



Genetic diversity and plant-plant interactions as drivers of disease resistance in cereals

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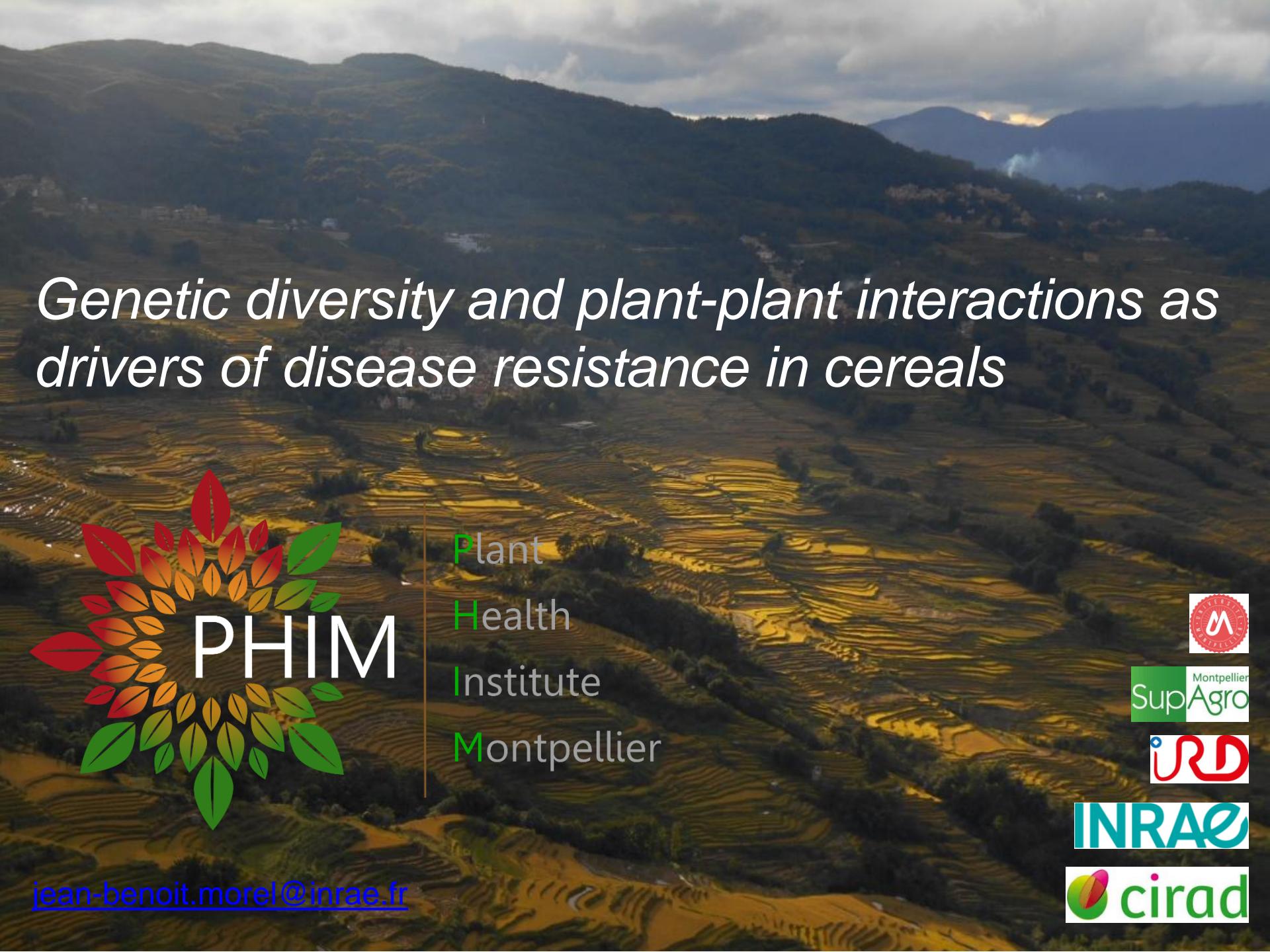
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Genetic diversity and plant-plant interactions as drivers of disease resistance in cereals

