Targeting Host Defense and Susceptibility Mechanisms for Engineering FHB Resistance

Jyoti Shah, Vamsi Nalam, Sujon Sarowar, Syeda Alam, Sumita Behera, Hyeonju Lee, Delia Burdan and Harold N. Trick

UNT A green light to greatness.

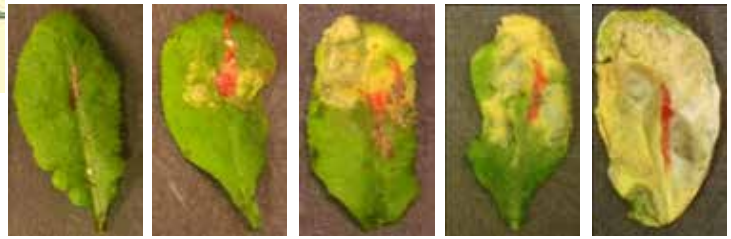
K-State Kansas State University

General Approach

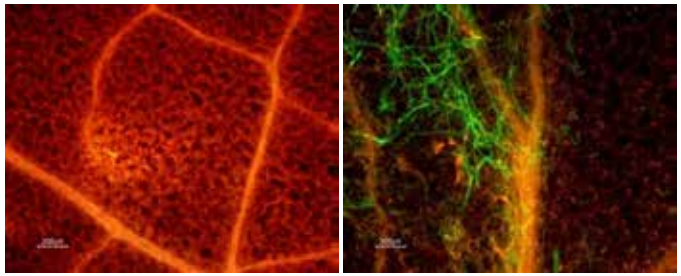
http://ec.europa.eu/research/quality-of life/image/arabidopsis.jpg

- Utilize *Arabidopsis thaliana* to identify and characterize plant genes and mechanisms that
  - contribute to resistance to *Fusarium graminearum*
  - contribute to susceptibility
  - can be used to enhance resistance against *Fusarium graminearum*
- Study the role of candidate genes and mechanisms in wheat interaction with *Fusarium graminearum*
- Target candidate genes and/or mechanisms to enhance immunity in wheat against *Fusarium graminearum*

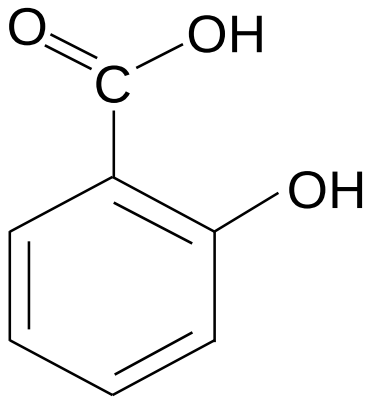
Picture: R. Makandar



Mock <25% 25-50% 50-75% >75%



Mock-inoculated *Fg*-infected



- Wheat and Arabidopsis utilize salicylic acid signaling to control *Fusarium graminearum* infection
- The fungus tries to suppress the sustained induction of salicylic acid signaling

- Makandar et al. 2012. Mol. Plant-Microbe Interact. 25: 431-439.
- Chaturvedi et al. 2012. Plant J. 71: 161-172.
- Makandar et al. 2010. Mol. Plant-Microbe Interact. 23: 861-870.
- Chaturvedi et al. 2008. Plant J. 54: 106-117.
- Makandar et al. 2006. Mol. Plant-Microbe Interact. 19:123-129.

Constitutive expression of *Arabidopsis thaliana NPR1* reduces FHB severity in transgenic wheat

