

Virulence Diversity of *Plasmopara halstedii* (Downy Mildew) in the Dakotas and Minnesota from 2019 to 2024

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NDSU

EXTENSION

Downy Mildew – Background

- Causes 100% yield loss – *to infected plants*.
- Prevalence and field incidence varies dramatically.
- Environment (infection needs cool and wet).
 - Pathogen is a soil-borne oomycete











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- Causes 100% yield loss – *to infected plants*.
- Prevalence and field incidence varies dramatically.
- Environment (infection needs cool and wet).
 - Pathogen is a soil-borne oomycete
- Efficacy of management tools
 - Genetic resistance and seed treatment can be effective
 - Pathogen is highly variable and overcomes tools

Management Tool

Seed treatment

Genetic resistance

2020

New genes becoming available
Oxathiapiprolin (Plenaris/Lumisena) available

2015

PI_8 gene overcome
Novel seed treatments developed

2010

Fenamidone (Idol) is no longer available
 PI_6 gene overcome
Fenamidone (Idol) becomes available

2005

PI_6 gene released in hybrids
Azoxystrobin (Dynasty) becomes available

2000

No effective R genes or fungicides
Metalaxyl insensitivity widespread
Metalaxyl insensitivity identified

1995

1990

1985

Metalaxyl (Apron) labeled
Early resistance genes overcome

1980

Resistant hybrids become available

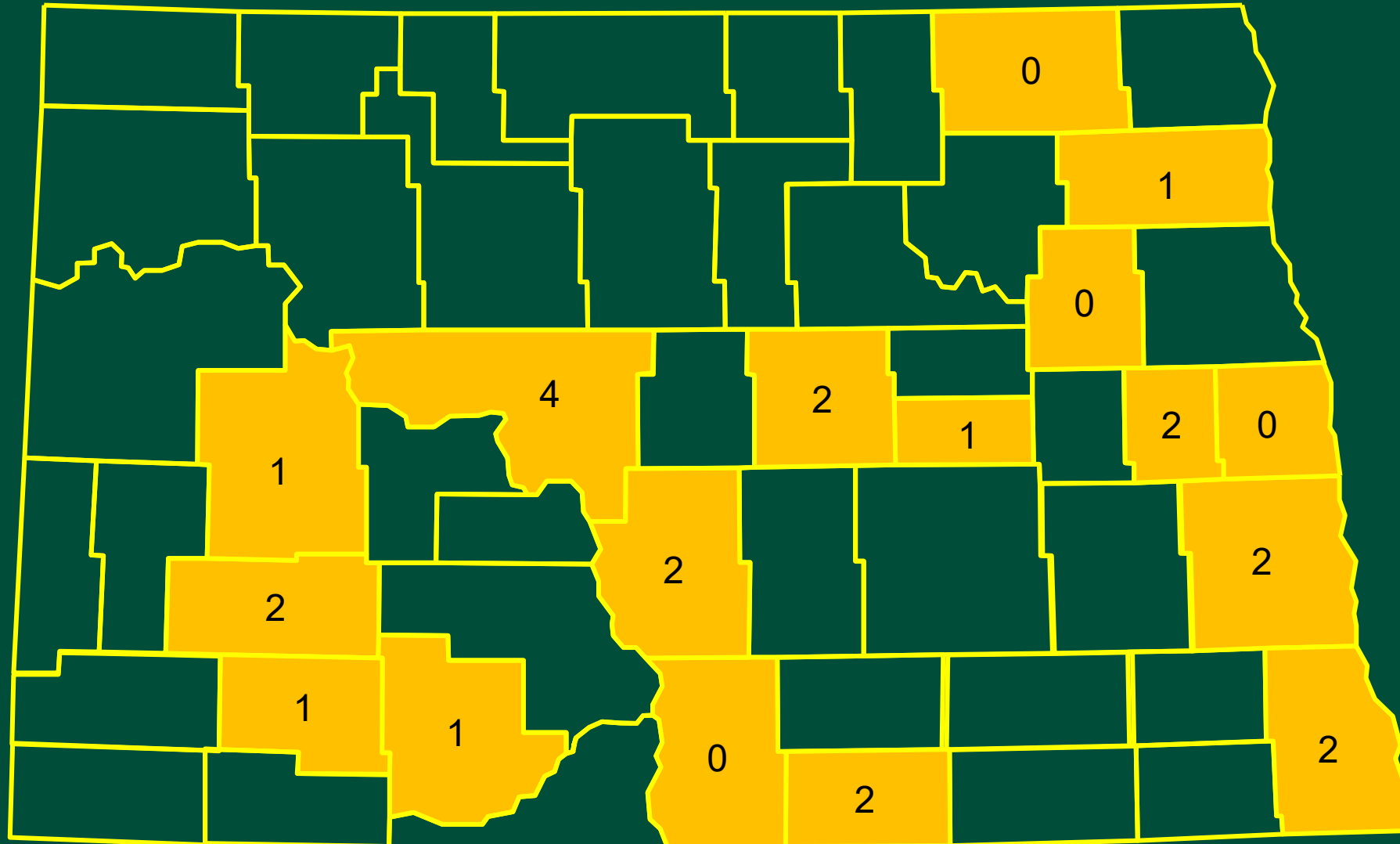
Objective

Determine Virulence Diversity of *Plasmopara halstedii*

2020-2024 Survey

Where the heck is all the downy mildew!?!?!?!?

North Dakota



Additional NGP Counties

Minnesota

- Clay - 1
- Kittson - 1
- Wilkin - 2
- Pennington - 1
- Morrison – 2
- Roseau – 2

