Genes and Mechanisms Associated with Plant Interaction with *F. graminearum*

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Poster # 55

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Outline

- Signaling mechanisms contributing to plant defense and susceptibility to *F. graminearum*
- Candidate genes for enhancing FHB resistance
- Targeting non-host defense mechanism for controlling FHB
- Plant metabolites for enhancing FHB resistance

1. Signaling mechanisms contributing to plant defense and susceptibility to *F. graminearum*

General Approach

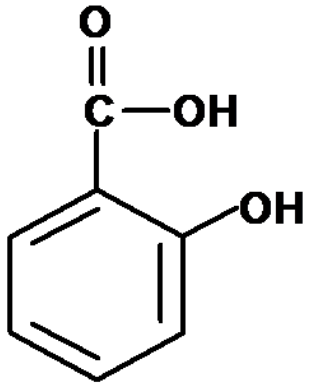
- Utilize genetic and molecular tools in *Arabidopsis thaliana* to identify and characterize plant mechanisms:
  - Contribute to resistance
  - Contribute to susceptibility
- Study the role of candidate mechanisms in wheat interaction with *F. graminearum*

Picture: R. Makandar

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

Phases of *F. graminearum* infection

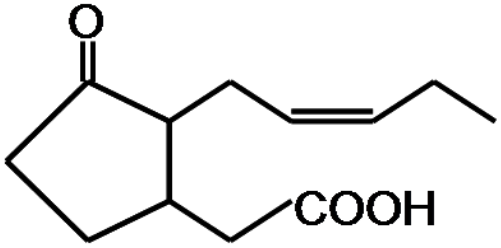
1. Initial biotrophic phase
2. Subsequent necrotrophic phase



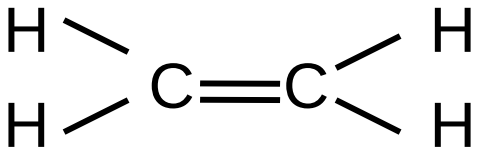
Salicylic acid

- Salicylic acid dependent defenses primarily effective against biotrophic pathogens

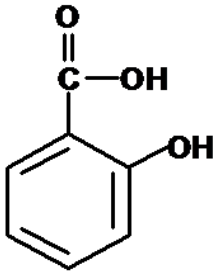
- Jasmonate and ethylene dependent defenses primarily effective against necrotrophic pathogens