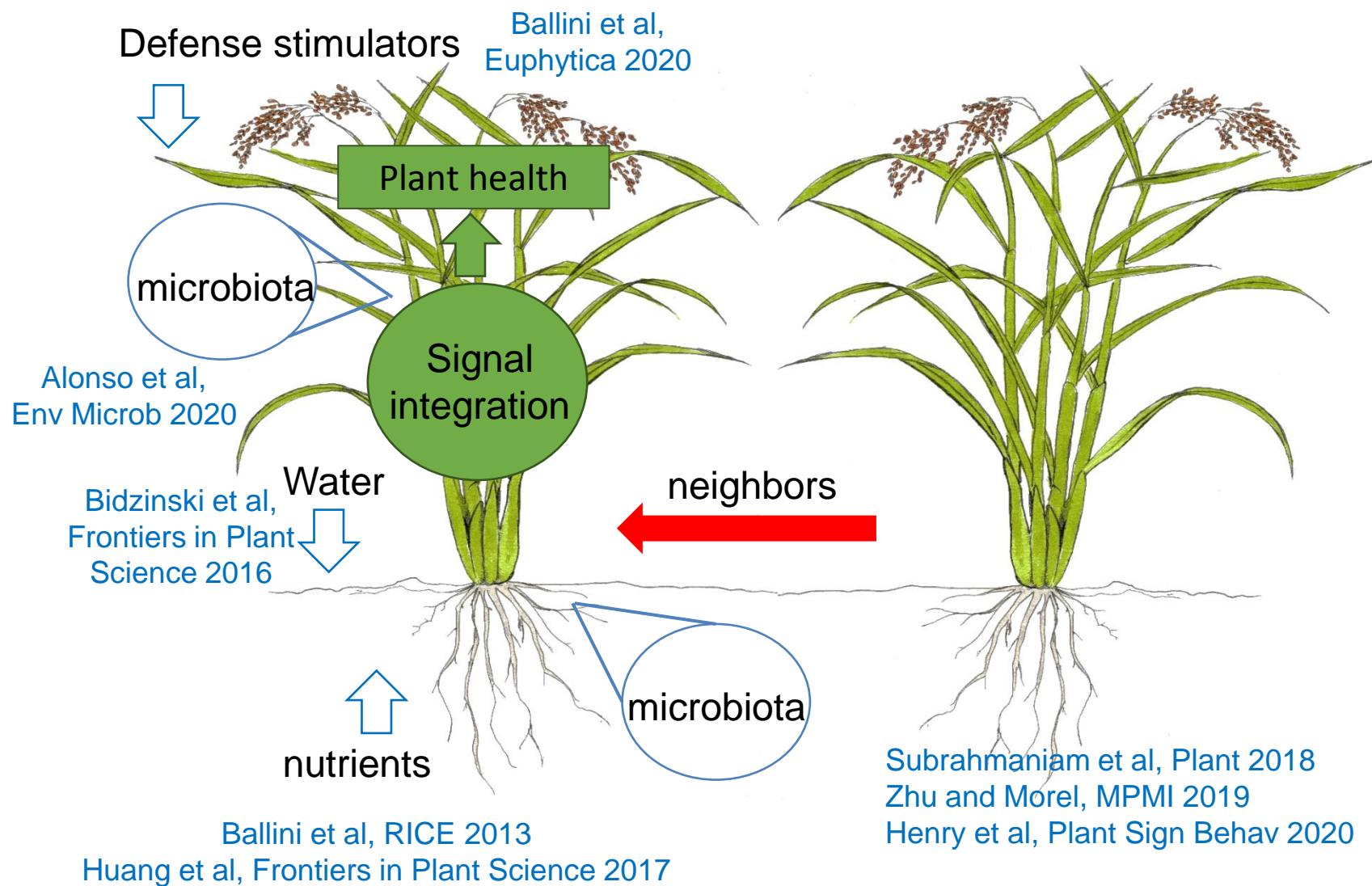


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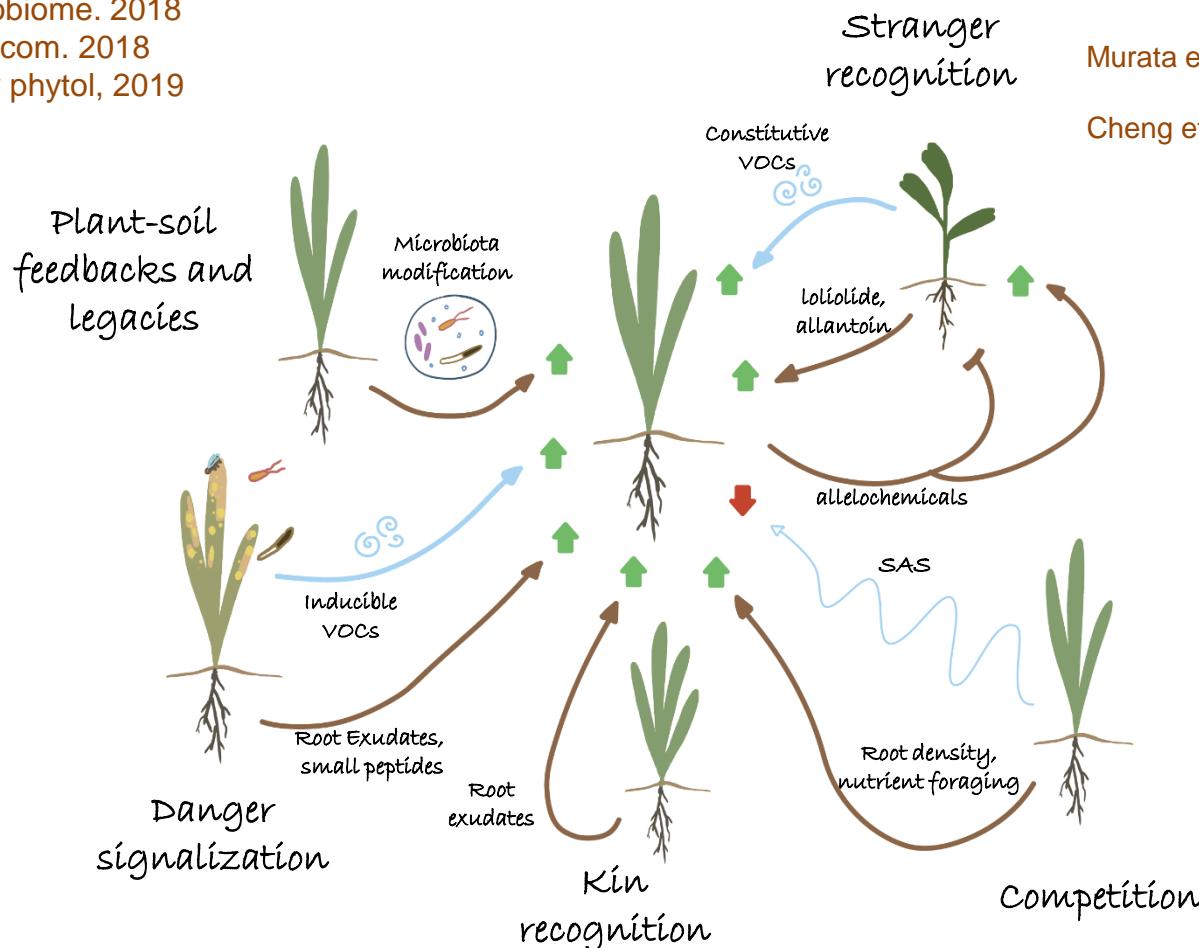
Plant immunity is modulated by the environment



Plants modulate immunity and susceptibility in their neighborhood

Ma et al, Frontier in plant science. 2017
Beredsen et al, ISME journal. 2018
Yuan et al, Microbiome. 2018
Hu et al, Nature com. 2018
Wang et al, New phytol, 2019

Sukegawa et al. Plant journal, 2018
Venturelli et al. Plant cell, 2015
Kong et al. 2018
Li et al. JEBX, 2020
Murata et al, Plant phisiology 2019
Takagi et al. JEBX, 2016
Cheng et al. Scientific report, 2016



Markovic et al, JEBX. 2019
Wenig et al, Nature com. 2019
Orlovskis et al, New phytol. 2020
Coppola et al, Scientific reports. 2017

Biedrzycki et al,
Plant Signaling &
Behavior 2011

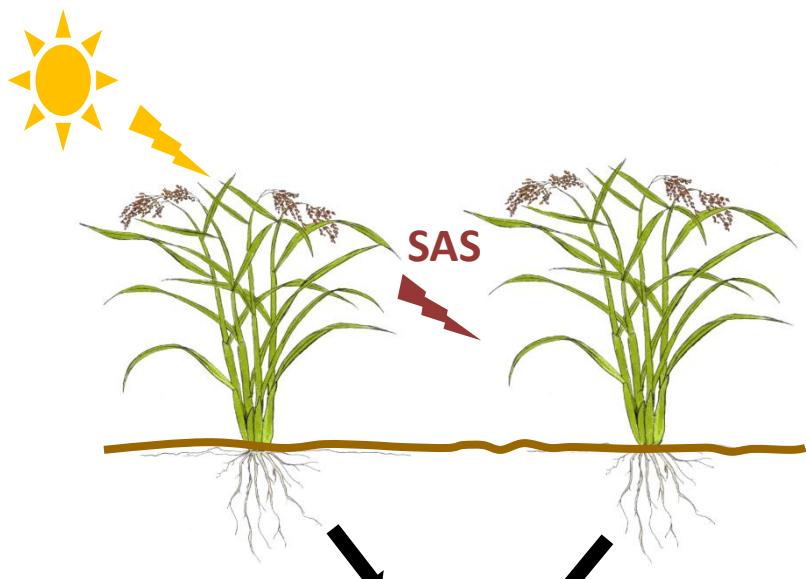
Wit et al, Plant Journal 2013
Cerrudo et al, Plant Physiology 2012
Ballaré, An. rev. of Plant biology 2014
Chen et al. Frontiers in P. Science, 2019