South Dakota

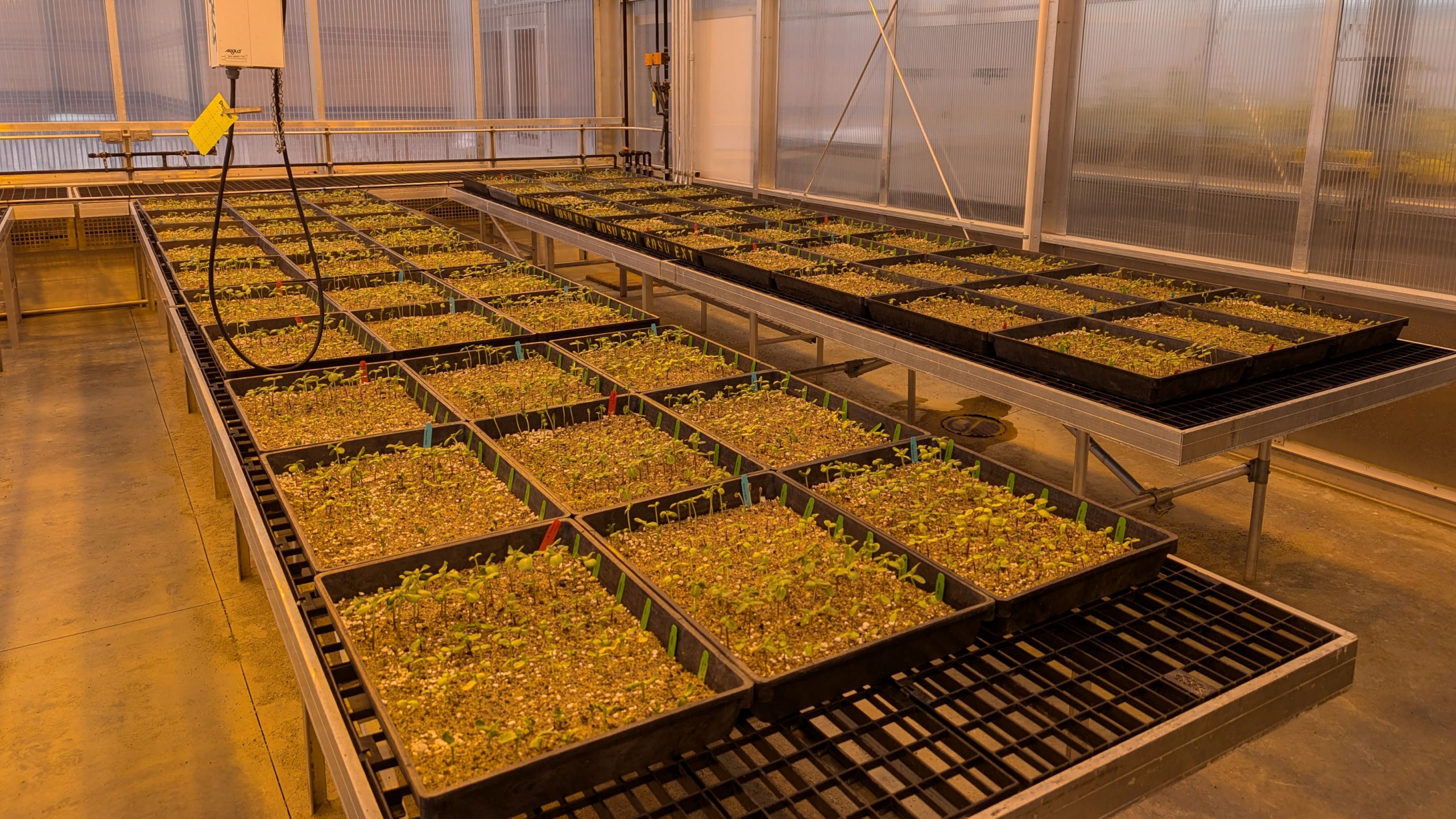
- Dewey - 2
- Jerauld – 1
- Hyde - 0

Differential Lines



#	Line	Resistance Gene
D-1	Susceptible	...
D-2	RHA 265	PI ₁
D-3	RHA 274	PI ₂ /PI ₂₁
D-4	DM-2	PI ₅
D-5	PM 17	PI ₅₋
D-6	803-1	PI ₅₊
D-7	HA-R4	PI ₁₆
D-8	HA-R5	PI ₁₃
D-9	HA 335	PI ₆

#	Line	Resistance Gene
D-10	Y7Q	PI ₆₋
D-11	PSC8	PI ₂
D-12	XA	PI ₄
D-13	PSS2RM	PI ₆ /PI ₂₁
D-14	VAQ	PI ₅
D-15	RHA 419	PI _{Arg}
D-16	RHA 491	PI ₁₅
D-17	RHA 340	PI ₈
D-18	RHA 490	PI ₁₇

