USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Update on USDA Sunflower Pathology Progress

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Sunflower Diseases

Downy Mildew
Oomycete
Plasmopara halstedii

Rust
Fungus
Puccinia helianthi

Sclerotinia Head Rot
Fungus
Sclerotinia sclerotiorum

Sclerotinia Stalk Rot
Fungus
Sclerotinia sclerotiorum

Phomopsis Stem Canker
Fungus
Diaporthe helianthi / Diaporthe gulyae

Sunflower Diseases

Single, dominant gene resistance

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Complex, polygenic resistance

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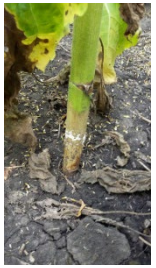
Lab Focus Areas



- Sclerotinia basal stalk rot
  - Identification of highly resistant germplasm resources and genetic mapping
  - Genome-wide association mapping with SAM population
  - Characterization of resistant lines and oxalic acid tolerance trait
  - Evaluation of breeding materials (w/ Brent Hulke)

- Sclerotinia head rot
  - Genetic mapping of resistance loci introgressed from wild perennials
  - Mapping of resistance in an OPV PI line with multiple resistance
  - Field evaluation of breeding materials (collaboration w/ Brent Hulke)

- Mechanisms of resistance to Sclerotinia
  - *Arabidopsis* resources to identify genes and mechanisms for *Sclerotinia* resistance

- Phomopsis stem canker
  - Identification of highly resistant germplasm resources and genetic mapping
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  - Characterization of *D. helianthi* genetic and pathogenic variation
  - Evaluation of sunflower response to toxins present in *D. helianthi* culture filtrates

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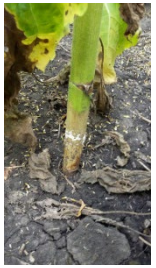

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Sunflower lines with resistance to basal stalk rot

Accession Name	*S. sclerotiorum* Isolate					
	NEB-274	BN 166	JS 577	BN 337	JS 679	BN 169
HA 124	20.2*	17.6*	27.1*	22.3*	29.0*	19.2*
HIR 34	20.6*	17.3*	16.6*	13.2*	28.7*	17.7*
Romsun V3355 AC	16.0*	16.7*	13.3	14.0*	27.9*	13.2*
A-1499	20.6*	15.2*	16.6*	25.2*	21.6*	11.4 *
HA 61	16.5*	15.1*	16.6*	13.9*	20.6*	13.9*
No. 9121	18.9*	14.8*	15.7*	12.1	24.9*	13.4*
Zelenka	16.8*	14.3*	17.7*	12.9*	22.6*	11.1*
RHA 408	16.4*	13.9*	16.8*	11	20.6*	11.3*
RHA 801	14.8*	13.8*	18.6*	12.4	22.0*	11.3*
VIR 160	16.3*	13.1*	13.5	14.7*	21.8*	12.4*
HA 390	15.3*	13.0*	15.2*	13.9*	19.8*	10.2*
FS-a-3	16.6*	13.0*	13.7	12.8*	27.2*	12.1*
CMG-3	16.3*	12.2*	12.3	12.4*	19.0*	11.0*
Short Russian	17.1*	12.1*	18.0*	10.1	23.5*	11.2*
Voshod Elite 7	16.4*	11.9*	11.8	10.1	18.4	10.9*
HA 441	14.1*	10.8*	14.2	10.9	19.5*	10.0*
RHA 439	16.1*	10.4*	13.9	10.6	16.2	10.1*
RHA 373	10.2	8.7	8.6	9	13	8.3
HA 89	11.8	8.5	10.4	10	16.3	8.7
Cabure 1004	8.8	6.9	10.7	9.4	7.8	6.5