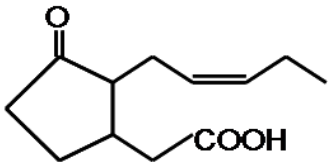
Jasmonic acid

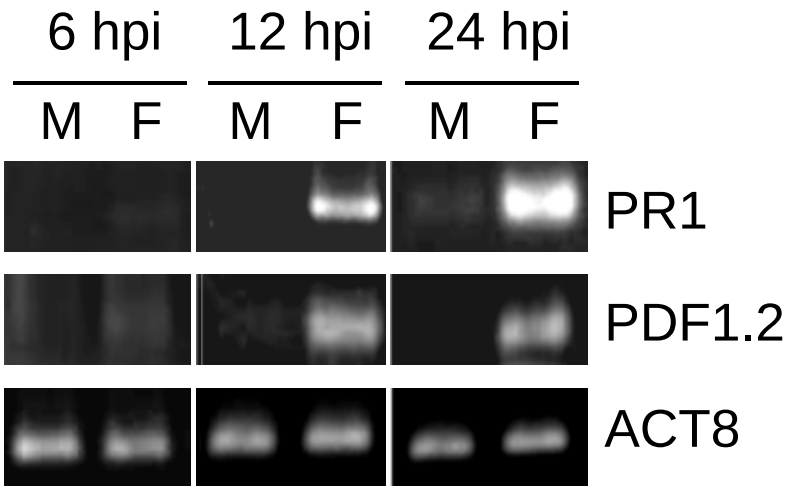


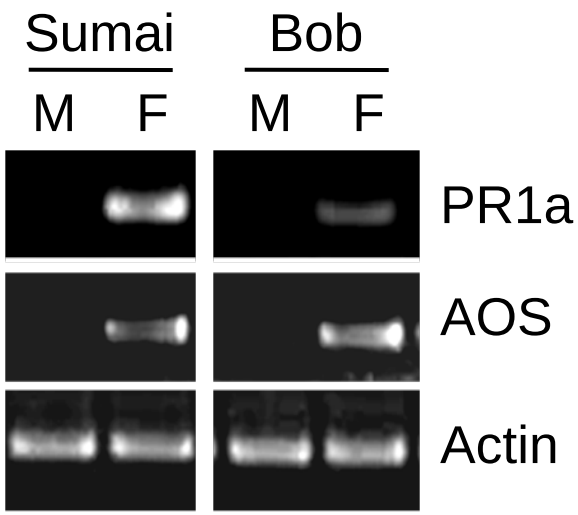
ethylene

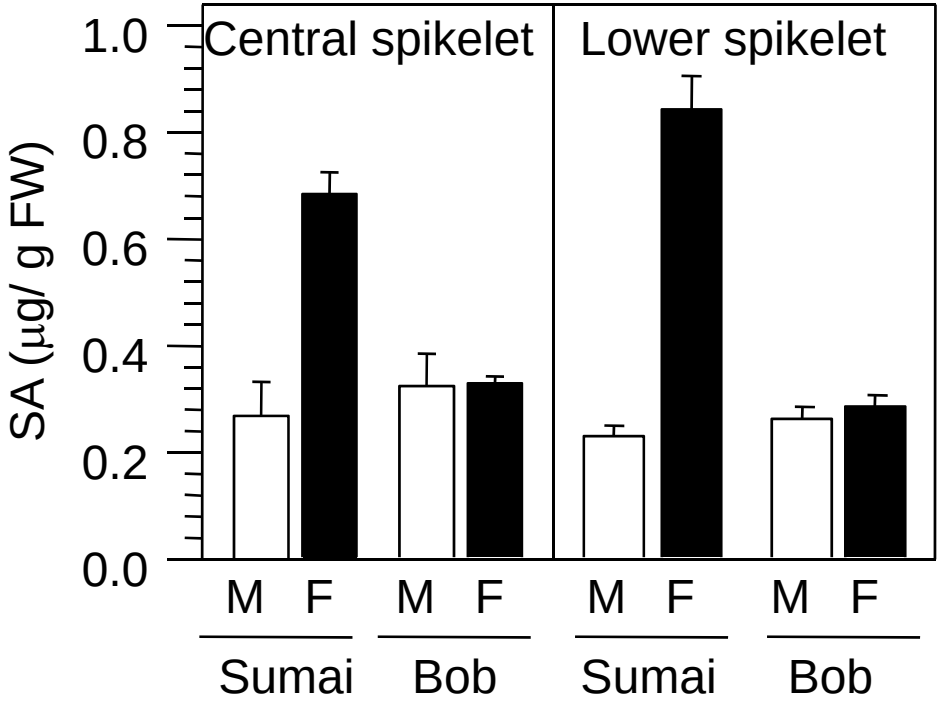


F. graminearum infection results in the activation of salicylic acid & jasmonic acid signaling in Arabidopsis & wheat

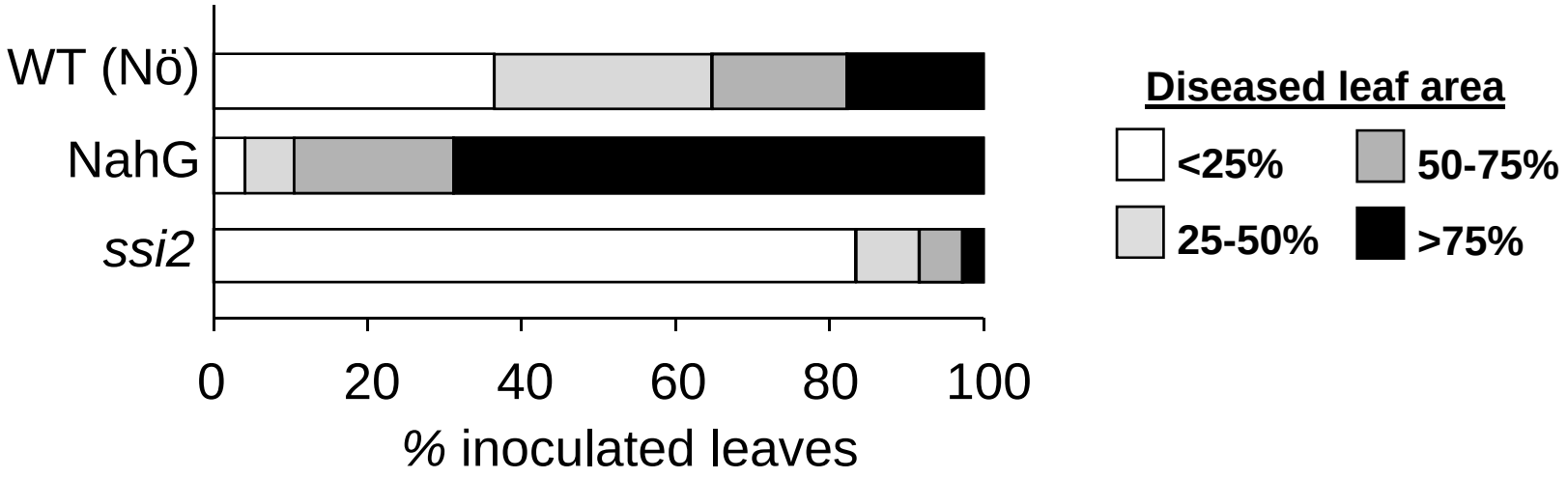




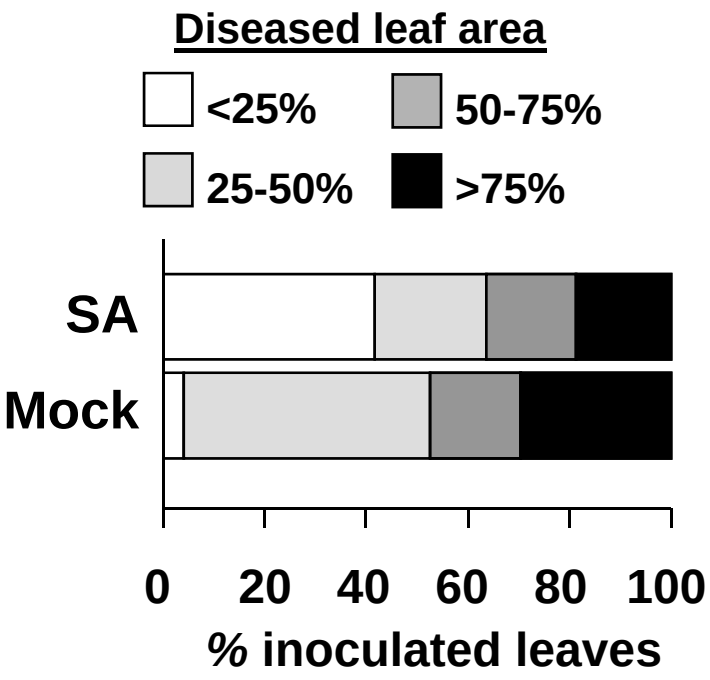


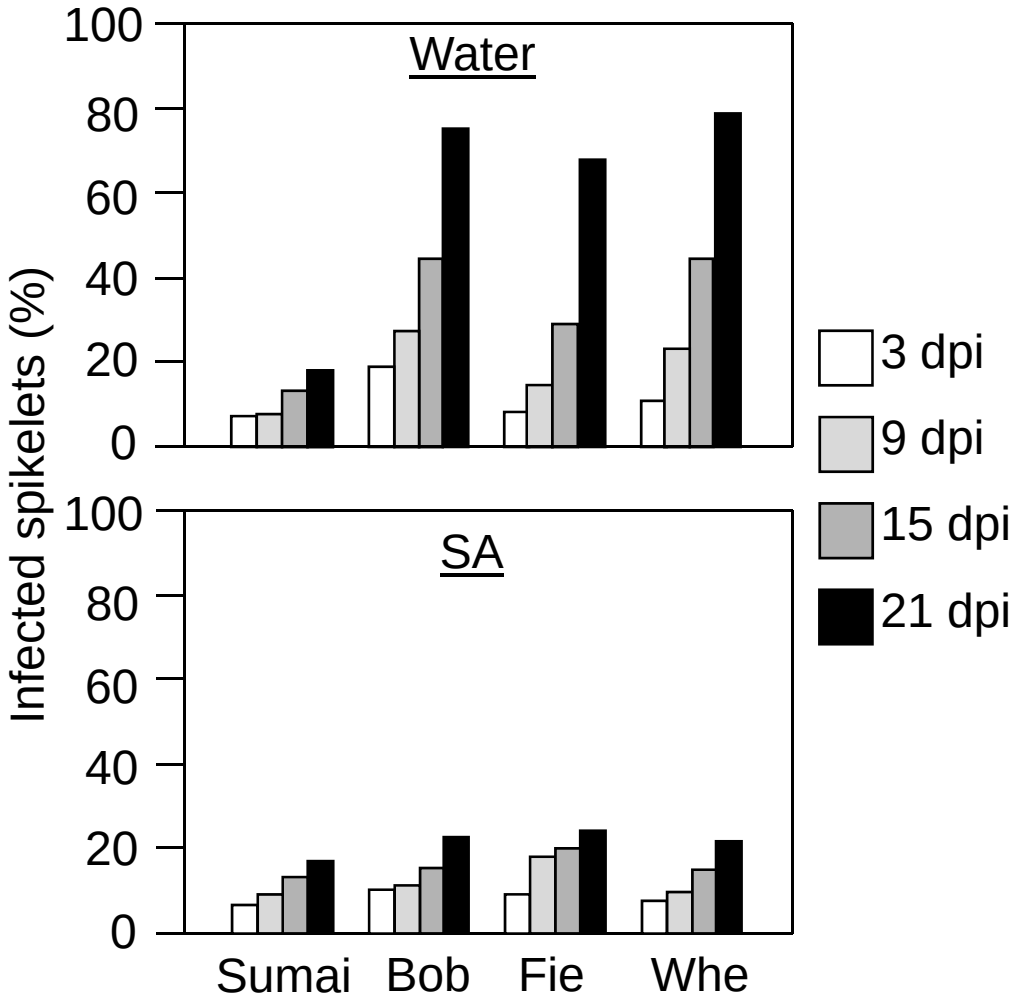


SA is essential for controlling *F. graminearum* disease in *Arabidopsis thaliana*