***F. graminearum* infection**

↓

Salicylic acid

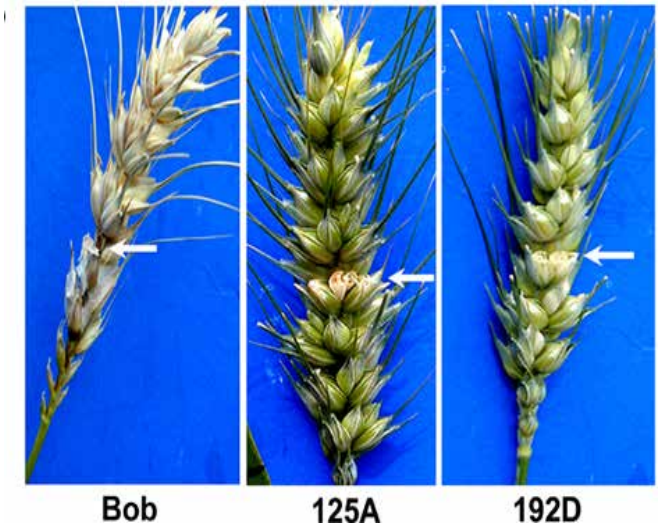
↓

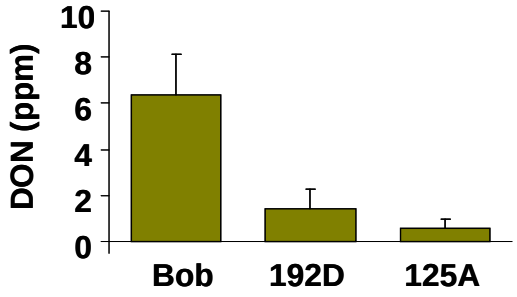
NPR1

↓

***PR* genes**

Protection against *F. graminearum*



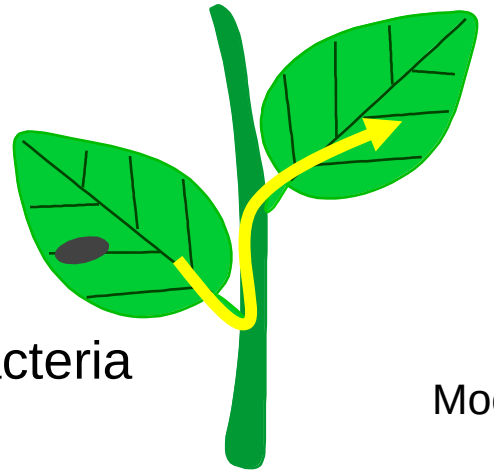


	2012				2011			
	FHB Inc (%)	FHB Sev %	VSK	DON (ppm)	FHB Inc (%)	FHB Sev %	VSK	DON (ppm)
NPR1	72	17	26	7	89	18	31	29
Bobwhite	99	41	36	11	100	50	59	39
Alsen	90	25	16	9	98	33	21	22
Wheaton	98	42	75	16	100	58	68	82
Roblin	98	35	38	7	96	26	41	18

Field trials conducted by Dr. Ruth Dill-Macky

Salicylic acid signaling is involved in systemic acquired resistance (SAR)

A SAR inducing diterpenoid present in petiole exudates of Arabidopsis promotes resistance against *Fusarium graminearum*