Angidi *et al.*, [2025] doi: 10.1094/PHYTO-05-25-0193-R

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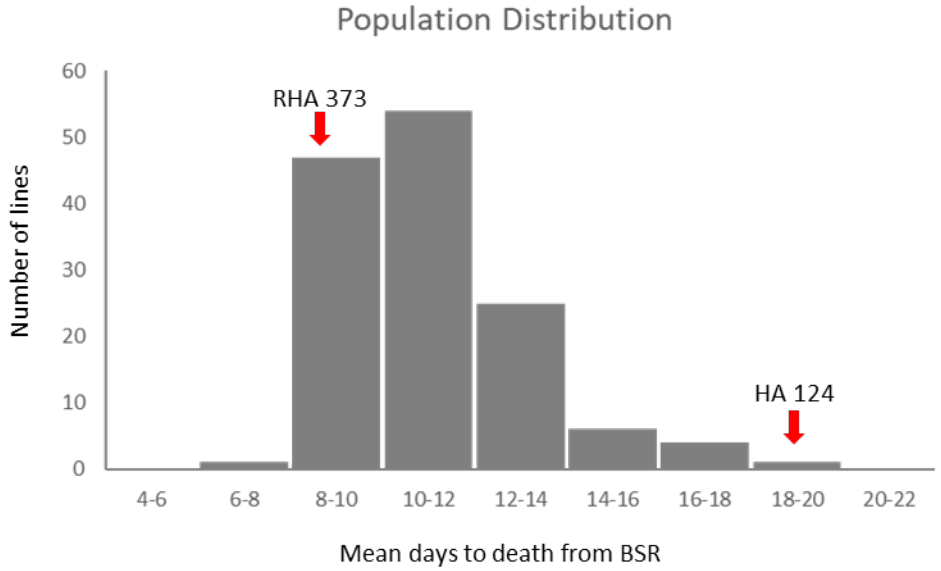
HA 124 – Highly resistant to basal stalk rot, resistance mechanisms unknown.

- Currently mapping resistance loci using RIL population from HA 124 x RHA 373 cross.

Angidi *et al.*, [2025] doi: 10.1094/PHYTO-05-25-0193-R

HA 124 x RHA 373 mapping population



Line	Rank	Mean Days to Death
HA 124	1	19.54347826
RIL 103	2	17.8125
RIL 19	3	16.46341463
RIL 128	4	16.25714286
RIL 14	5	16.21276596
RHA 373	128	8.583333333
RIL 113	138	7

- Population of 138 RILs along with 2 parents inoculated with aggressive *S. sclerotiorum* isolate BN 166, data from 3 reps of greenhouse stalk rot trials.

- Currently evaluating population with isolate NEB-274.

- DNA isolation completed, genotyping data pending.

Underwood *et al*, [unpublished data]

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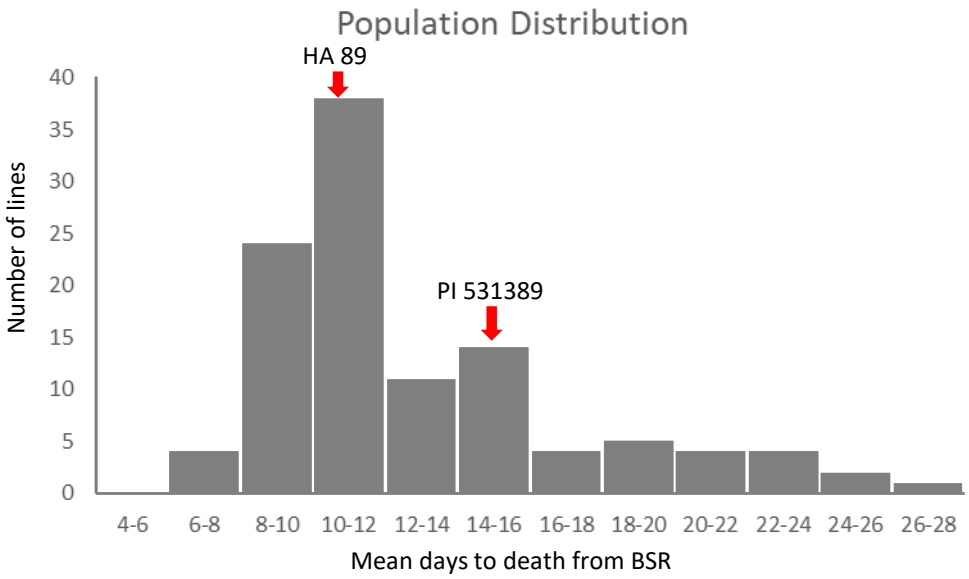
PI 531389 (Slovenska siva) – Partial resistance to basal stalk rot, head rot, and Phomopsis stem canker.

- Currently mapping resistance to stalk rot and Phomopsis using RIL population from PI 531389 x HA 89 cross.