Irrigating plants with SA enhances resistance against *F. graminearum*





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

F. graminearum **infection**

↓

Salicylic acid

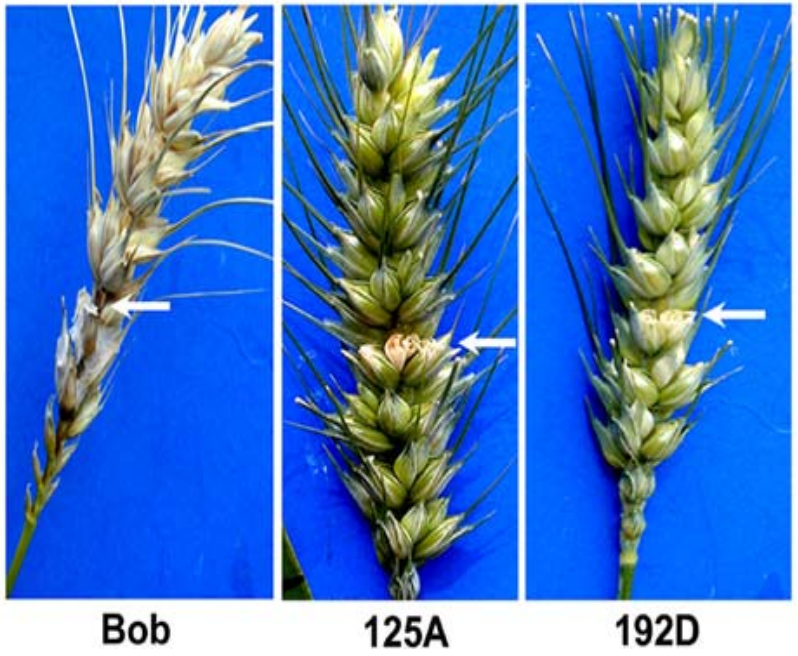
↓

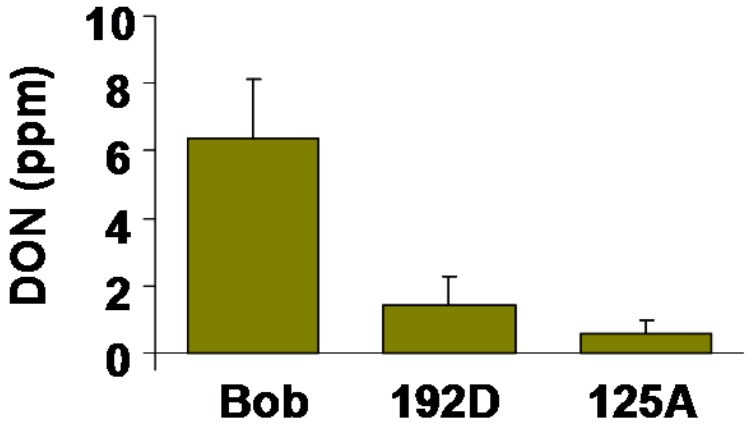
NPR1

↓

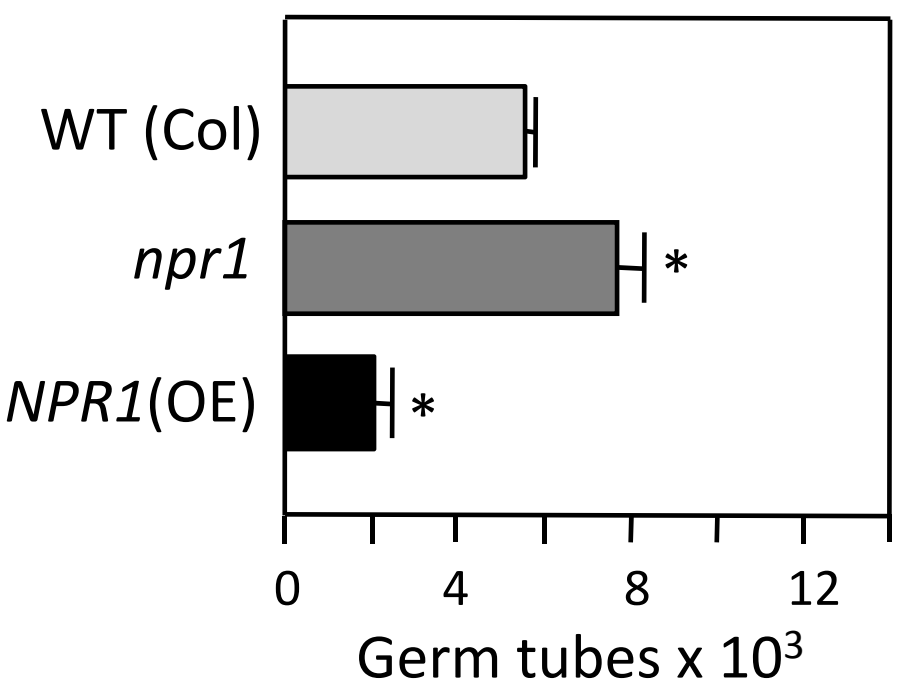
PR **genes**

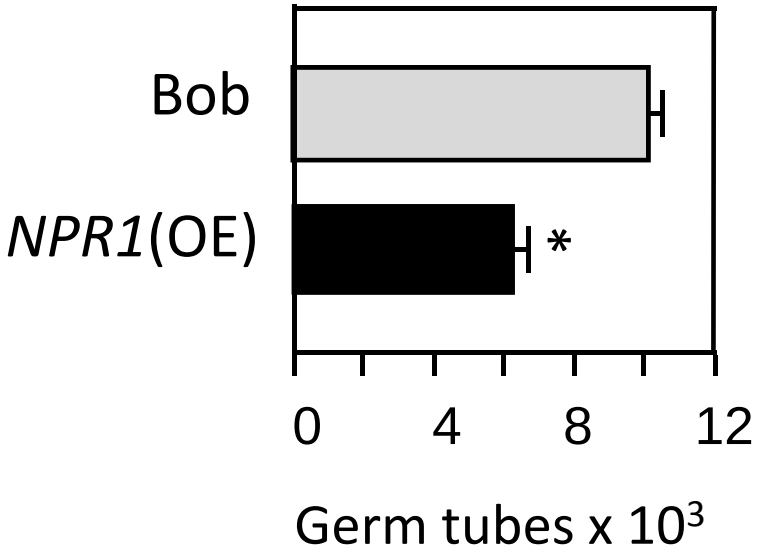
Protection against *F. graminearum*



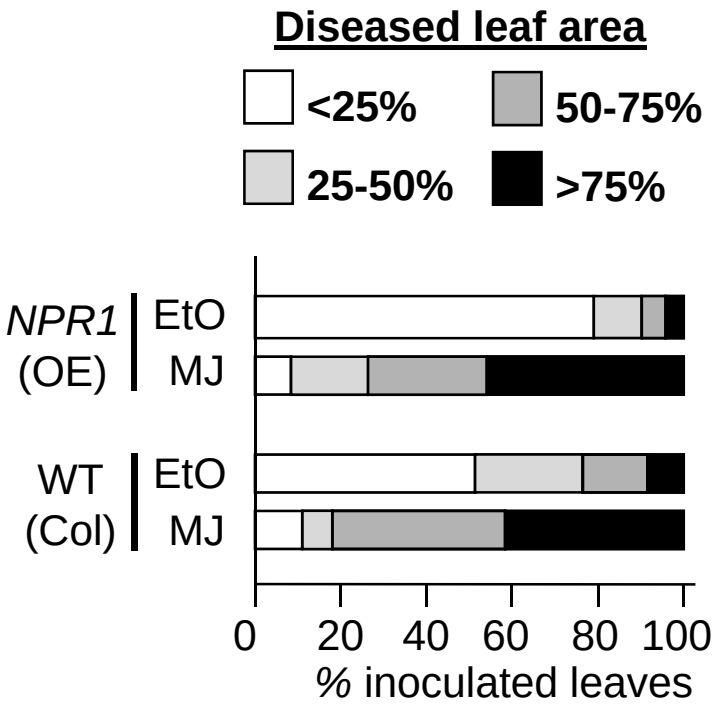


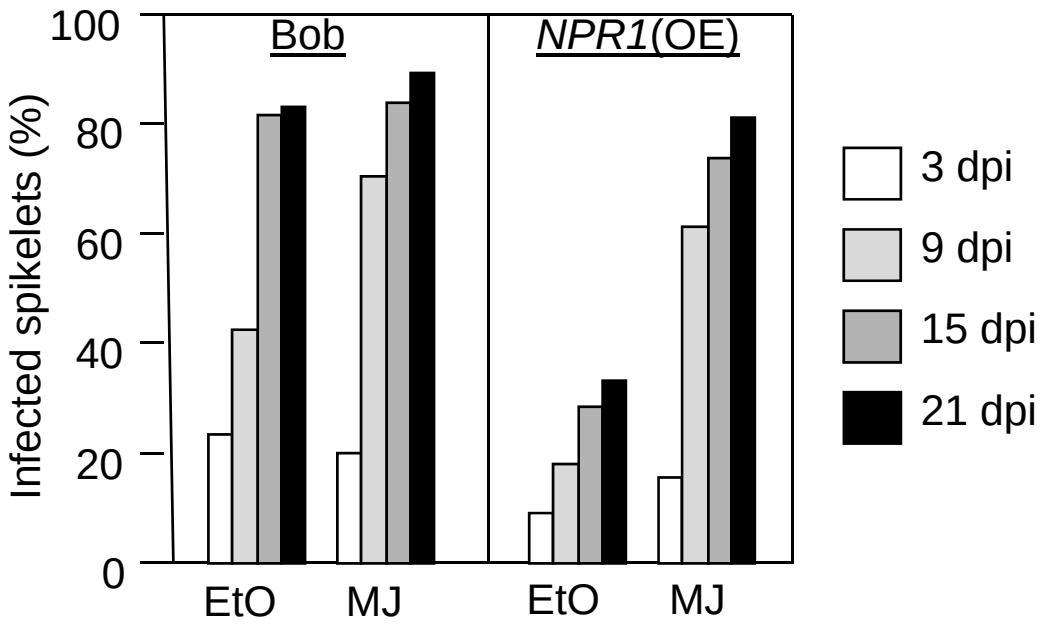
SA signaling through *NPR1* restricts fungal spore germination





