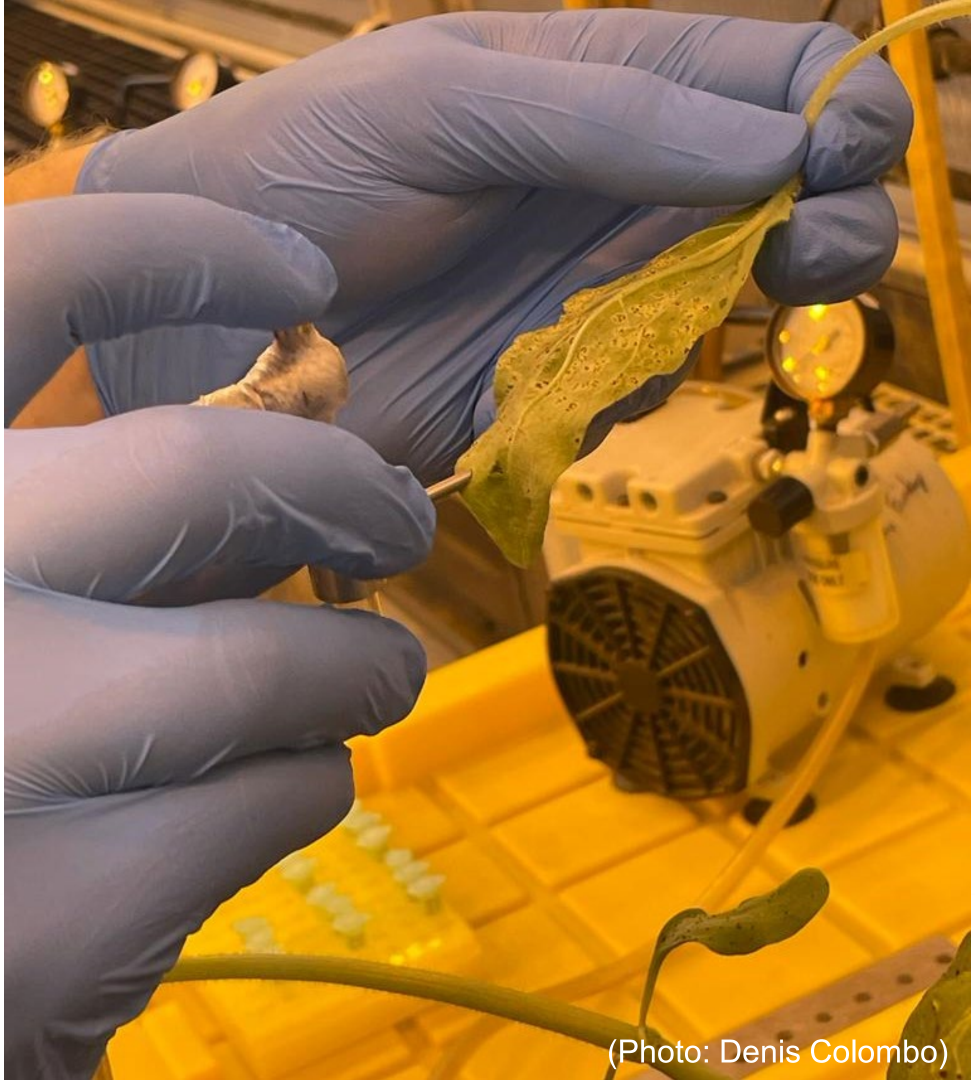
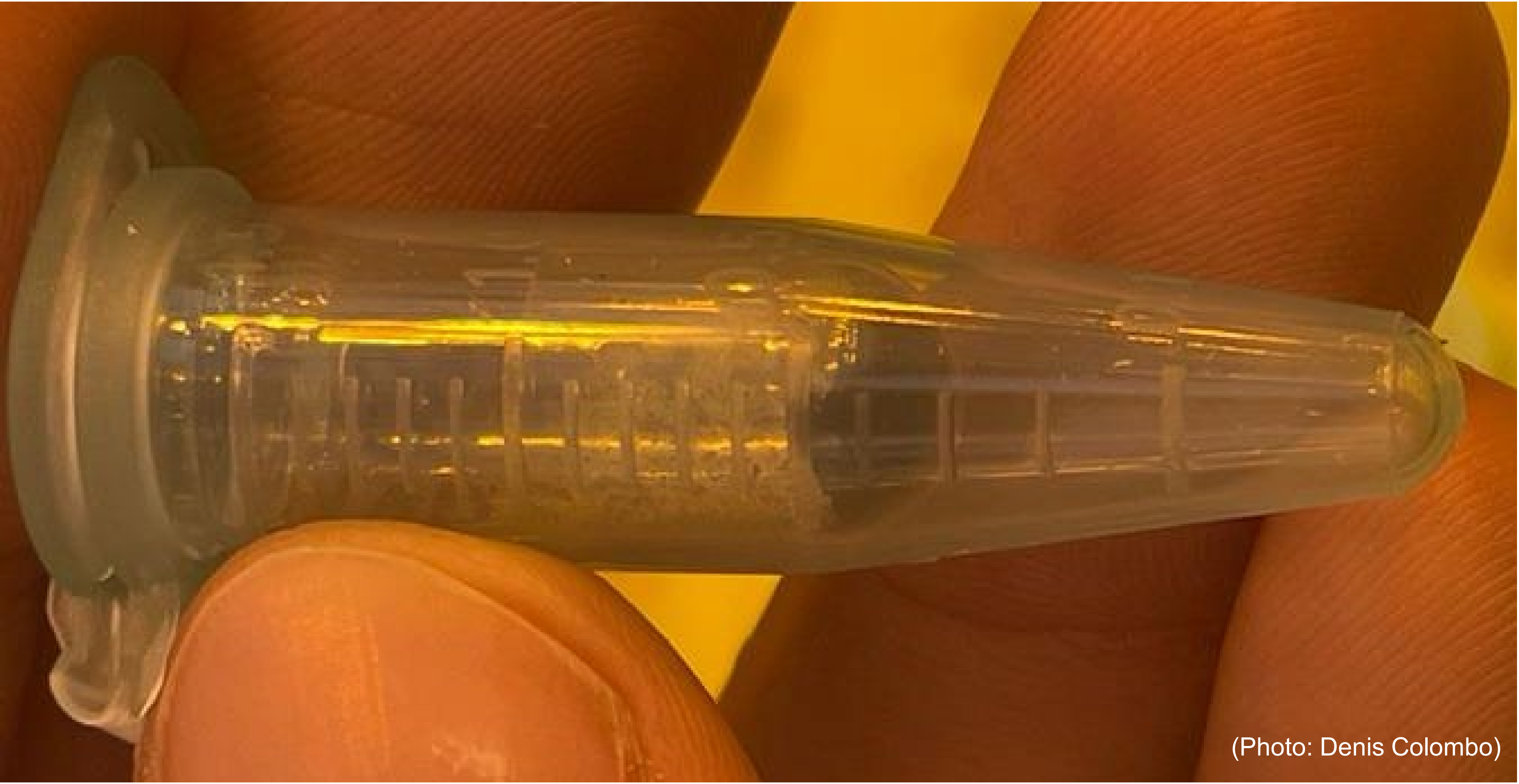