Angidi *et al.*, [2025] doi: 10.1094/PHYTO-05-25-0193-R

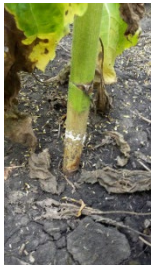
PI 531389 x HA 89 mapping population



- Population of 109 RILs along with 2 parents inoculated with moderately aggressive *S. sclerotiorum* isolate NEB 274.
- DNA isolation completed, genotyping data pending.
- RIL 44 highly resistant, near immune.

Underwood *et al*, [unpublished data]

Lab Focus Areas



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Mechanisms of resistance to Phomopsis

- Reported disease process –
  - Pathogen enters through hydathodes at leaf margin
  - Progresses through leaf tissue to petiole
  - Progresses through petiole to stem
  - Causes stem lesion and pith destruction resulting in early senescence, lateral wilting, necrosis of distal leaves, negative impact on yield, and potential lodging.

- Potential types of resistance –
  - Resistance to pathogen entry
  - Leaf lesion resistance
  - Petiole resistance
  - Stem lesion resistance
  - Resistance to pith degradation

Resistance to stem lesioning

- Evaluated 80 lines in greenhouse experiments with stem-wound inoculation. Selected lines with some evidence of resistance in field trials under natural infection.
- Materials evaluated:
  - 29 lines showing resistance in MN and SD trials in 2011-2012 (Talukder, Hulke, Gulya).
  - 20 lines showing resistance in MN (Gulya) and Yugoslavia (Masirevic) trials in 1997-1999.
  - 31 lines acquired in germplasm exchange with Russia and showing resistance in Russian field trials.
- Goals:
  - Determine type of resistance.
  - Identify lines with best resistance of different types.

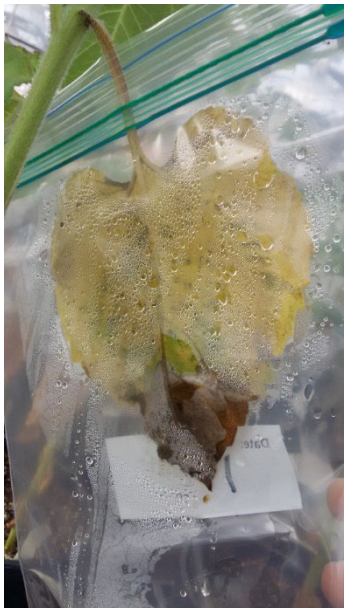
PI 650675 (CO-PB 39)

HA 410 (S control)

Underwood and Misar, [2024] doi: 10.1094/PDIS-03-23-0610-RE

Resistance to leaf lesioning

- Evaluated 25 lines for progression of pathogen through leaf and petiole tissues after leaf inoculation. Lines are subset of those evaluated for stem lesion resistance.


Underwood and Misar, [2024] doi: 10.1094/PDIS-03-23-0610-RE

Resistance at petiole to stem transition

- Evaluated 60 lines for stem lesion formation after cut petiole inoculation with *D. helianthi* or *D. gulyae*.

D. helianthi

HA 337

PI 250085

D. gulyae

HA 337

PI 250085

Underwood and Misar, [2024] doi: 10.1094/PDIS-03-23-0610-RE

Summary of lines with different physiological forms of resistance

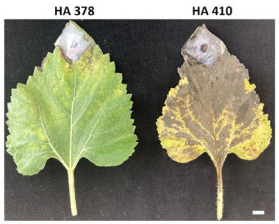
Stem

PI 650675

HA 410

Line	Stem Lesion		Disease Rating		Resistant	
	D. helianthi	*D. gulyae*	*D. helianthi*	*D. gulyae*	*D. helianthi*	*D. gulyae*
HA 378	43.25	57.15	2.75	3.17	**Y**	**Y**
CM 198	50.38	105.95	2.5	4	Y	N
HA 323	55.46	N/A	3.17	4.33	Y	N
PI 650675	63.64	78.58	3.25	3.42	**Y**	**Y**
PI 526254	73.08	N/A	3.25	4.33	Y	N
PI 531389	68.97	103.54	3.33	4.83	Y	N
PI 650703	87.68	N/A	3.36	4	Y	N
PI 433862	88.89	117.2	3.5	4.67	Y	N
PI 650699	68.25	106.52	3.25	4.58	Y	N
HA 421	108.97	74.35	4	3	N	Y
HA 410	132.49	113.91	4.75	4.75	Susceptible Control	