Intraspecific competition for nutrients between conspecifics

Intraspecific competition



Intraspecific plant density



Competition for nutrient

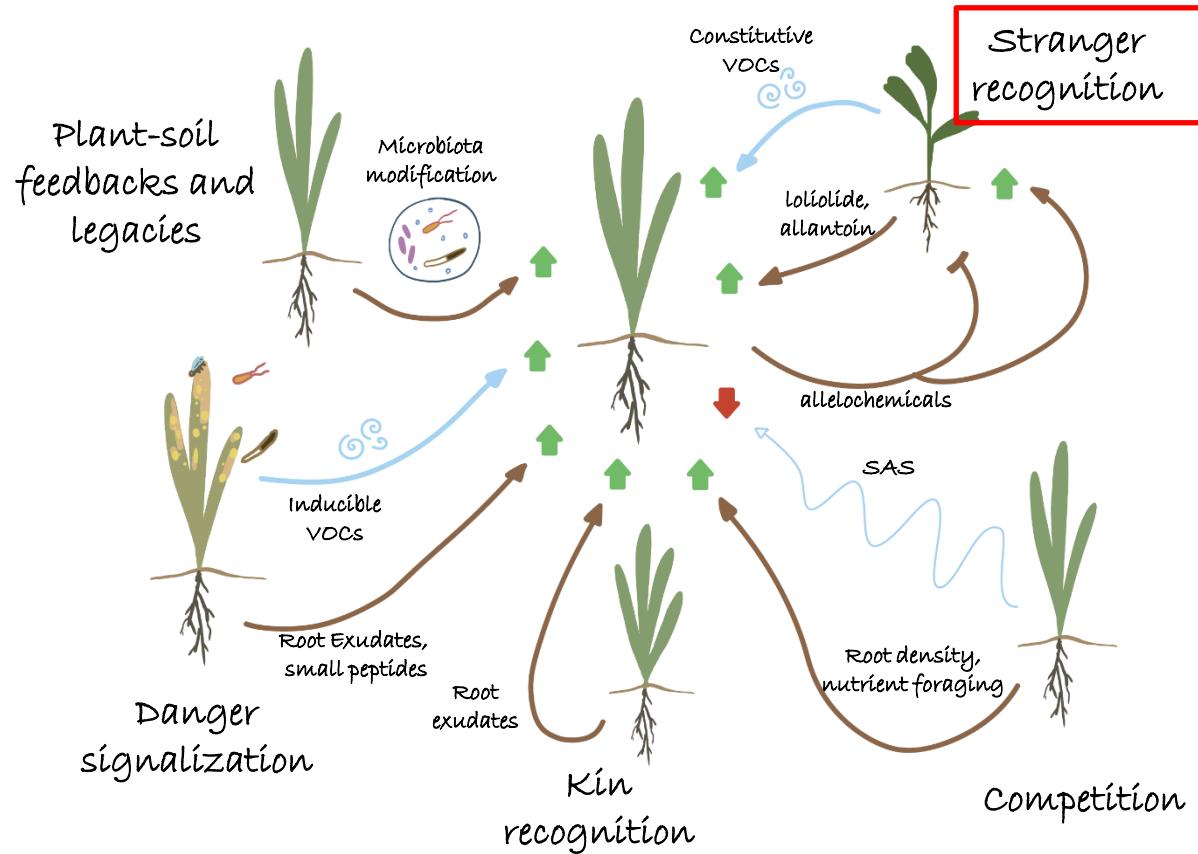
Shade Avoidance Syndrom
increases *A.thaliana* susceptibility
to pathogens

Wit et al, Plant Journal 2013
Cerrudo et al, Plant Physiology 2012
Review in Ballaré, An. rev. of Plant biology 2014

Root interaction with conspecifics
increases accumulation of chemical
defense in tobacco

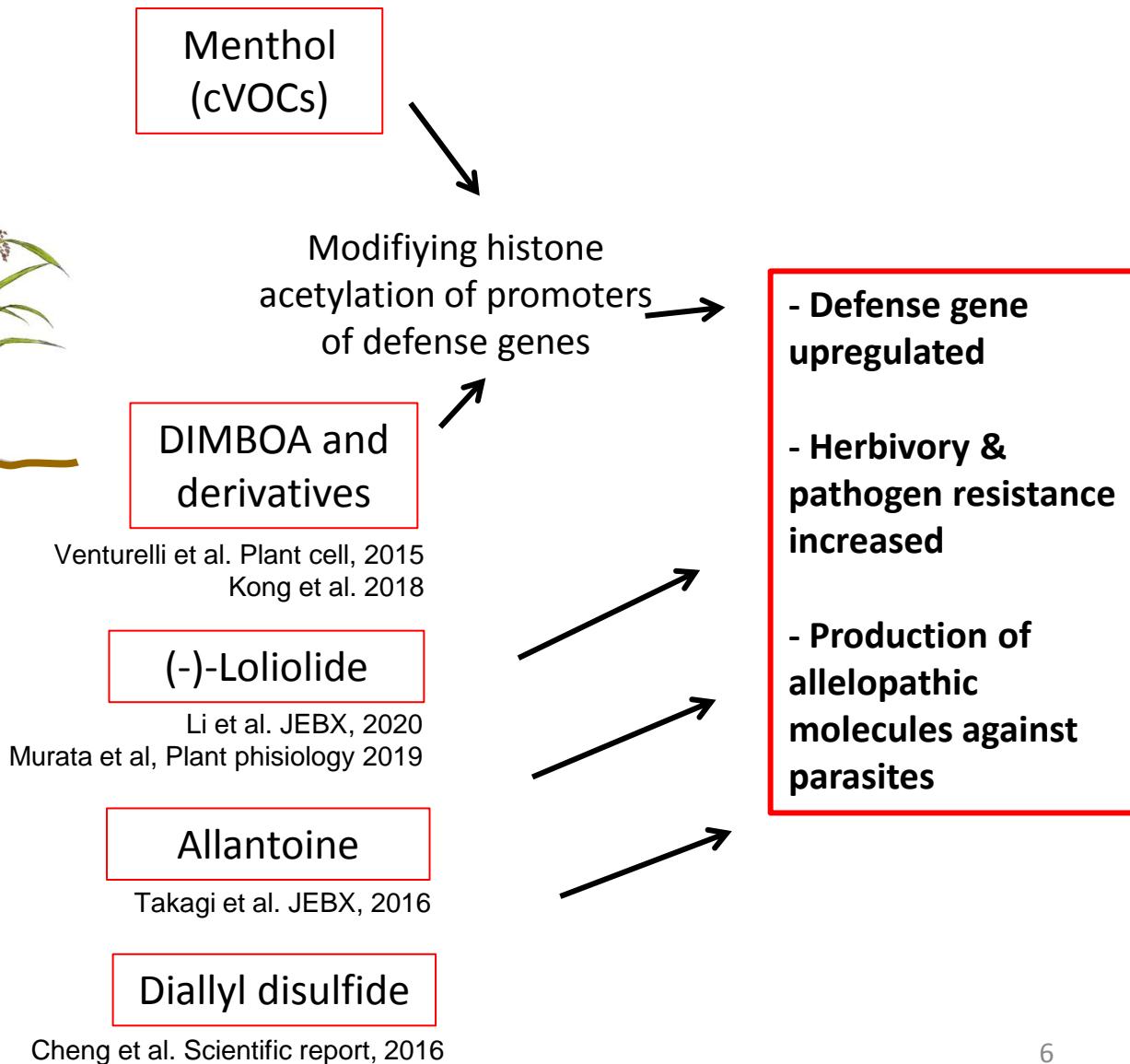
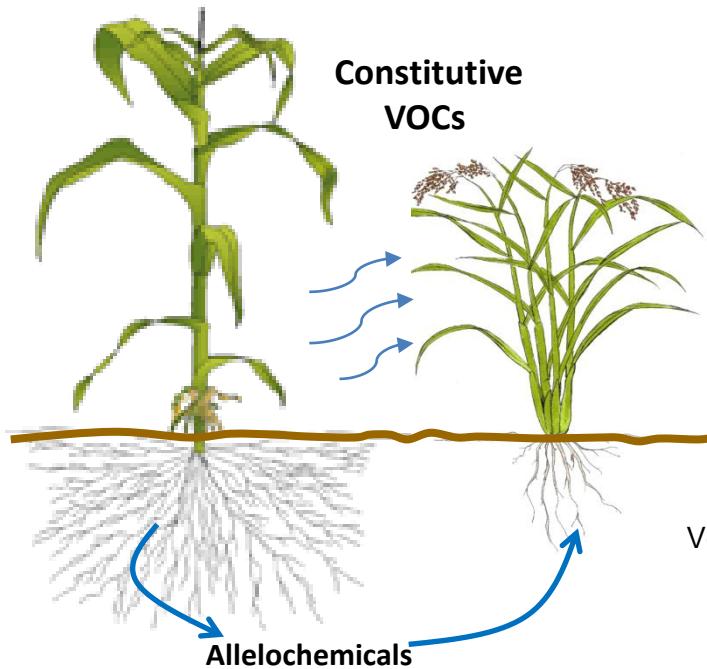
Chen et al. Frontiers in Plants Science, 2019