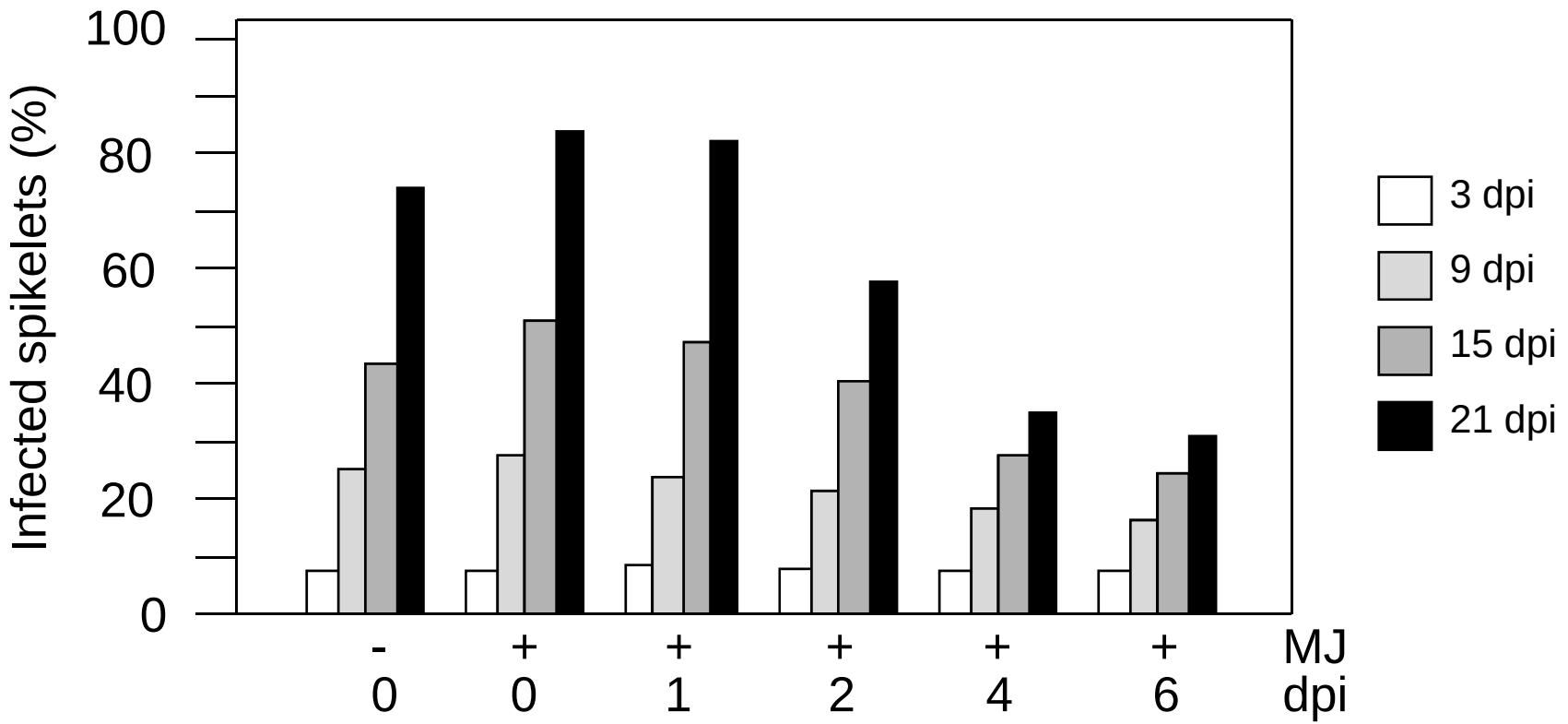
Pre-treatment with methyl-JA attenuates *NPR1*-conferred resistance to *F. graminearum*