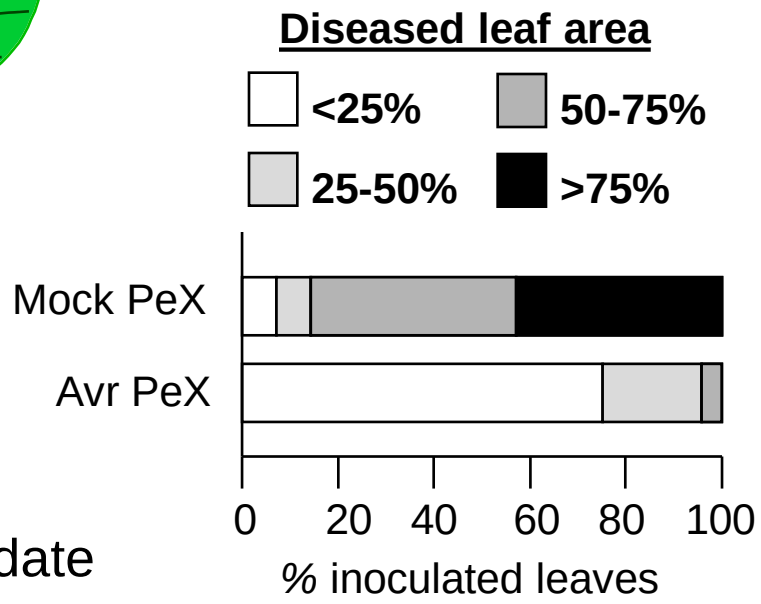


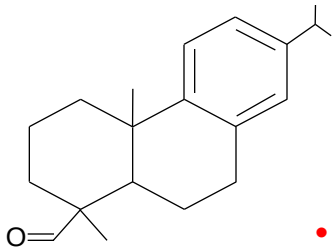
Bacteria

Collect petiole exudate

Inject into healthy plant

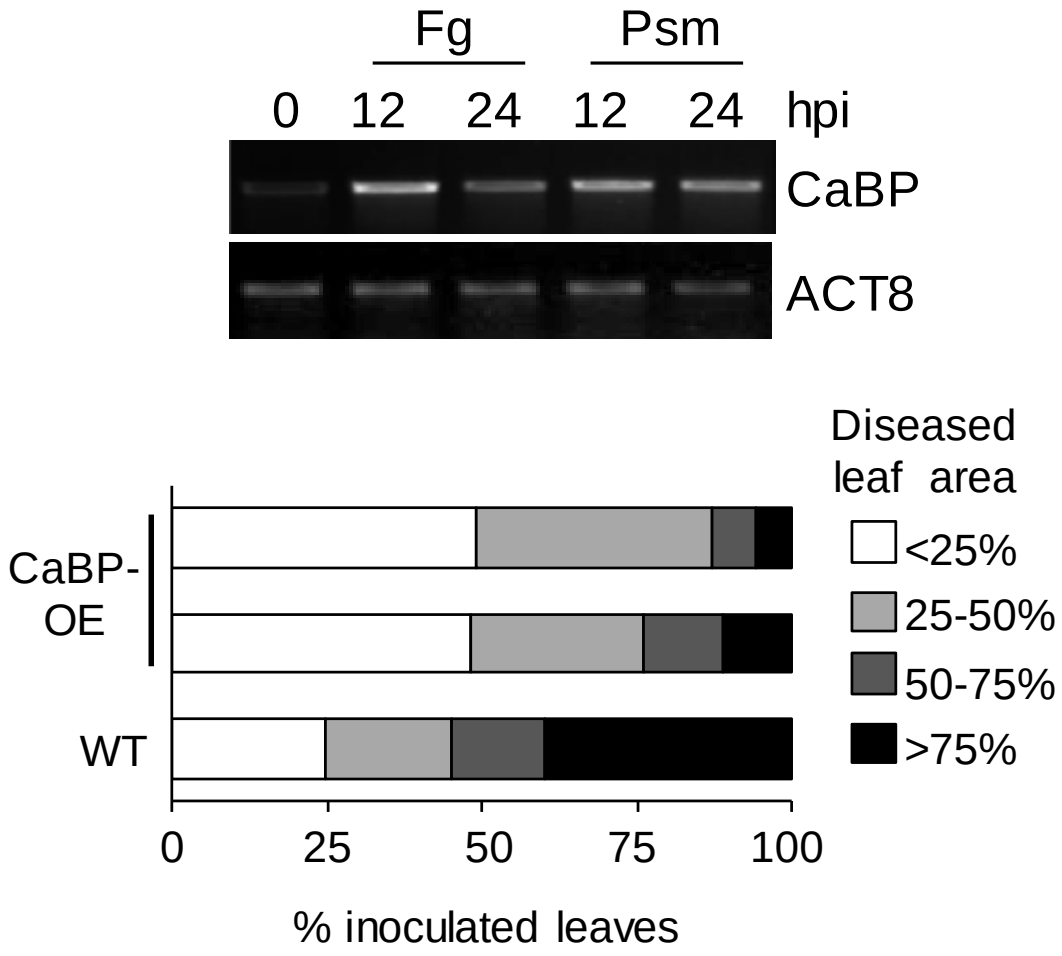