Plants modulate immunity and susceptibility in their neighborhood



Stranger's things from healthy neighbors

Sukegawa et al. Plant journal, 2018



DIMBOA hypothesis

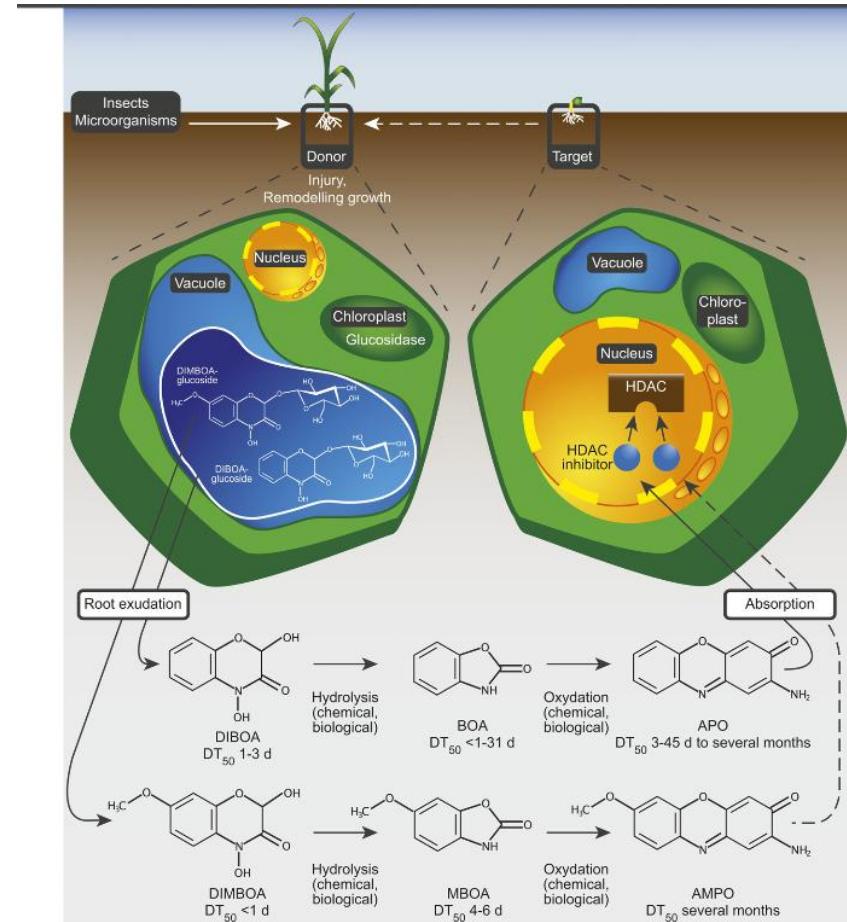
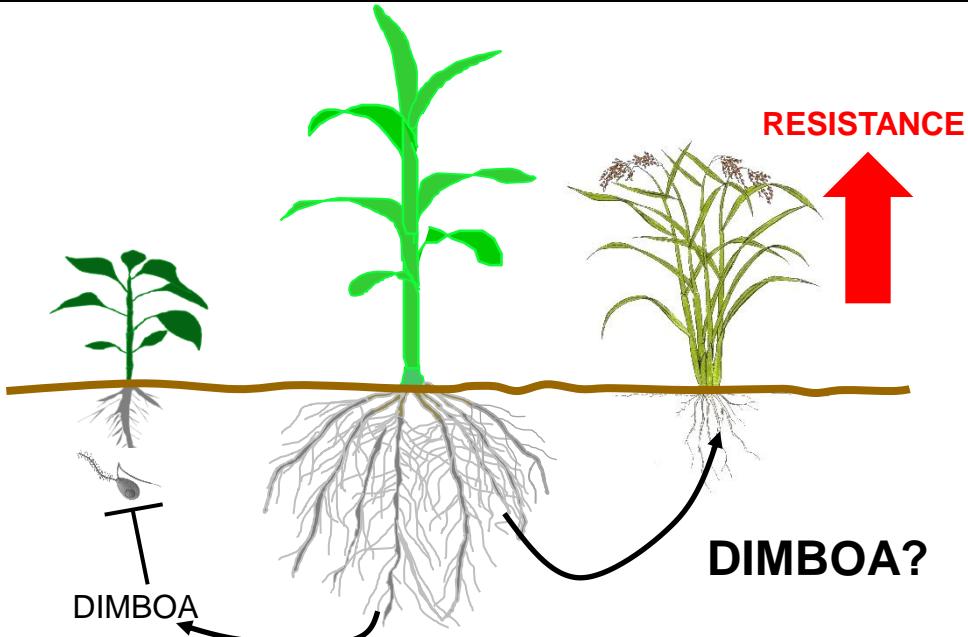


Figure 5. Model of a Chromatin-Based Mode of Action of the Allelochemicals APO and AMPO.