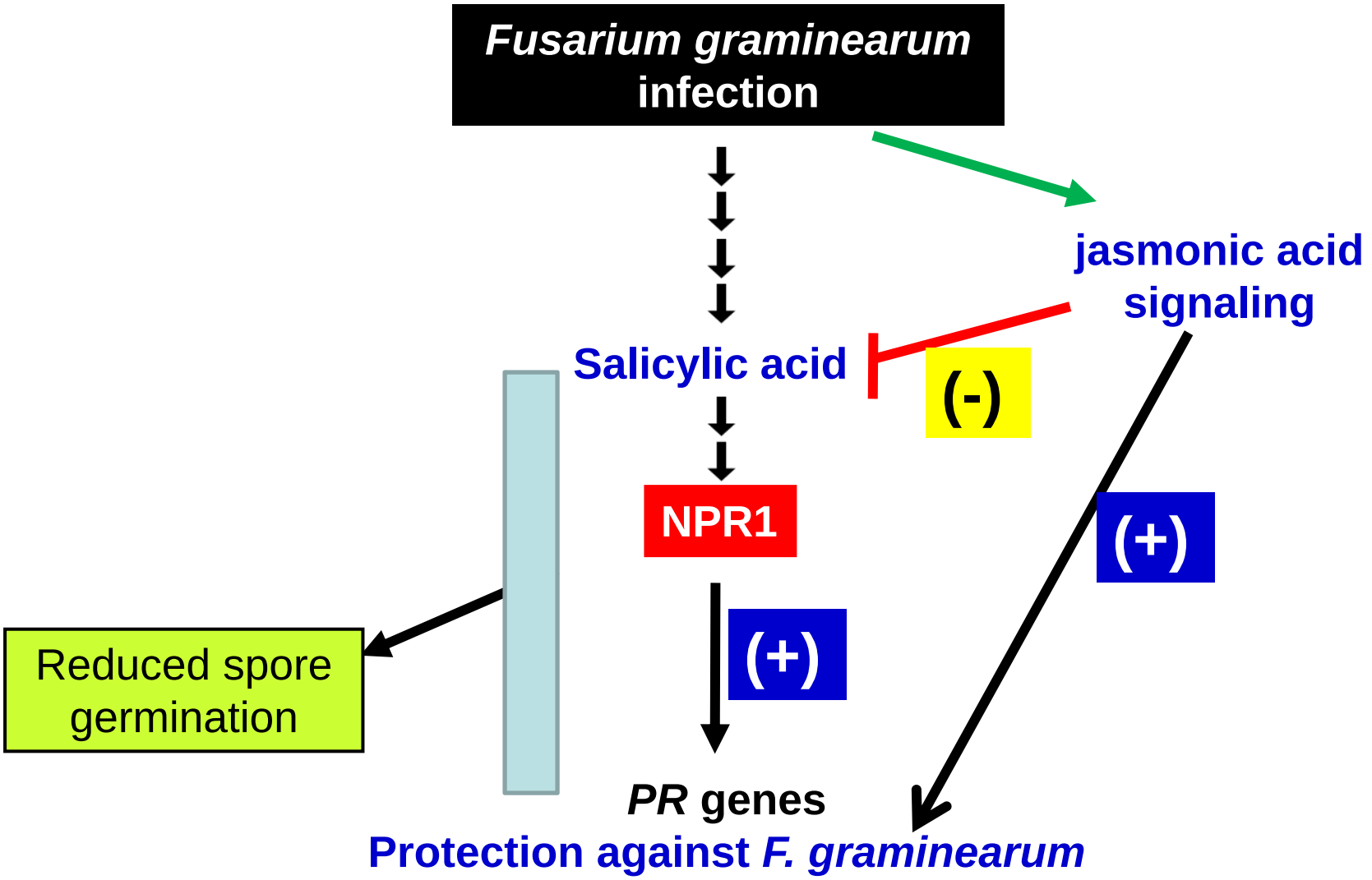


JA functions as a susceptibility factor during the early stages of infection by limiting the activation of SA signaling

Methyl-JA limits FHB symptoms when applied during later stages of infection



Cross talk between SA and JA signaling

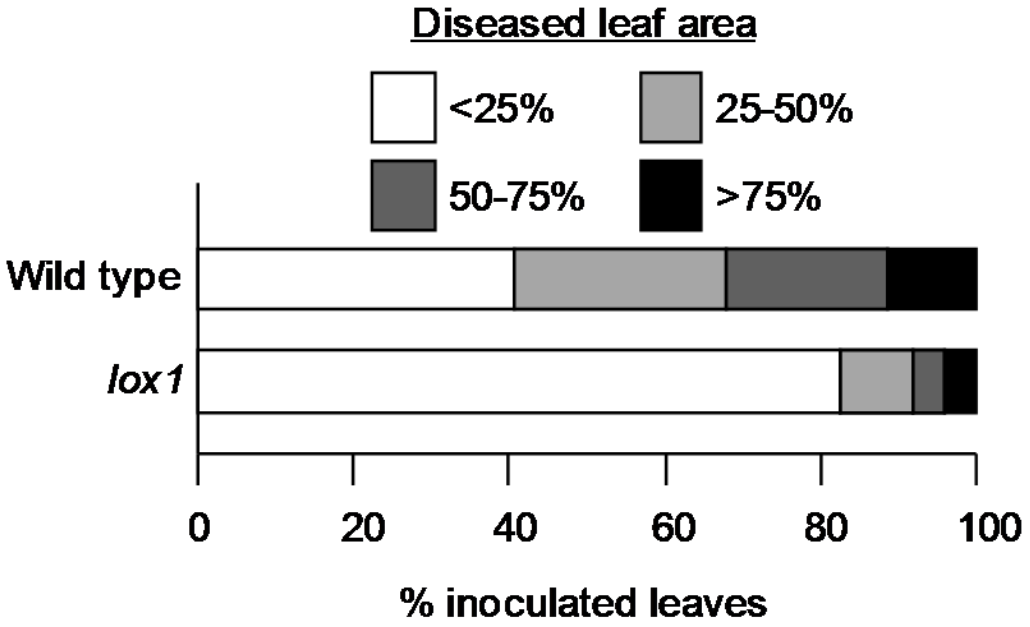


2. Candidate genes for enhancing FHB resistance

A 9-LOX encoding gene is associated with susceptibility to *F. graminearum*

- Lipoxygease synthesize precursors for oxylipins
- In maize, 9-LOXs are susceptibility factors for disease caused by *Fusarium verticillioides* and *Colletotrichum graminicola*