(Photo: Denis Colombo)


(Photo: Denis Colombo)

(Photo: Zachary Ittel)

Virulence: Next Steps

Bulk Recovery

Recovery

Differential Testing

SPI Creation

Determining Virulence Phenotype (Race)

Universal Differential Set

Triplet	Differential	Resistance Gene	Scoring Value
One	7350	…	[illegible]
	MC90	[illegible]	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

Since 1996

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

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Race Name = 346

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	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

Meyer et al. 2021; Qi et al. 2021 and 2014; Bulos et al. 2013; Ma et al. 2018; Gong et al. 2013

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	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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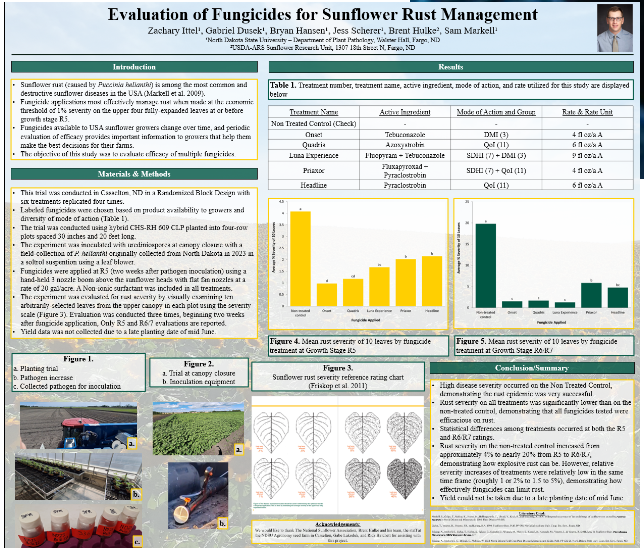
Future Objectives

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



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  - His team
- Co-advisor: Upinder Gill
- Brent Hulke

Survey Help:

- ND (County Agents, NSA Board members, and Farmers)
- 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

National Sunflower Association

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Thank you

Questions?