(Venturelli et al, 2015)

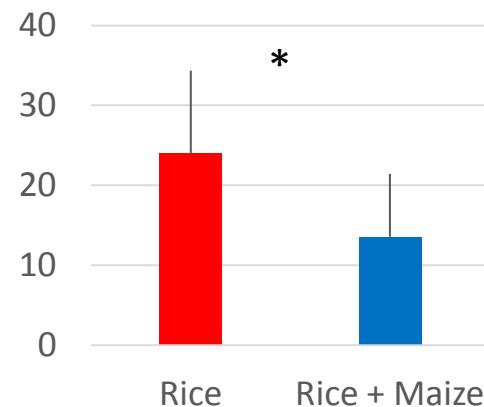
DIMBOA derivates — HDAC — defense

Intercropping rice and maize



**Rice blast disease
(GY11)**

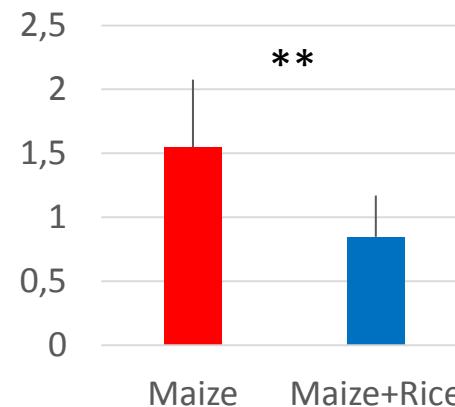
average lesions/ rice leaf



(Nipponbare and B73)

**Maize blast disease
(2 isolates)**

normalized average lesions/maize leaf



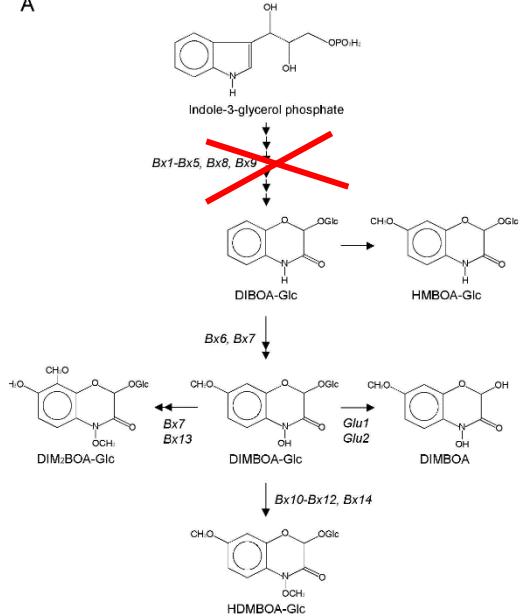
(B73 and Maratelli)

~40% reduction of symptoms

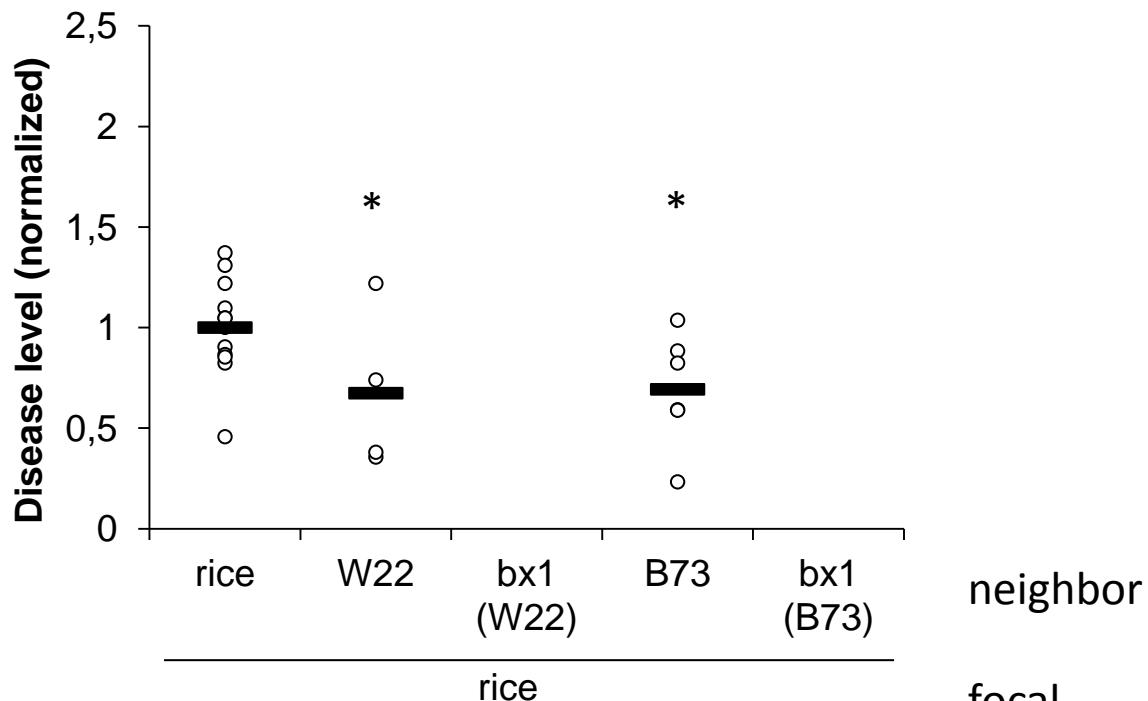
DIMBOA biosynthesis is required for protection in intercropping