Challenge with pathogen

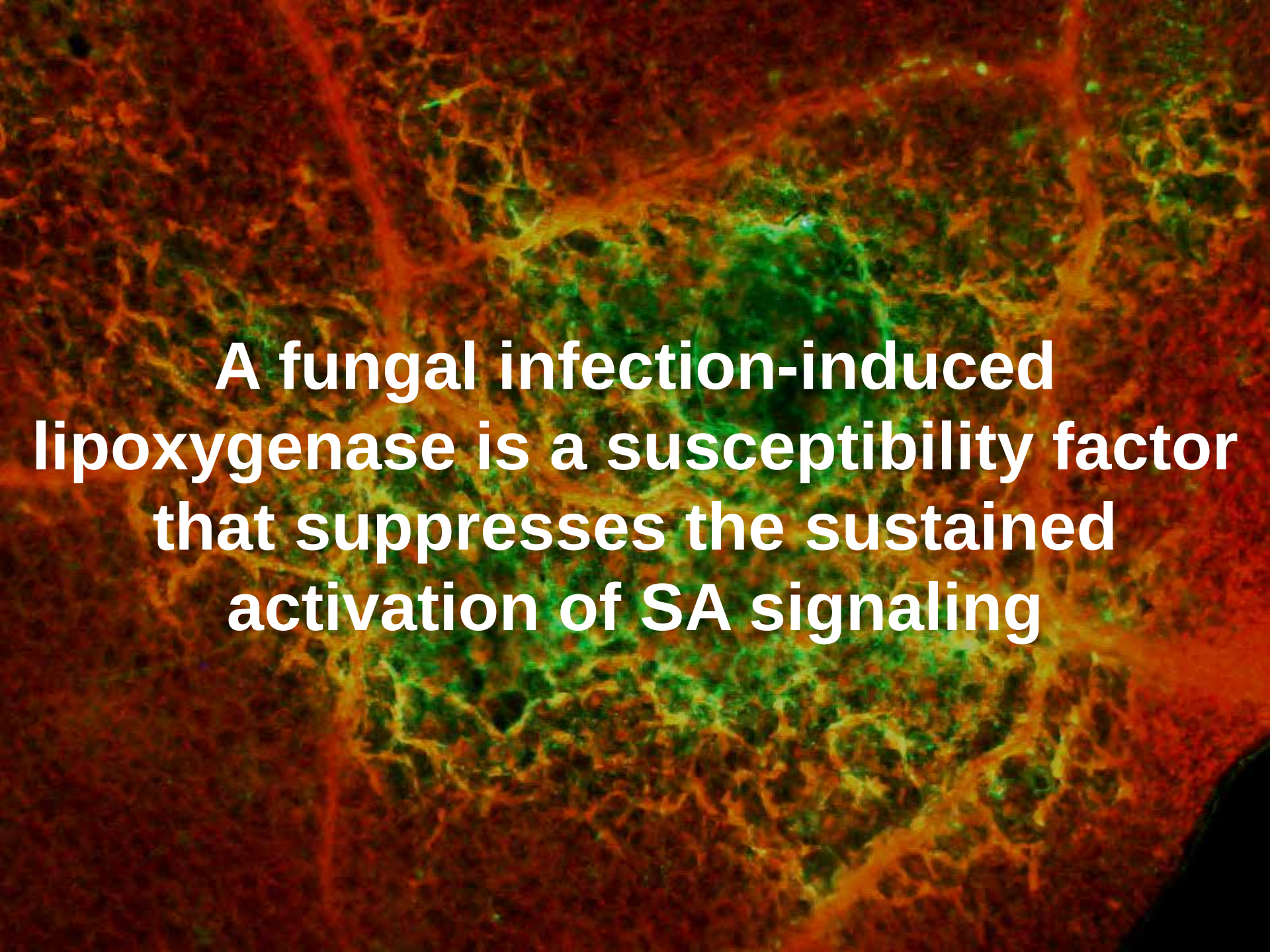




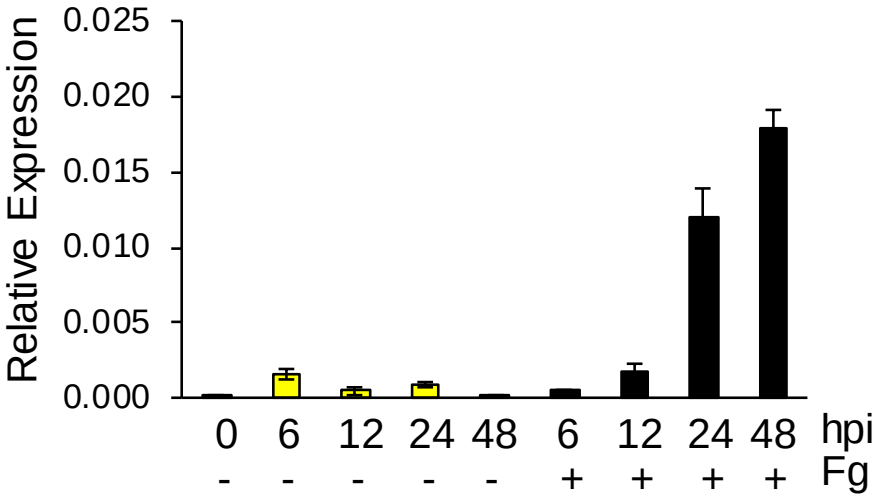
- Chaturvedi et al. 2012. Plant J. 71: 161-172.
- Chaturvedi et al. 2008. Plant J. 54: 106-117.