Leaf



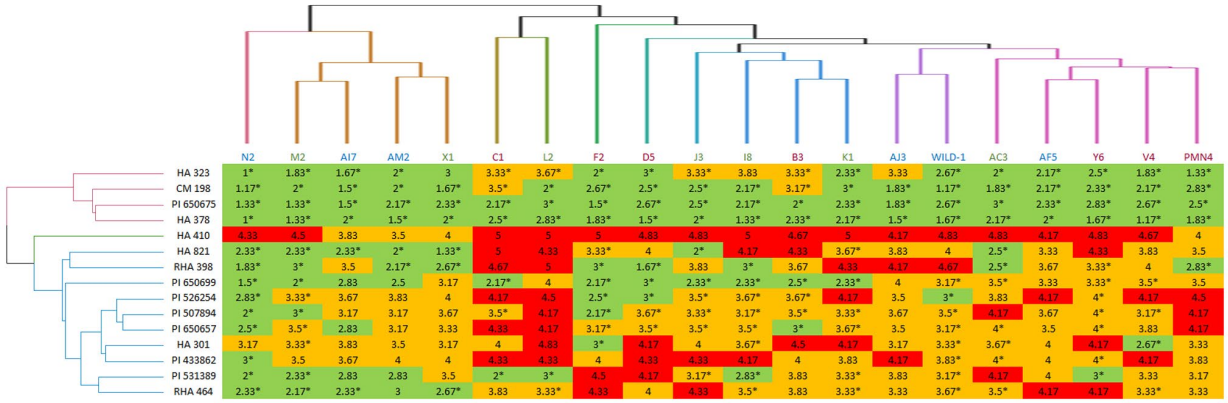
Line	Lesion Rate (mm/h)		Resistant	
	D. helianthi	*D. gulyae*	*D. helianthi*	*D. gulyae*
RHA 354	0.29	0.34	Y	
HA 378	0.36	0.32	Y	
HA 421	0.38	0.33	Y	
HA 821	0.4	0.32	Y	
HA-R4	0.4	0.34	Y	
HA 410	0.56	0.26	Susceptible Control	

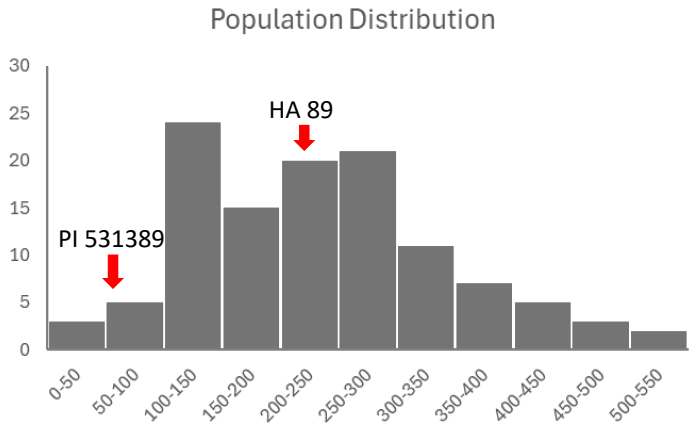
Petiole

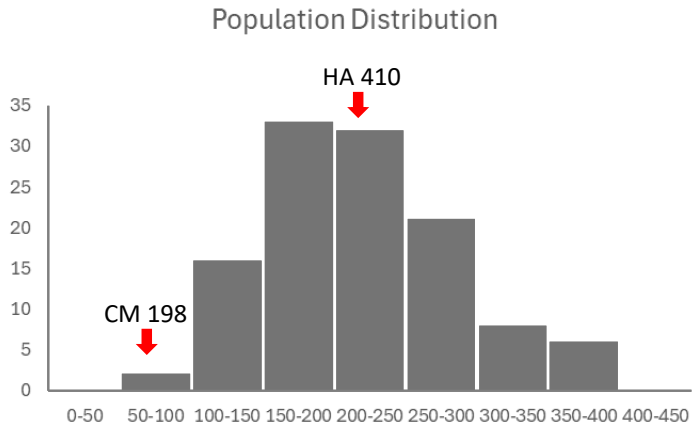
Line	Lesion length 14 dpi		Lesion Frequency 14 dpi		Resistant	
	D. helianthi	*D. gulyae*	*D. helianthi*	*D. gulyae*	*D. helianthi*	*D. gulyae*
PI 250085	3.76	18.28	18.18	77.78	**Y**	**Y**
PI 162454	8.79	N/A	50	N/A	Y	N/A
PI 507896	10.12	7.68	50	54.54	**Y**	**Y**
PI 531377	11.16	11.82	54.54	62.5	**Y**	**Y**
PI 531340	14.16	5.73	33.33	44.44	**Y**	**Y**
RHA 397	16.35	14.3	57.14	83.33	**Y**	**Y**
PI 650681	17.46	9.61	75	50	**Y**	**Y**
RHA 486	21.18	21.24	55.55	70	**Y**	**Y**
PI 650385	31.97	1.43	60	11.1	N	Y
PI 490282	38.68	6.91	70	54.54	N	Y
PI 494856	33.85	7.02	55.54	50	N	Y
HA 337	123.43	57.34	100	100	Susceptible Control	
HA 410	73.5	50.51	75	100	Susceptible Control	