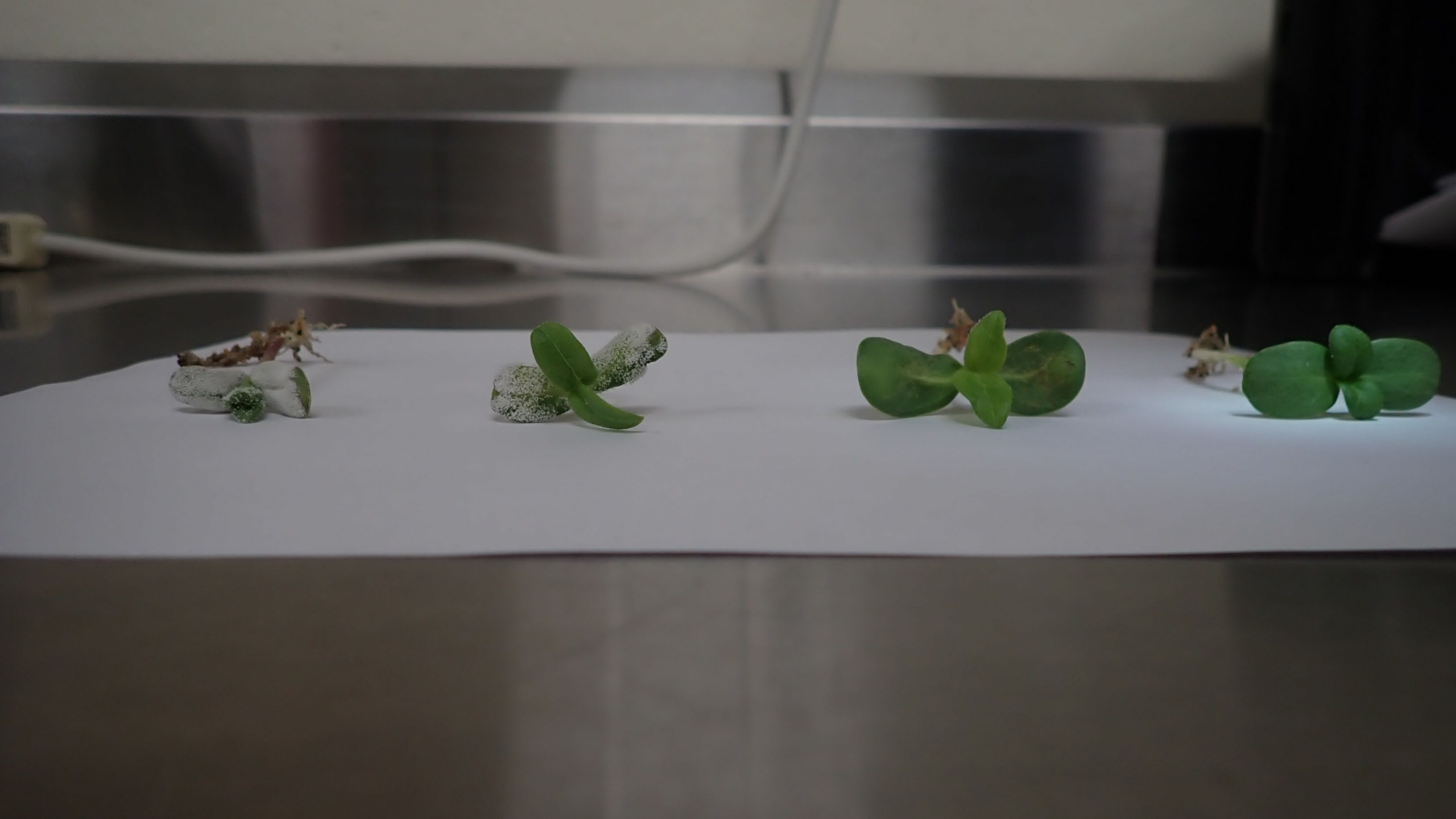




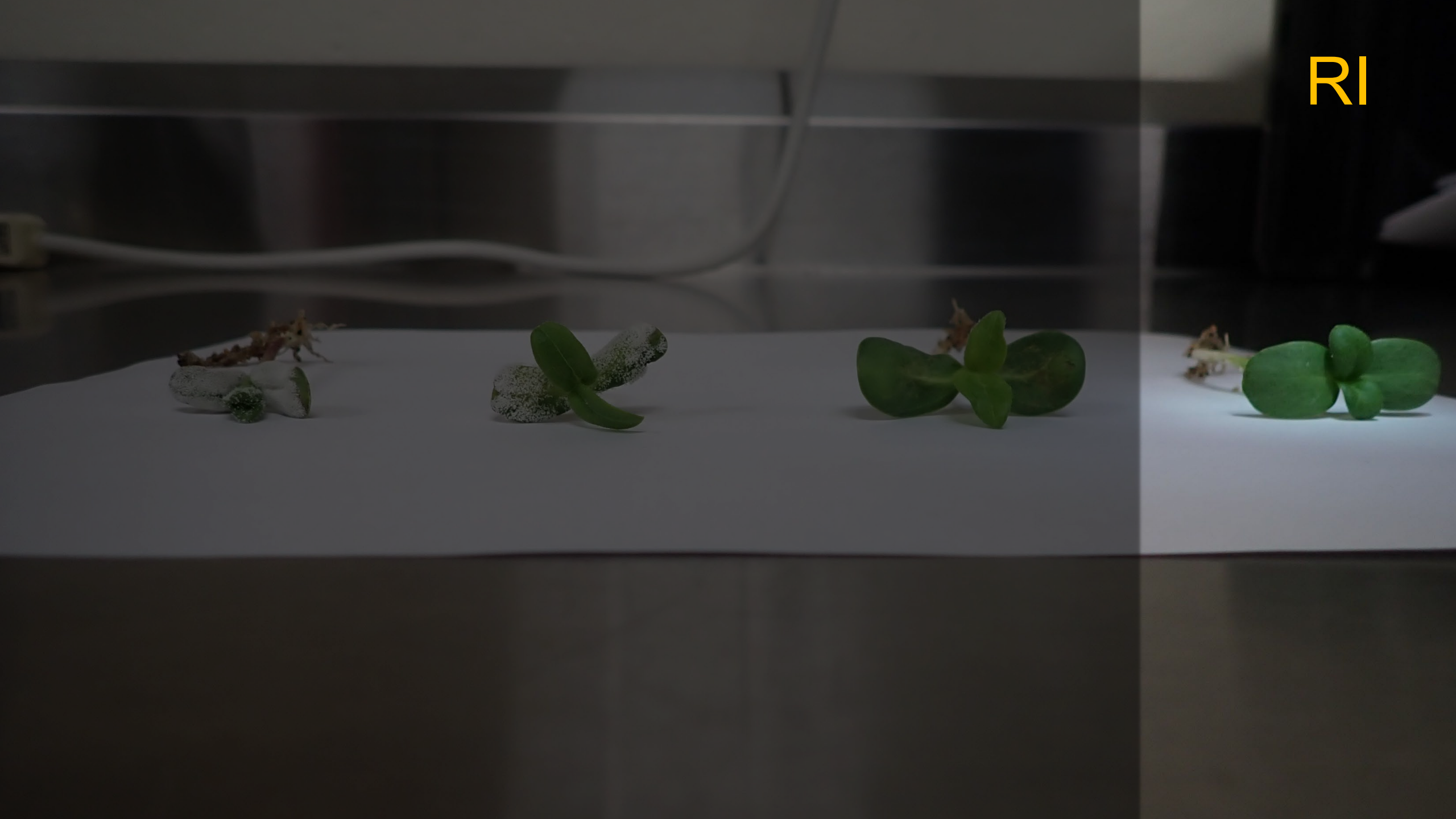


Visual Evaluation = Reaction Types

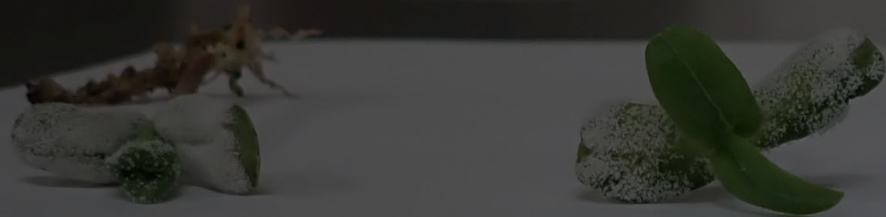
- SI = susceptible, sporulation on cotyledons and true leaves
- SII = abundant sporulation on cotyledons only
- RII = weak sporulation on cotyledons (spores not easily seen from 50 cm away in normal light)
- RI = resistant, no sporulation



RI



R11



SII



SI



US Standard Differential Lines

	Line	Resistance Gene	Virulent/ Screened	Percent Virulent
D-1	Susceptible	...		
D-2	RHA 265	PI ₁		
D-3	RHA 274	PI ₂ /PI ₂₁		
D-4	DM-2	PI ₅		
D-5	PM 17	PI ₅₋		
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D-8	HA-R5	PI ₁₃		
D-9	HA 335	PI ₆		