A

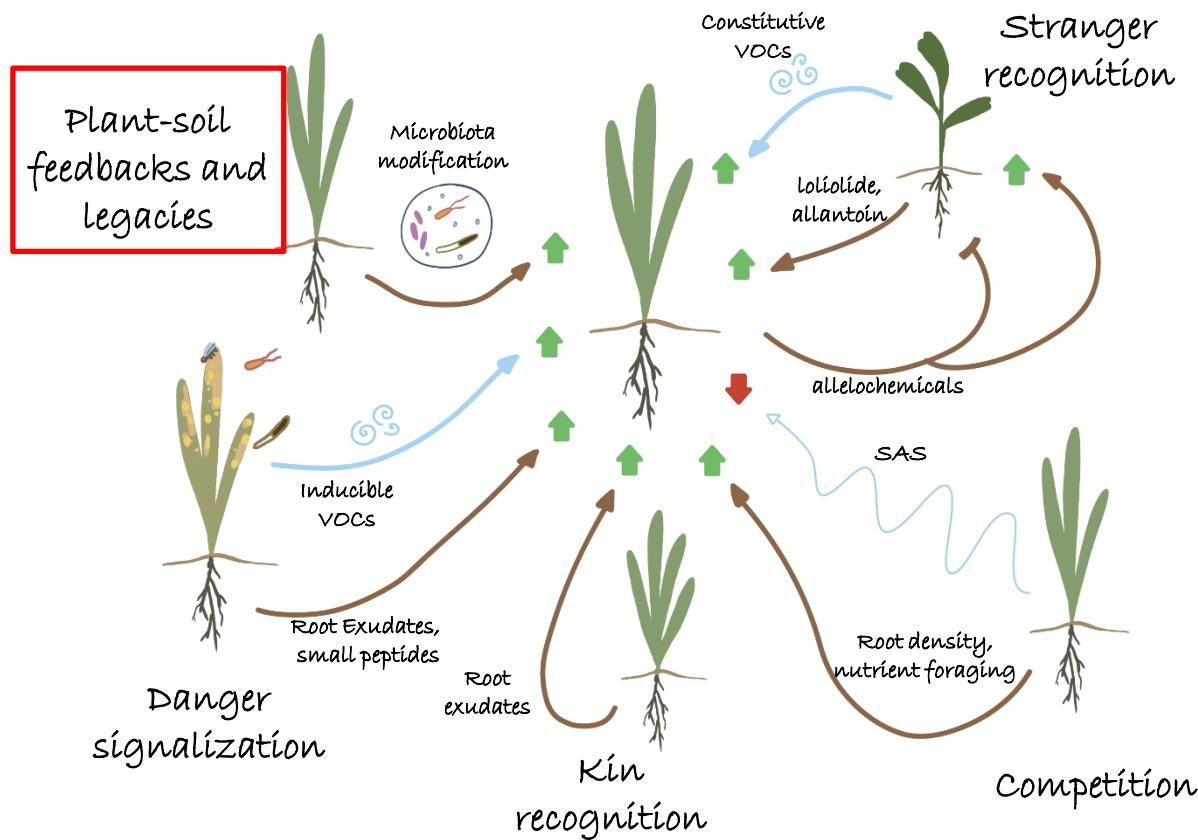


Rice blast disease (on rice)



neighbor
focal

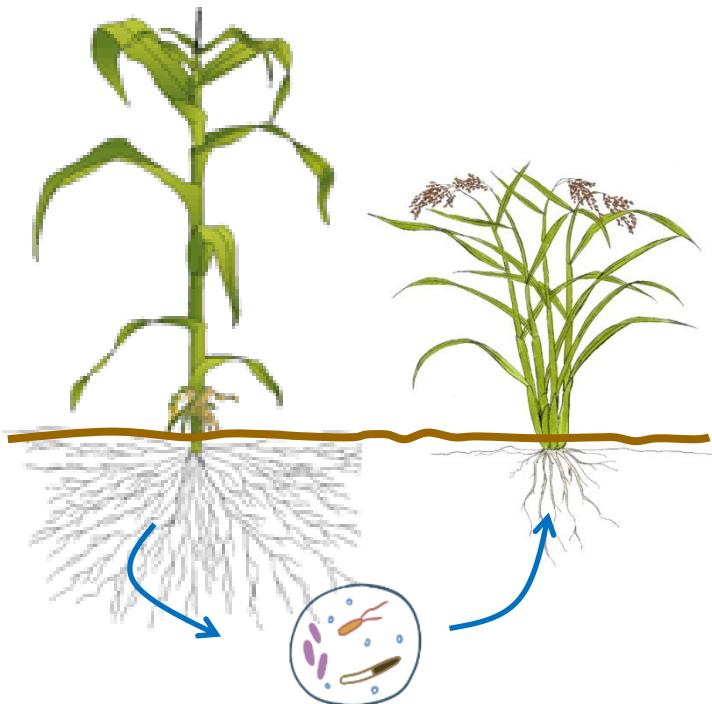
Plants modulate immunity and susceptibility in their neighborhood



Plants leave a message : plant soil feedback and legacies

Plant–soil feedback is a process where plants alter the biotic and abiotic qualities of soil they grow in, which then alters the ability of plants to grow in that soil in the future