Underwood and Misar, [2024] doi: 10.1094/PDIS-03-23-0610-RE
Underwood *et al*, [unpublished data]

Mapping stem lesion resistance in PI 531389 and CM 198





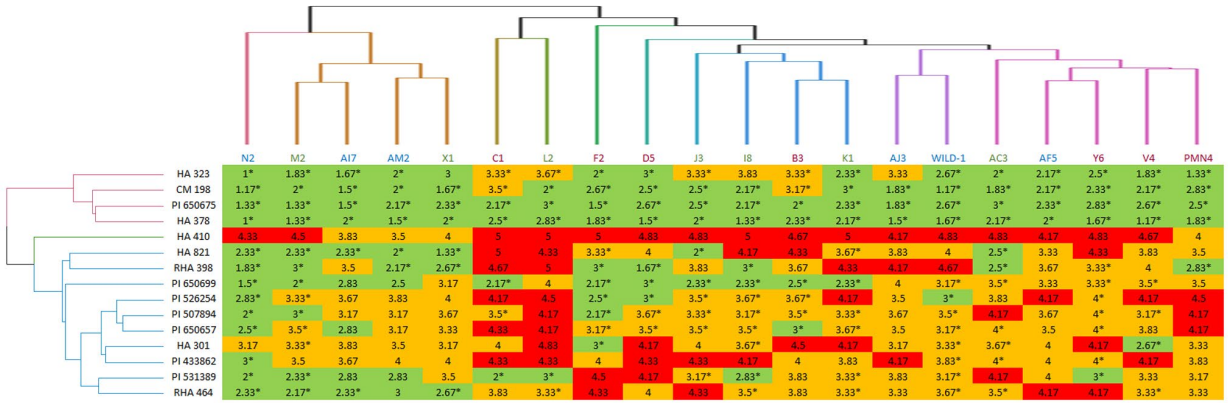


- PI 531389 x HA 89 RILs inoculated w/ D. helianthi L2
- RIL 44 most resistant to Phomopsis and Sclerotinia stalk rot

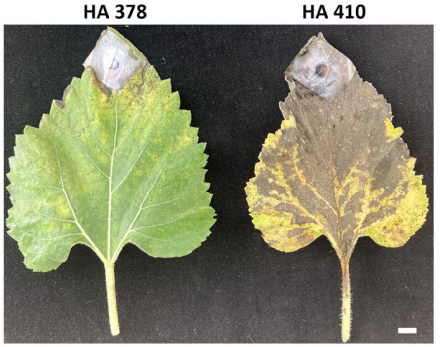
- CM 198 x HA 410 RILs inoculated w/ *D. helianthi* Wild-1

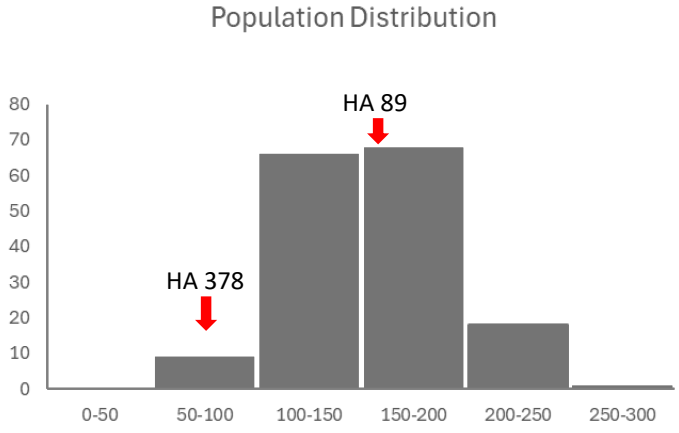
Underwood [2025] doi: 10.1111/ppa.14061
Underwood *et al*, [unpublished data]