wild type *lox1*

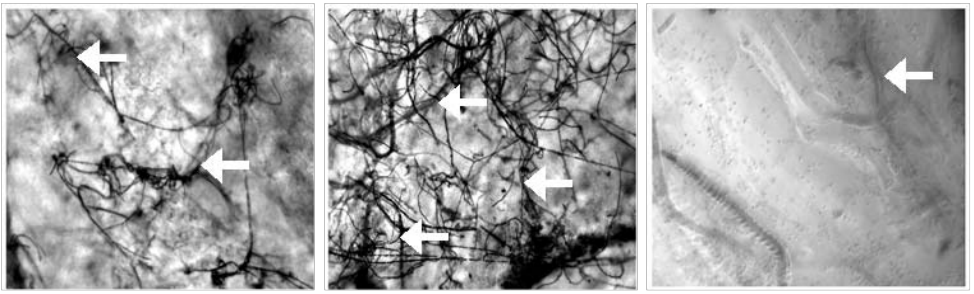


Ongoing: RNAi mediated silencing of 9-LOXs in wheat

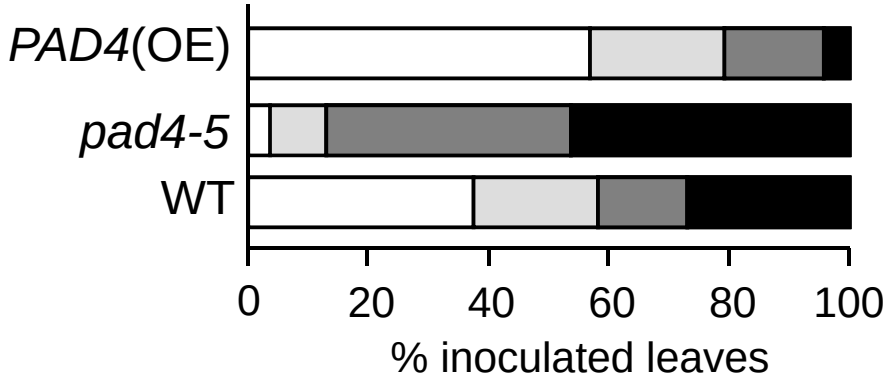
Overexpression of *PAD4* enhances resistance to *F. graminearum* in Arabidopsis

PAD4

- modulates phytoalexin synthesis
- modulates salicylic acid synthesis
- controls resistance against aphids