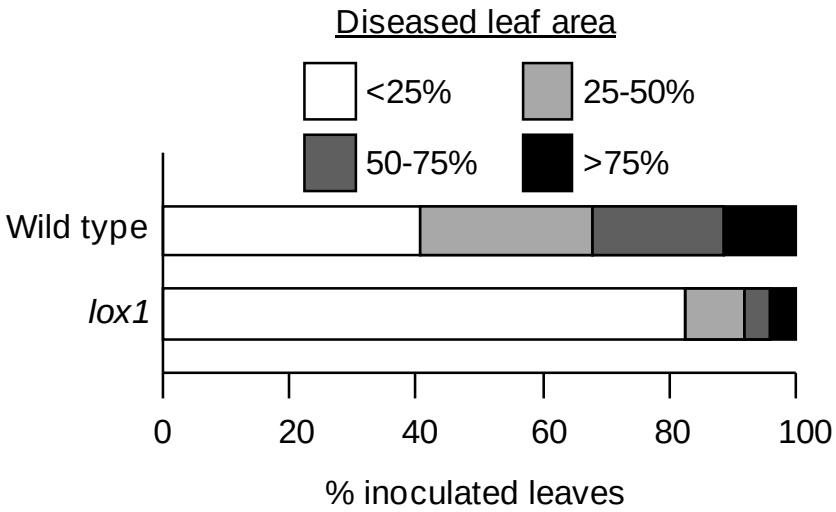
Overexpression of a Ca^{2+}-binding protein that is required for dehydroabietinal-induced SAR enhances resistance against *Fusarium graminearum*

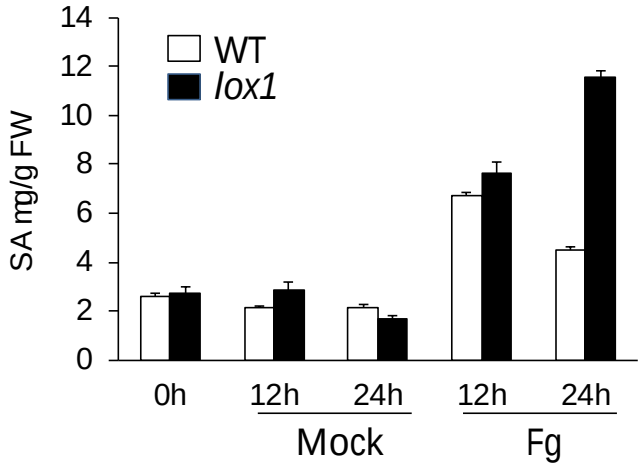



A fungal infection-induced lipoxygenase is a susceptibility factor that suppresses the sustained activation of SA signaling