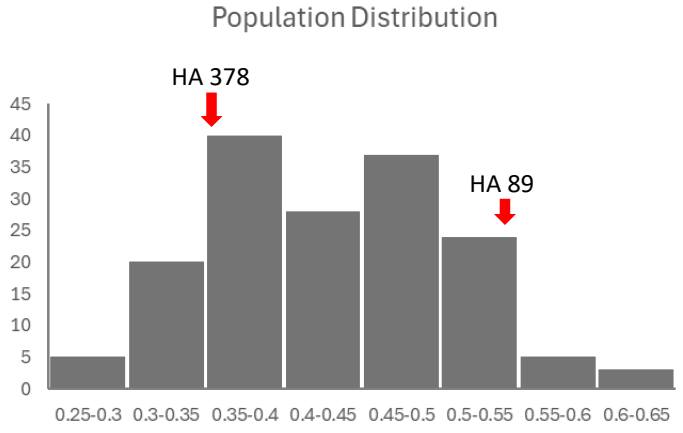
Mapping stem and leaf resistance in HA 378



	N2	M2	AI7	AM2	X1	C1	L2	F2	D5	J3	I8	B3	K1	AJ3	WILD-1	AC3	AF5	Y6	V4	PMN4
HA 323	1*	1.83*	1.67*	2*	3	3.33*	3.67*	2*	3*	3.33*	3.83	3.33*	2.33*	3.33	2.67*	2*	2.17*	2.5*	1.83*	1.33*
CM 198	1.17*	2*	1.5*	2*	1.67*	3.5*	2*	2.67*	2.5*	2.5*	2.17*	3.17*	3*	1.83*	1.17*	1.83*	2.17*	2.33*	2.17*	2.83*
PI 650675	1.33*	1.33*	1.5*	2.17*	2.33*	2.17*	3*	1.5*	2.67*	2.5*	2.17*	2*	2.33*	1.83*	2.67*	3*	2.33*	2.83*	2.67*	2.5*
HA 378	1*	1.33*	2*	1.5*	2*	2.5*	2.83*	1.83*	1.5*	2*	1.33*	2.33*	2.17*	1.5*	1.67*	2.17*	2*	1.67*	1.17*	1.83*
HA 410	4.33	4.5	3.83	3.5	4	5	5	5	4.83	4.83	5	4.67	5	4.17	4.83	4.83	4.17	4.83	4.67	4
HA 821	2.33*	2.33*	2.33*	2*	1.33*	5	4.33	3.33*	4	2*	4.17	4.33	3.67*	3.83	4	2.5*	3.33	4.33	3.83	3.5
RHA 398	1.83*	3*	3.5	2.17*	2.67*	4.67	5	3*	1.67*	3.83	3*	3.67	4.33	4.17	4.67	2.5*	3.67	3.33*	4	2.83*
PI 650699	1.5*	2*	2.83	2.5	3.17	2.17*	4	2.17*	3*	2.33*	2.33*	2.5*	2.33*	4	3.17*	3.5*	3.33	3.33*	3.5*	3.5
PI 526254	2.83*	3.33*	3.67	3.83	4	4.17	4.5	2.5*	3*	3.5*	3.67*	3.67*	4.17	3.5	3*	3.83	4.17	4*	4.17	4.5
PI 507894	2*	3*	3.17	3.17	3.67	3.5*	4.17	2.17*	3.67*	3.33*	3.17*	3.5*	3.33*	3.67	3.5*	4.17	3.67	4*	3.17*	4.17
PI 650657	2.5*	3.5*	2.83	3.17	3.33	4.33	4.17	3.17*	3.5*	3.5*	3.5*	3*	3.67*	3.5	3.17*	4*	3.5	4*	3.83	4.17
HA 301	3.17	3.33*	3.83	3.5	3.17	4	4.83	3*	4.17	4	3.67*	4.5	4.17	3.17	3.33*	3.67*	4	4.17	2.67*	3.33
PI 433862	3*	3.5	3.67	4	4	4.33	4.33	4	4.33	4.33	4.17	4	3.83	4.17	3.83*	4*	4	4*	4.17	3.83
PI 531389	2*	2.33*	2.83	2.83	3.5	2*	3*	4.5	4.17	3.17*	2.83*	3.83	3.33*	3.83	3.17*	4.17	4	3*	3.33	3.17
RHA 464	2.33*	2.17*	2.33*	3	2.67*	3.83	3.33*	4.33	4	4.33	3.5*	3.83	3.33*	3.33	3.67*	3.5*	4.17	4.17	3.33*	3.33