US Standard Differential Lines

	Line	Resistance Gene	Virulent/ Screened	Percent Virulent
D-1	Susceptible	...	35/35	
D-2	RHA 265	PI ₁	31/35	
D-3	RHA 274	PI ₂ /PI ₂₁	29/35	
D-4	DM-2	PI ₅	31/35	
D-5	PM 17	PI ₅₋	0/35	
D-6	803-1	PI ₅₊	0/35	
D-7	HA-R4	PI ₁₆	1/35	
D-8	HA-R5	PI ₁₃	1/35	
D-9	HA 335	PI ₆	21/35	

US Standard Differential Lines

	Line	Resistance Gene	Virulent/ Screened	Percent Virulent
D-1	Susceptible	...	35/35	100%
D-2	RHA 265	PI ₁	31/35	89%
D-3	RHA 274	PI ₂ /PI ₂₁	29/35	83%
D-4	DM-2	PI ₅	31/35	89%
D-5	PM 17	PI ₅₋	0/35	0%
D-6	803-1	PI ₅₊	0/35	0%
D-7	HA-R4	PI ₁₆	1/35	3%
D-8	HA-R5	PI ₁₃	1/35	3%
D-9	HA 335	PI ₆	21/35	60%

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D-2	RHA 265	PI ₁	31/35	89%
D-3	RHA 274	PI ₂ /PI ₂₁	29/35	83%
D-4	DM-2	PI ₅	31/35	89%
D-5	PM 17	PI ₅₋	0/35	0%
D-6	803-1	PI ₅₊	0/35	0%
D-7	HA-R4	PI ₁₆	1/35	3%
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D-5	PM 17	PI ₅₋	0/35	0%
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D-7	HA-R4	PI ₁₆	1/35	3%
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Supplemental Differential Lines

	Line	Resistance Gene	Virulent/ Screened	Percent Virulent (%)
D-10	Y7Q	PI ₆₋		
D-11	PSC8	PI ₂		
D-12	XA	PI ₄		
D-13	PSS2RM	PI ₆ /PI ₂₁		
D-14	VAQ	PI ₅		
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D-14	VAQ	PI ₅	1/35	
D-15	RHA 419	PI _{Arg}	0/35	
D-16	RHA 491	PI ₁₅	0/35	
D-17	RHA 340	PI ₈	10/35	
D-18	RHA 490	PI ₁₇	0/35	

Supplemental Differential Lines

	Line	Resistance Gene	Virulent/ Screened	Percent Virulent (%)
D-10	Y7Q	PI ₆₋	21/35	60%
D-11	PSC8	PI ₂	34/35	97%
D-12	XA	PI ₄	29/35	83%
D-13	PSS2RM	PI ₆ /PI ₂₁	16/35	46%
D-14	VAQ	PI ₅	1/35	3%
D-15	RHA 419	PI _{Arg}	0/35	0%
D-16	RHA 491	PI ₁₅	0/35	0%
D-17	RHA 340	PI ₈	10/35	29%
D-18	RHA 490	PI ₁₇	0/35	0%

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D-15	RHA 419	PI _{Arg}	0/35	0%
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D-13	PSS2RM	PI ₆ /PI ₂₁	16/35	46%
D-14	VAQ	PI ₅	1/35	3%
D-15	RHA 419	PI _{Arg}	0/35	0%
D-16	RHA 491	PI ₁₅	0/35	0%
D-17	RHA 340	PI ₈	10/35	29%
D-18	RHA 490	PI ₁₇	0/35	0%

Race

- Way to code the virulence into a name (race)
- Helpful way to visualize diversity