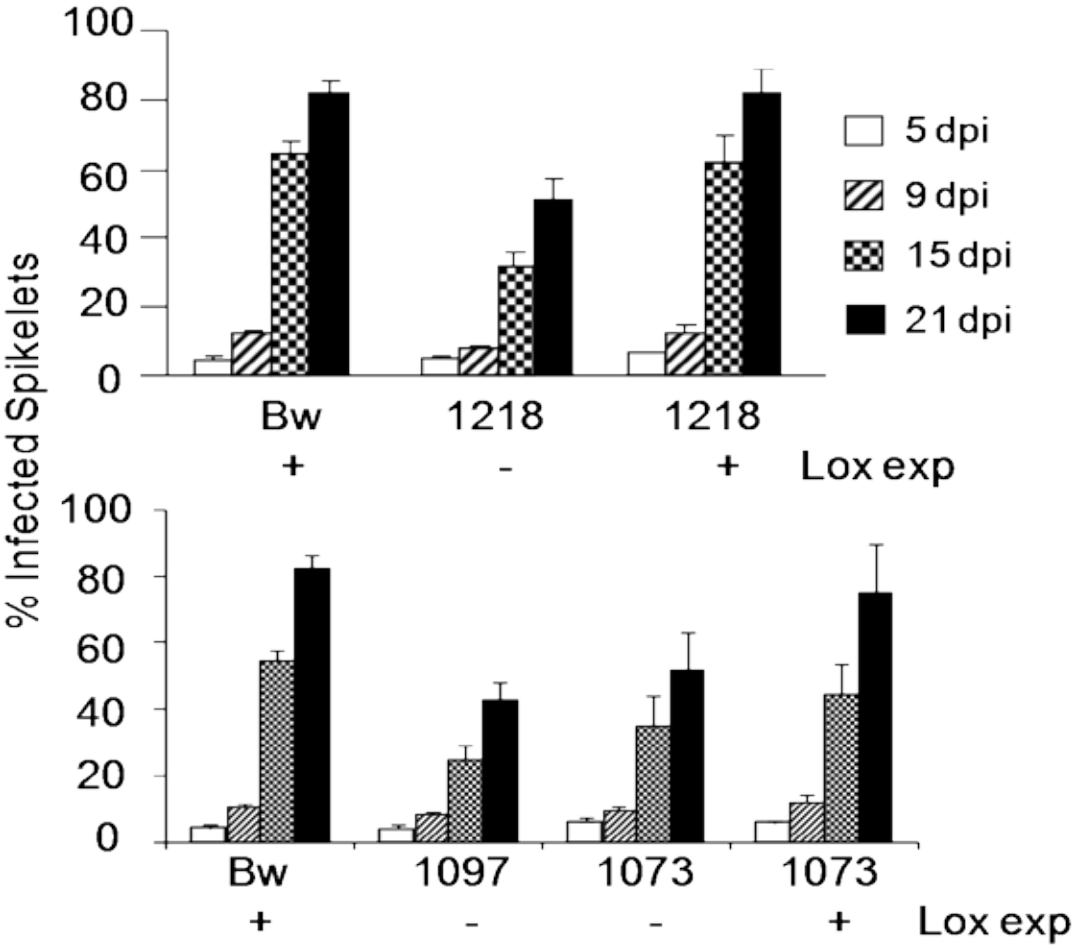
A 9-LOX contributes to susceptibility to *Fusarium graminearum* by suppressing the sustained activation of SA signaling





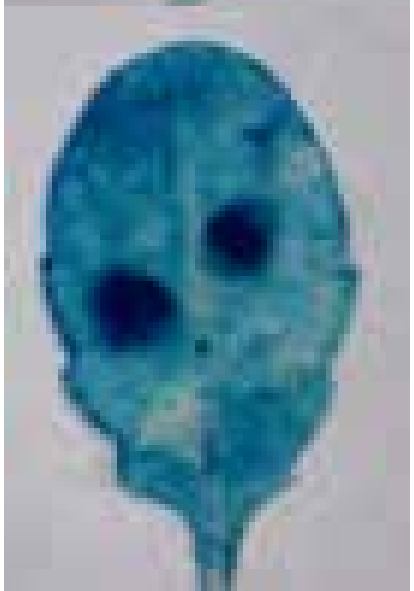


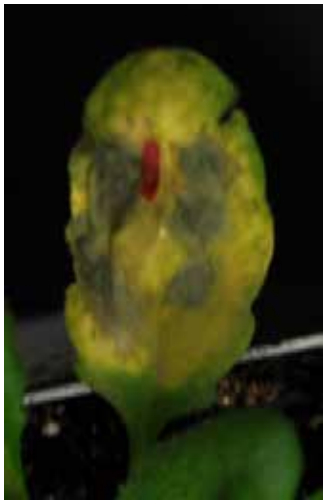
Silencing of 9-LOX in wheat confers enhanced FHB resistance

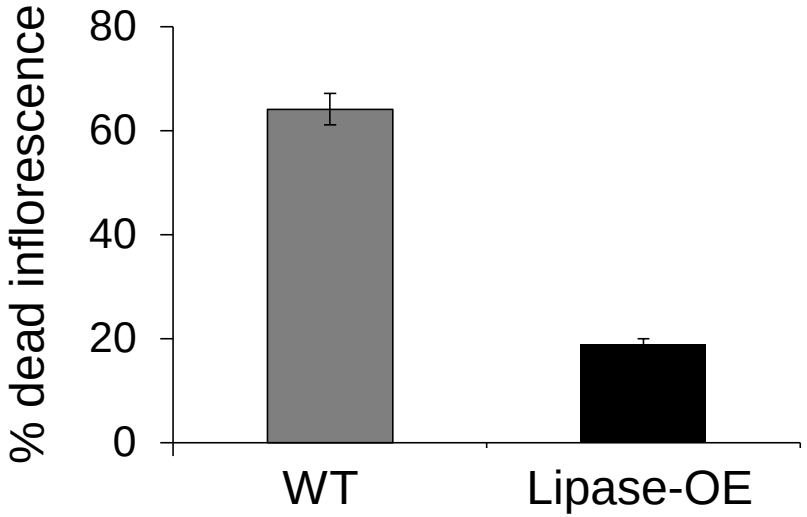



A lipase expressed in floral tissues that is up-regulated upon fungal infection promotes resistance against *Fusarium graminearum*