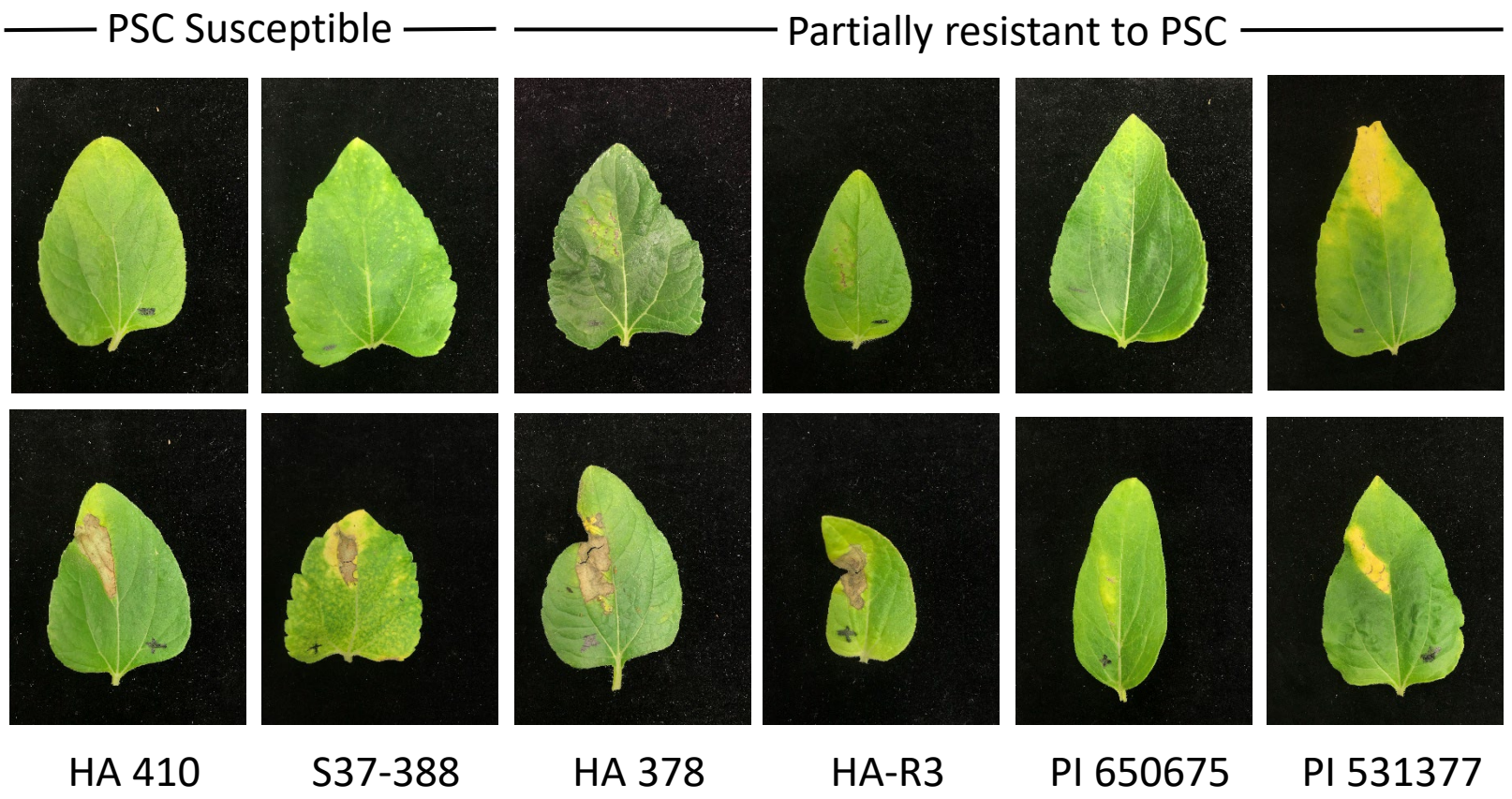
- Stem inoculation with *D. helianthi* isolate L2
- No correlation between stem and leaf responses, consistent with prior observations