Wikipedia



Intraspecific & Interspecific

Ma et al, Frontier in plant science. 2017



Inductible or constitutive

Beredsen et al, ISME journal. 2018
Yuan et al, Microbiome. 2018



Induces defense genes, pathogen and herbivory resistance

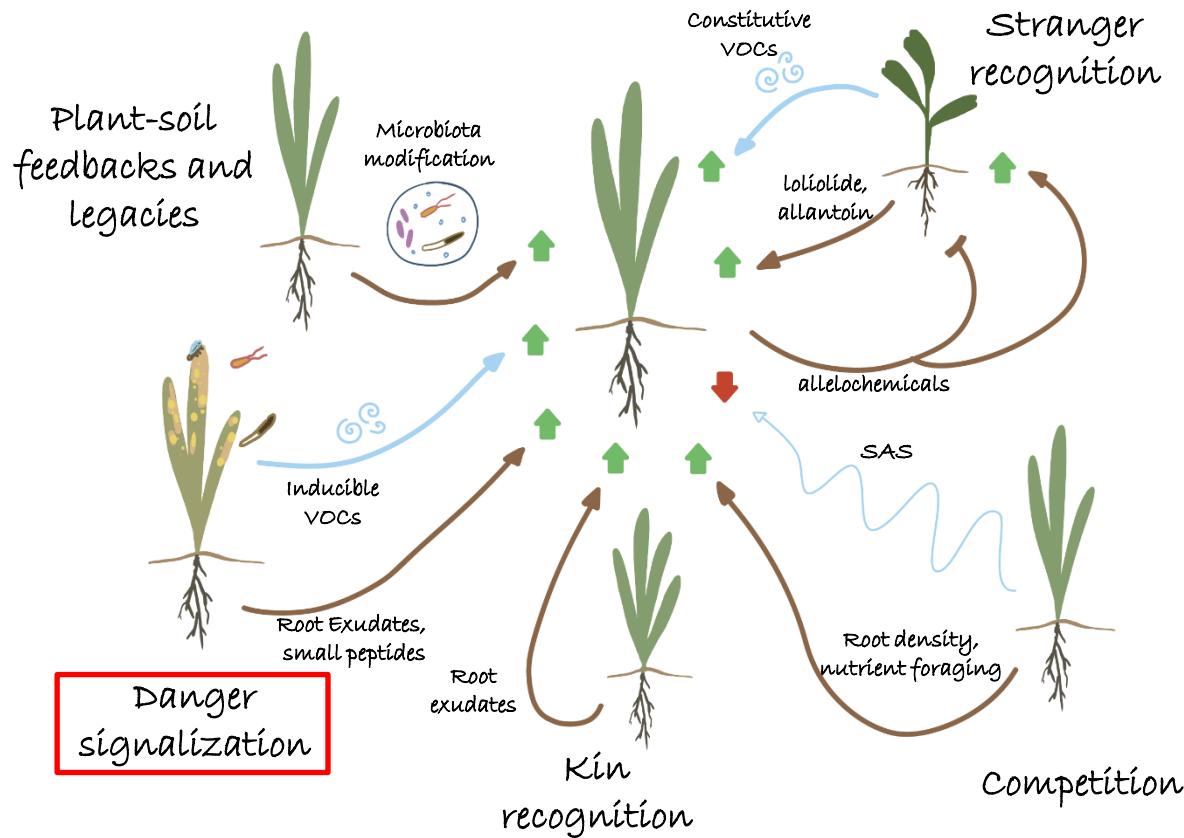
Hu et al, Nature com. 2018



Depend on specific species of fungi, bacteria or combinaison

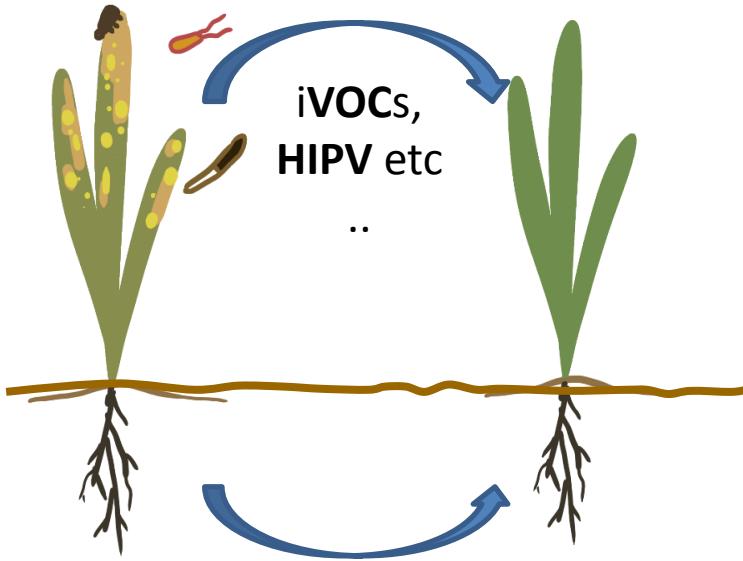
Wang et al. New phytol, 2019

Plants modulate immunity and susceptibility in their neighborhood



The neighbor watch, Signalisation of danger between plant

Disease / attack
plant



Inducible VOCs → Can be triggered by touch in maize
Markovic et al, JEBX. 2019

Monoterpene
Wenig et al, Nature com. 2019

Unknown root signal
Orlovskis et al, New phytol. 2020

Coppola et al, Scientific reports. 2017



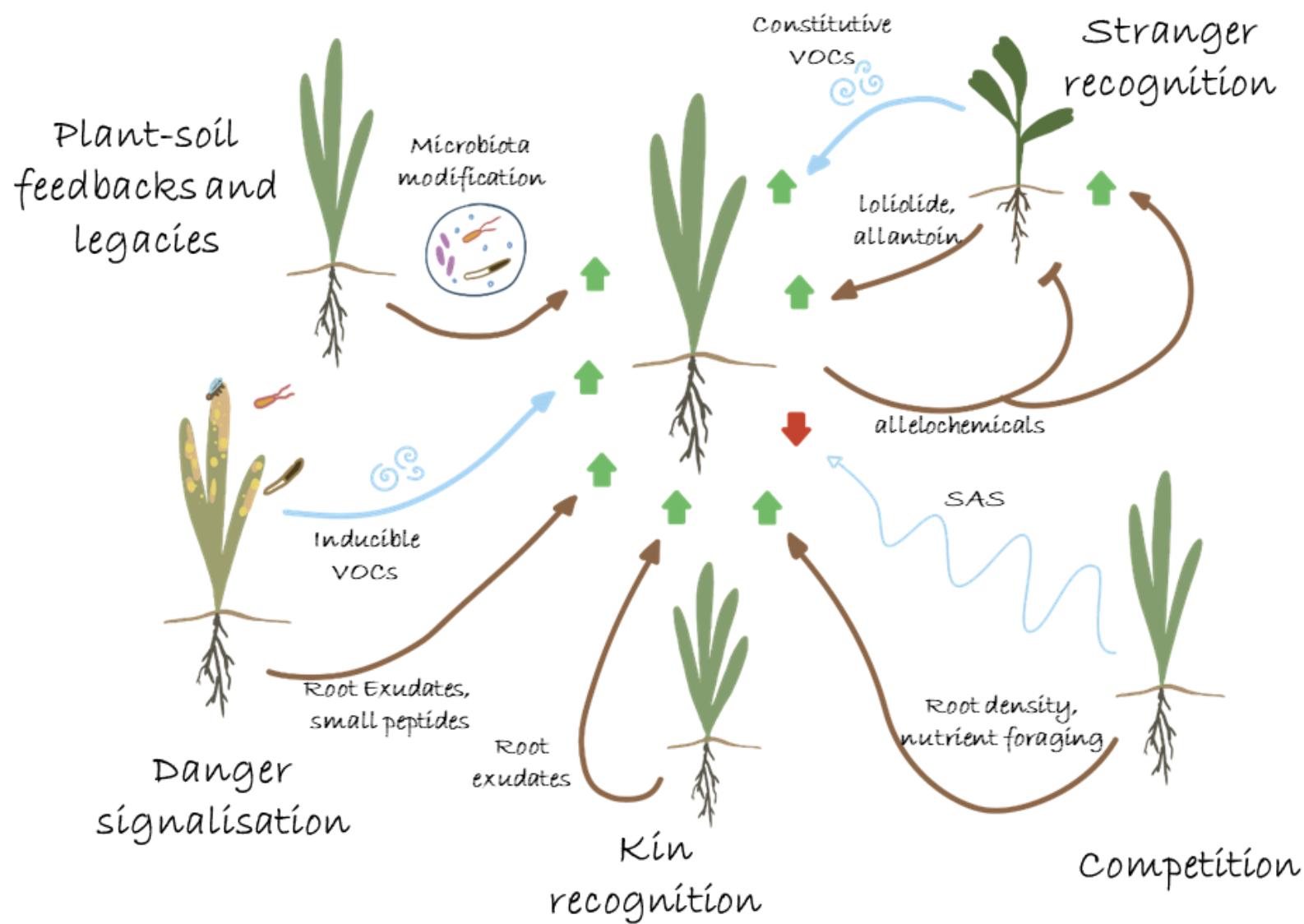
Propagation of SAR (Systemic acquired Resistance) between neighbor plants