Constitutive expression of lipase confers enhanced resistance against *F. graminearum*



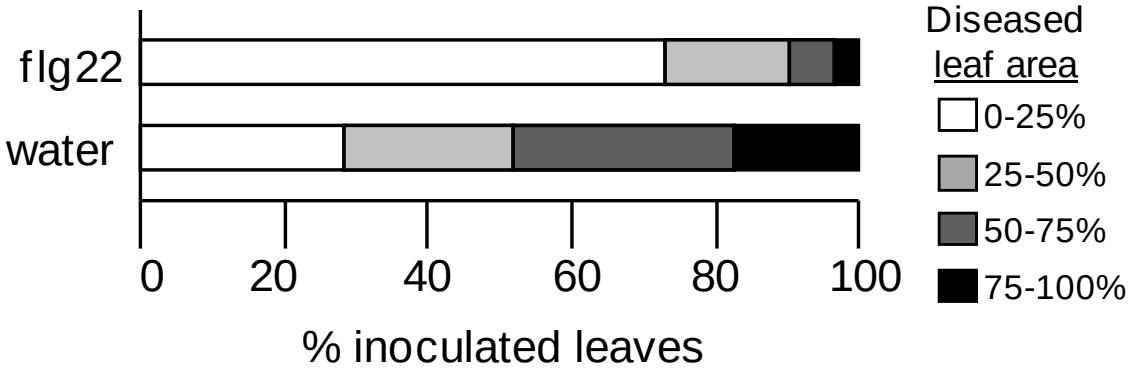


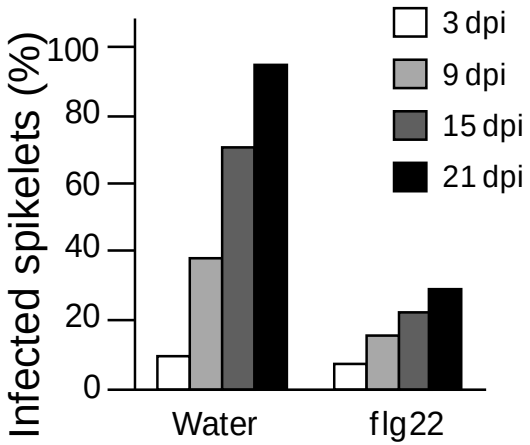


Targeting pathogen-triggered immunity mechanism for promoting resistance against *Fusarium graminearum*

http://www.apsnet.org/education/intropl antpath/Topics/plantdefenses/images/fig05.jpg

The bacterial flagellar protein flagellin-derived flg22 peptide enhances resistance against *Fusarium graminearum*





Can the flg22-inducible mechanism be targeted for enhancing resistance against *Fusarium graminearum*?

Poster # 43
Poster Session 2
Tuesday, December 4, 4:30-6:00 PM
Dr. Sujon Sarowar

Summary

- SA signaling and SAR à important role in defense against *Fusarium graminearum.*
- *NPR1* expression was successfully targeted in wheat to enhance FHB resistance.
- Silencing of a 9-LOX promoted the sustained activation of SA signaling and enhanced FHB resistance.
- New targets/approaches for enhancing resistance against *Fusarium graminearum.*
  - Signaling by the recently discovered SAR inducer, dehydroabietinal.
  - A Ca^{2+}-binding protein that is involved in SAR and dehydroabietinal signaling.
  - A lipase-encoding gene that is expressed in floral tissues and induced upon fungal infection
  - A flg22-mediated mechanism.

Acknowledgements

Dr. Ratnesh Chaturvedi (Univ. North Texas)
Dr. Barney Venables (Univ. North Texas)
Dr. Robby Petros (Univ. North Texas)
Dr. Ruth Welti (Kansas State Univ.)
Dr. Ruth Dill-Macky (Univ. Minnesota)
Dr. Yanhong Dong (Univ. Minnesota)