- Leaf inoculation with *D. helianthi* isolate L2

Underwood [2025] doi: 10.1111/ppa.14061
Underwood *et al*, [unpublished data]

Diaporthe helianthi toxic metabolites

- Evaluation of lines with partial PSC resistance for response to crude *D. helianthi* culture filtrate



Underwood *et al*, [unpublished data]

Diaporthe helianthi isolates

Underwood *et al*, [unpublished data]

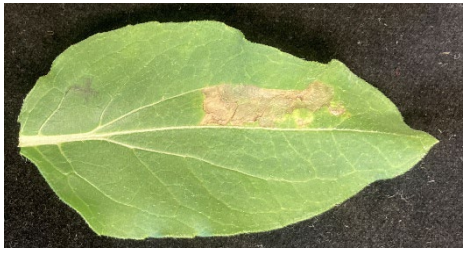
Mapping toxin insensitivity trait

PI 650675

HA 410

- Crossed insensitive PI 650675 w/ sensitive HA 410.
- Complication - PI 650675 not day neutral, flowering under normal conditions highly delayed.
- Inheritance of toxin insensitivity and day neutrality.
  - F1 plants sensitive to toxin and day neutral.
  - F2 plants show 3:1 ratio of sensitive to insensitive, consistent with single gene controlling sensitivity.

PI 650675 x HA 410
F1



D. helianthi filtrate

Malt broth control

Underwood *et al*, [unpublished data]

Ongoing and Future Work

- Sclerotinia basal stalk rot
  - Characterization of highly resistant lines.
  - Mapping resistance QTL in multiple populations.
  - RNAseq transcriptomic comparison of resistant and susceptible lines.
  - Genetic and physiological evaluation of oxalic acid tolerance trait.
  - Comparison of transcriptional responses to oxalic acid and stalk rot.

- Phomopsis
  - Physiological characterization of stem lesion resistance and petiole transmission resistance.
  - Genetic mapping of resistance loci for specific resistance traits.
  - Bulked segregant sequencing to map toxin insensitivity trait from PI 650675.
  - Combining multiple forms of resistance to determine if strong, durable resistance can be achieved.

Acknowledgements

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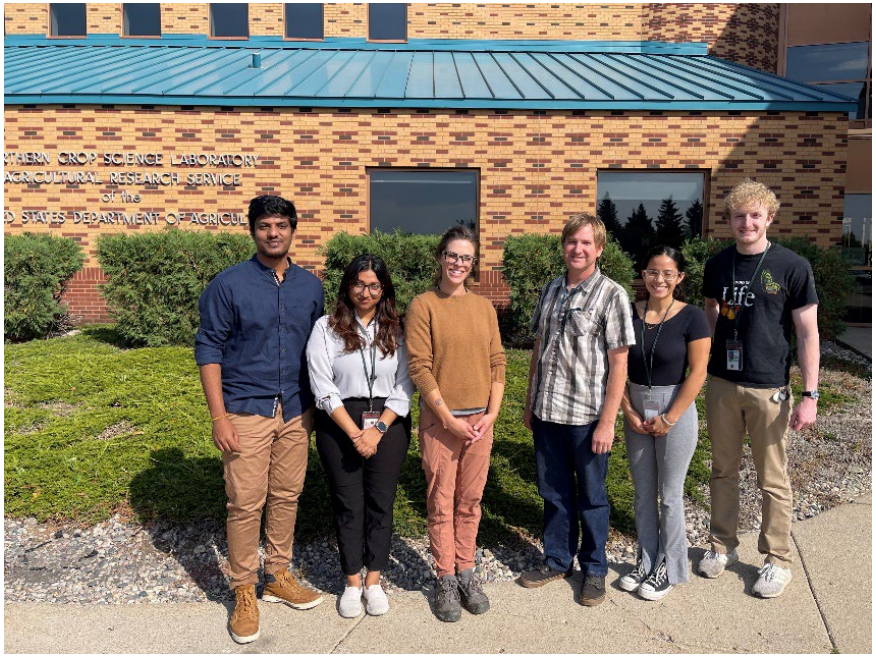

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National Sclerotinia Initiative

THANK YOU

QUESTIONS?

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