wild type ***pad4*** ***PAD4* (OE)**

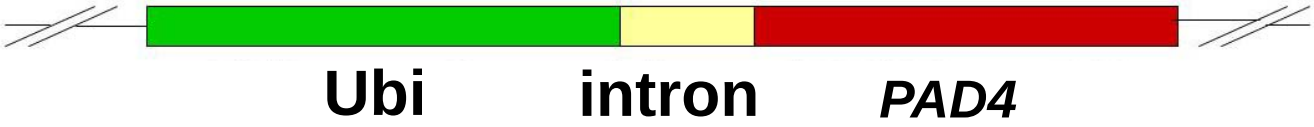


Diseased leaf area

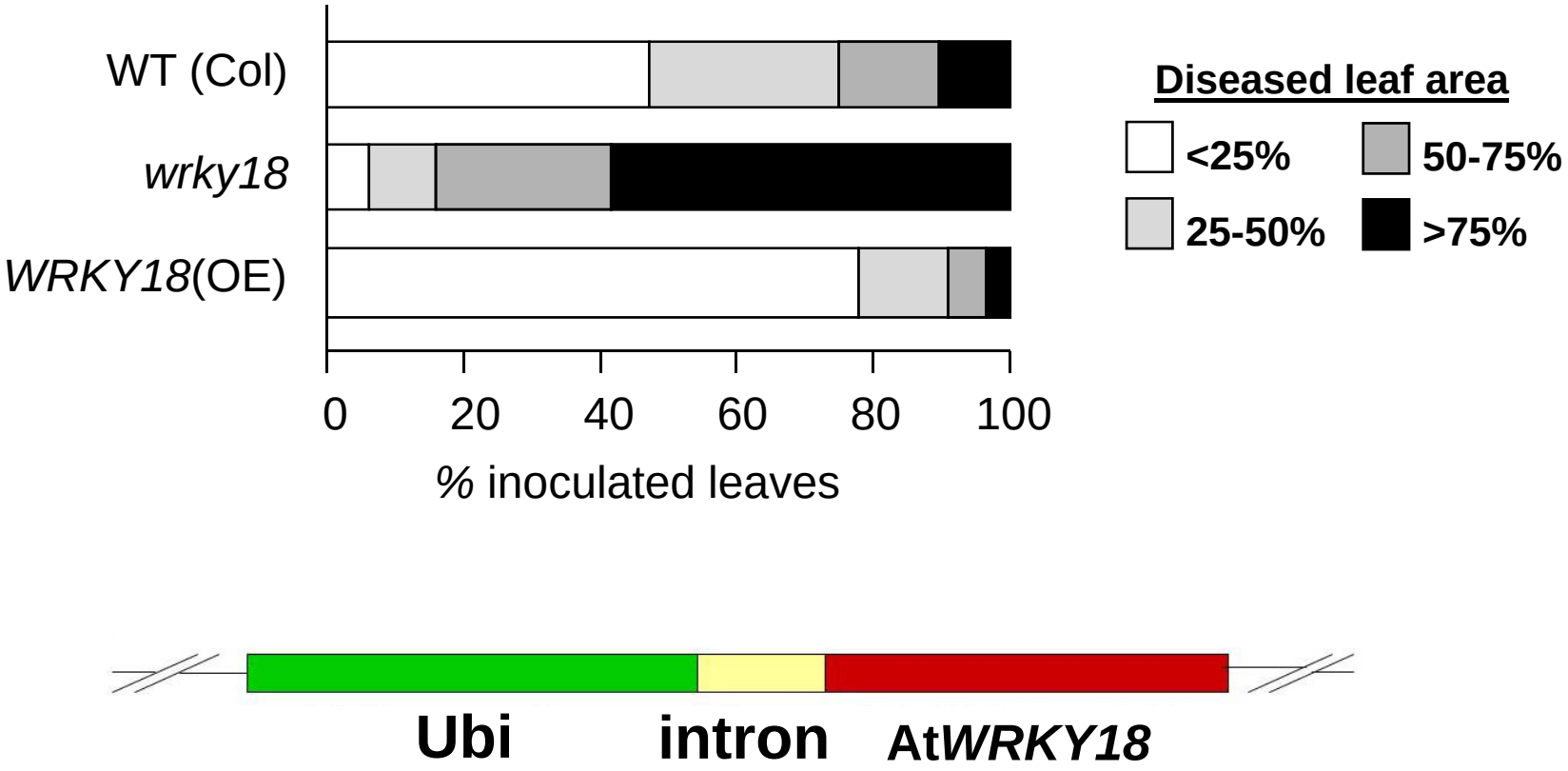
<25% **50-75%**

25-50% **>75%**

Transgenic wheat overexpressing *PAD4*



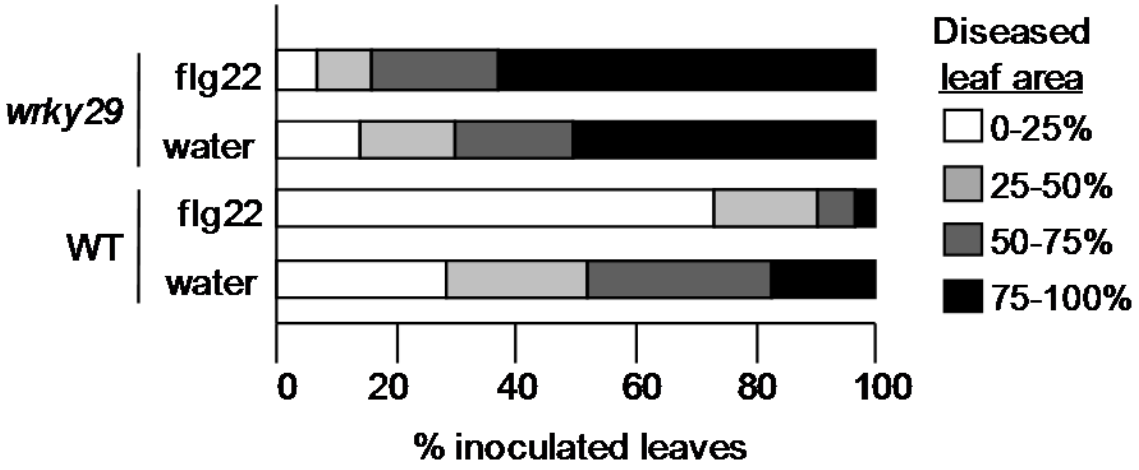
WRKY18 encoding a transcription factor is involved in defense against *F. graminearum*



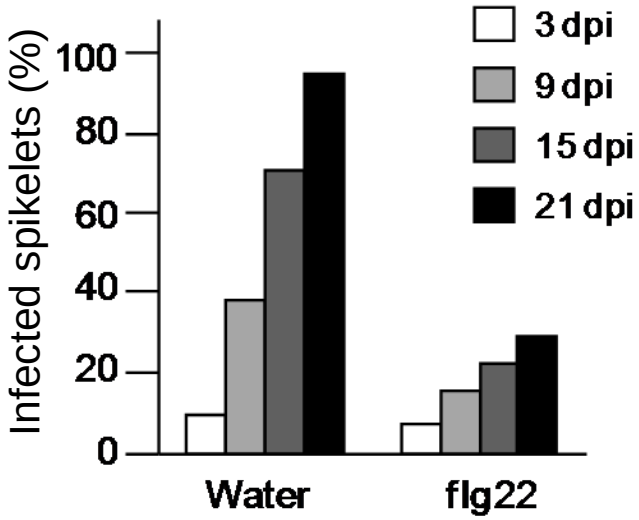
3. Targeting non-host defense mechanism for controlling FHB

Bacterial flagellin protein derived flg22 peptide enhances resistance against *F. graminearum*

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

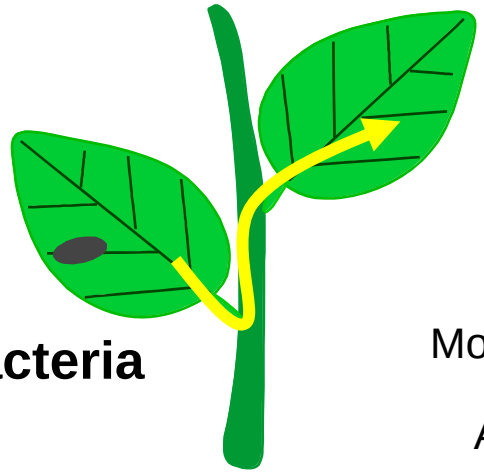


Target the flagellin-inducible mechanism or enhancing FHB resistance in wheat



4. Plant metabolites for enhancing FHB resistance

FHB resistance inducing factor present in petiole exudates of bacterial pathogen challenged Arabidopsis

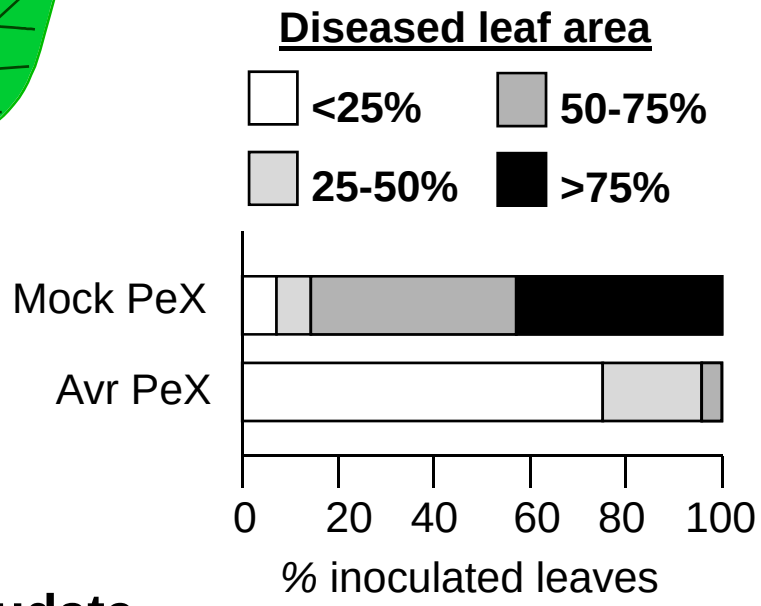


Bacteria

Collect petiole exudate

Inject into healthy plant

Challenge with pathogen



Chaturvedi et al. Plant J. 2008

Summary

- **SA→ important role in defense against *F. graminearum***
  - **SA signaling through NPR1 suppresses macroconidia germination**
- **JA →dichotomous role; susceptibility factor early during infection; subsequently contributes to defense**
- **Other candidate genes that promote resistance: *PAD4* and *WRKY18***
- **Candidate susceptibility genes/mechanisms: 9-LOX (oxylipin)**
- **Other defense mechanisms to control FHB: flg22 inducible**
- **Arabidopsis derived metabolites for enhancing FHB resistance**

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