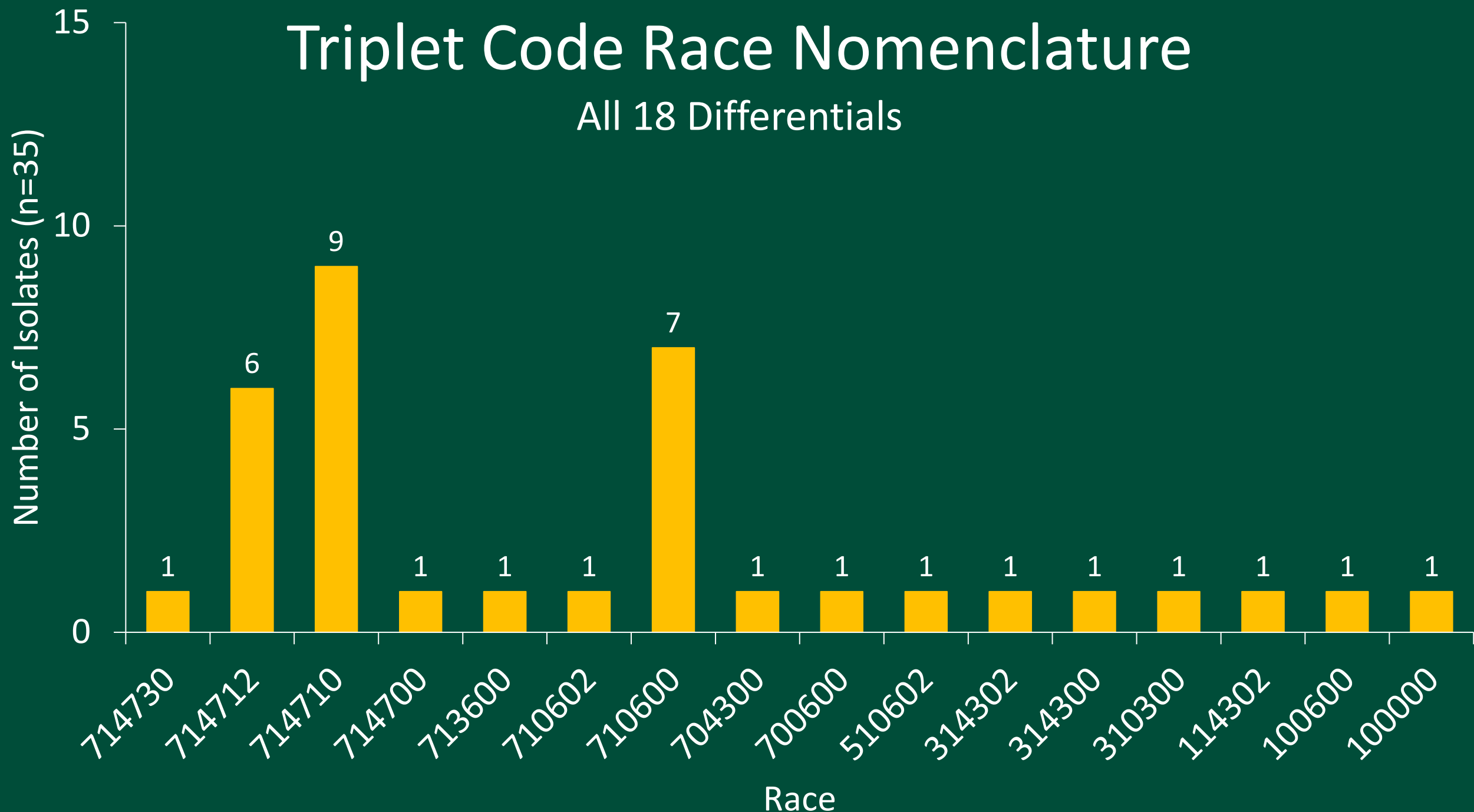
Triplet Code Race Nomenclature

All 18 Differentials

Number of Isolates (n=35)

714730 714712 714710 714700 713600 710602 710600 704300 700600 510602 314302 314300 310300 114302 100600 100000

Race



Take home messages

- Limited Downy Mildew Prevalence
- No *new* virulence
- Percent isolates virulence on
 - PI₈ increased from 4% (2015) to 29%
 - PI₆ increased from 47% (2015) to 60%
- Periodic monitoring remains important

Thank You!

- Everyone who submitted or collected samples!!!
- National Sunflower Association
- Jess, Bryan, Gabe D., Rick, Gabe L.