Systemin

→ Excreted soil peptide (18 AA) by tomato roots

Plants modulate immunity and susceptibility in their neighborhood

Pelissier, Violle and Morel, review submitted

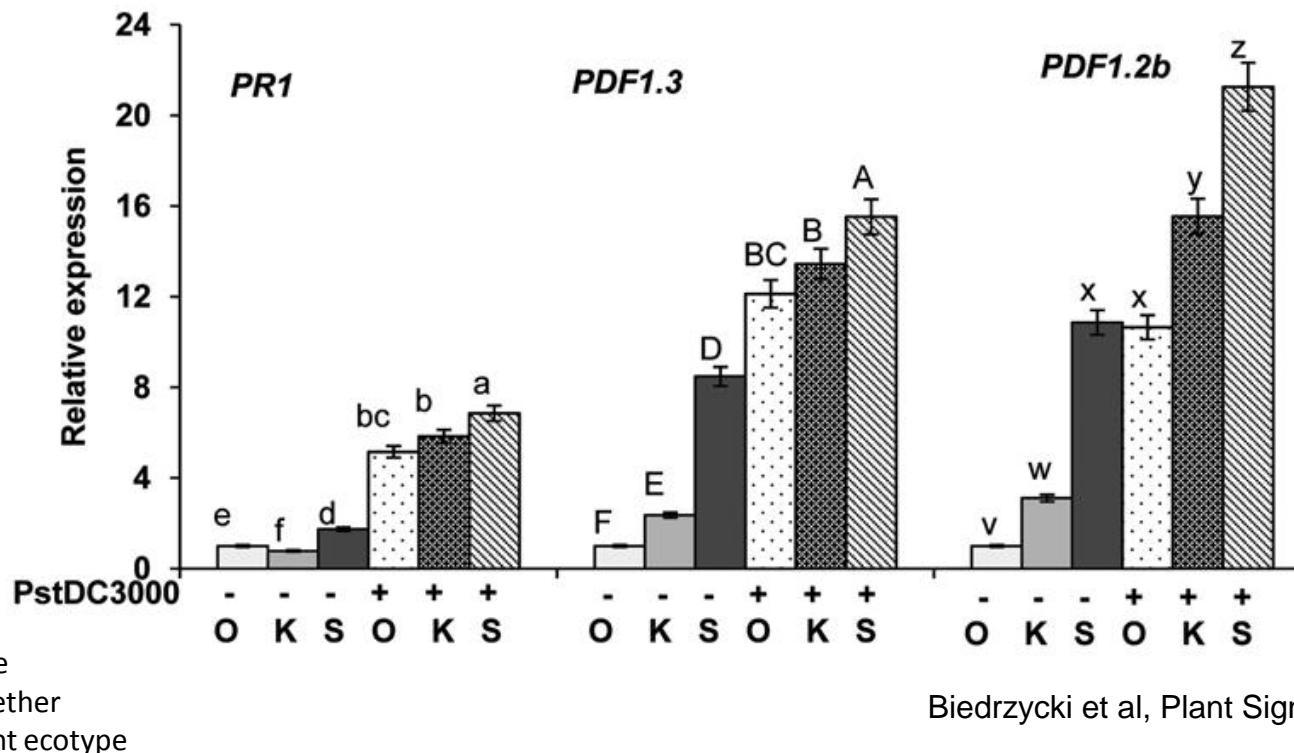


Can kins/conspecifics modulate susceptibility in their neighborhood?

Kin recognition: when plants recognize conspecifics

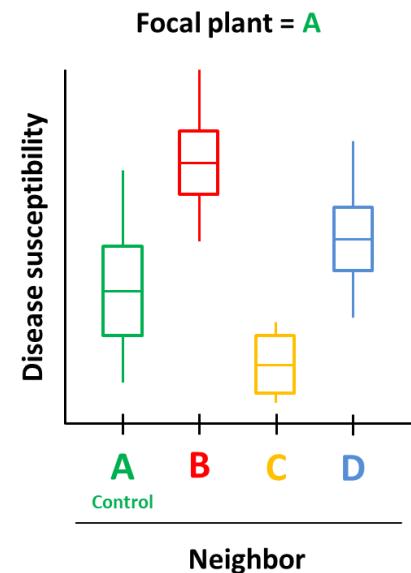
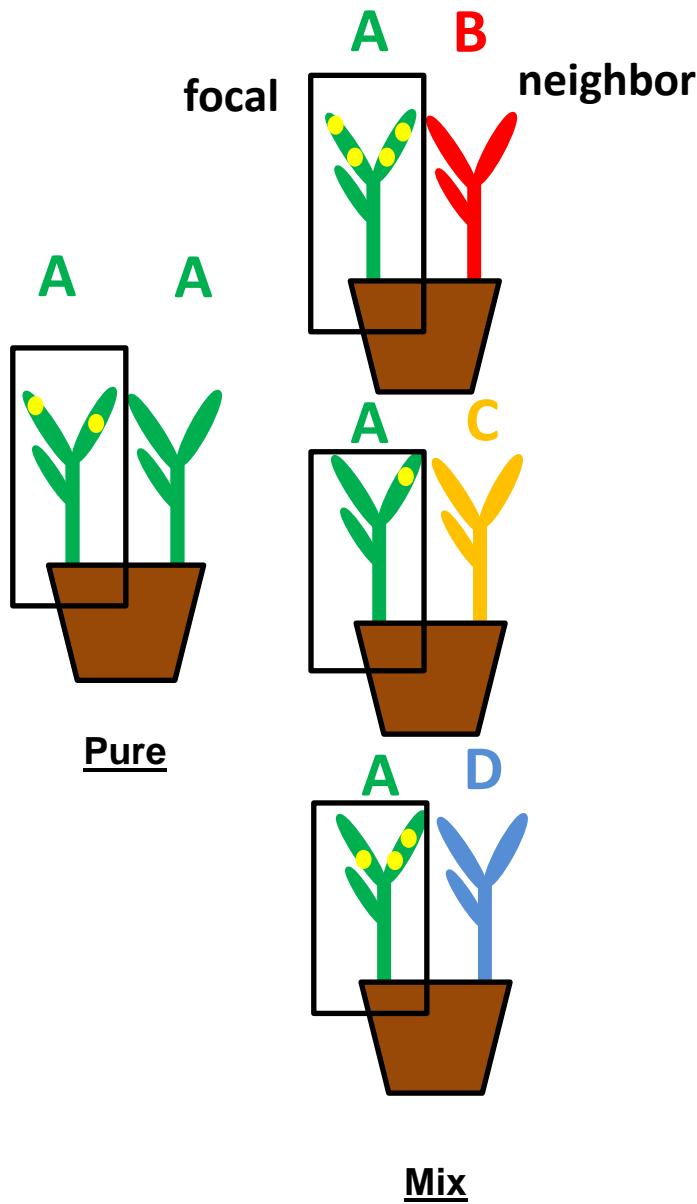
Kin recognition is an organism's ability to distinguish between close genetic kin and non-kin

Wikipedia



→ Only one example to our knowledge shows that **Kin recognition** can trigger the expression of immunity (kin relations known to affect response to insects)

Screening for Neighbor-modulated susceptibility

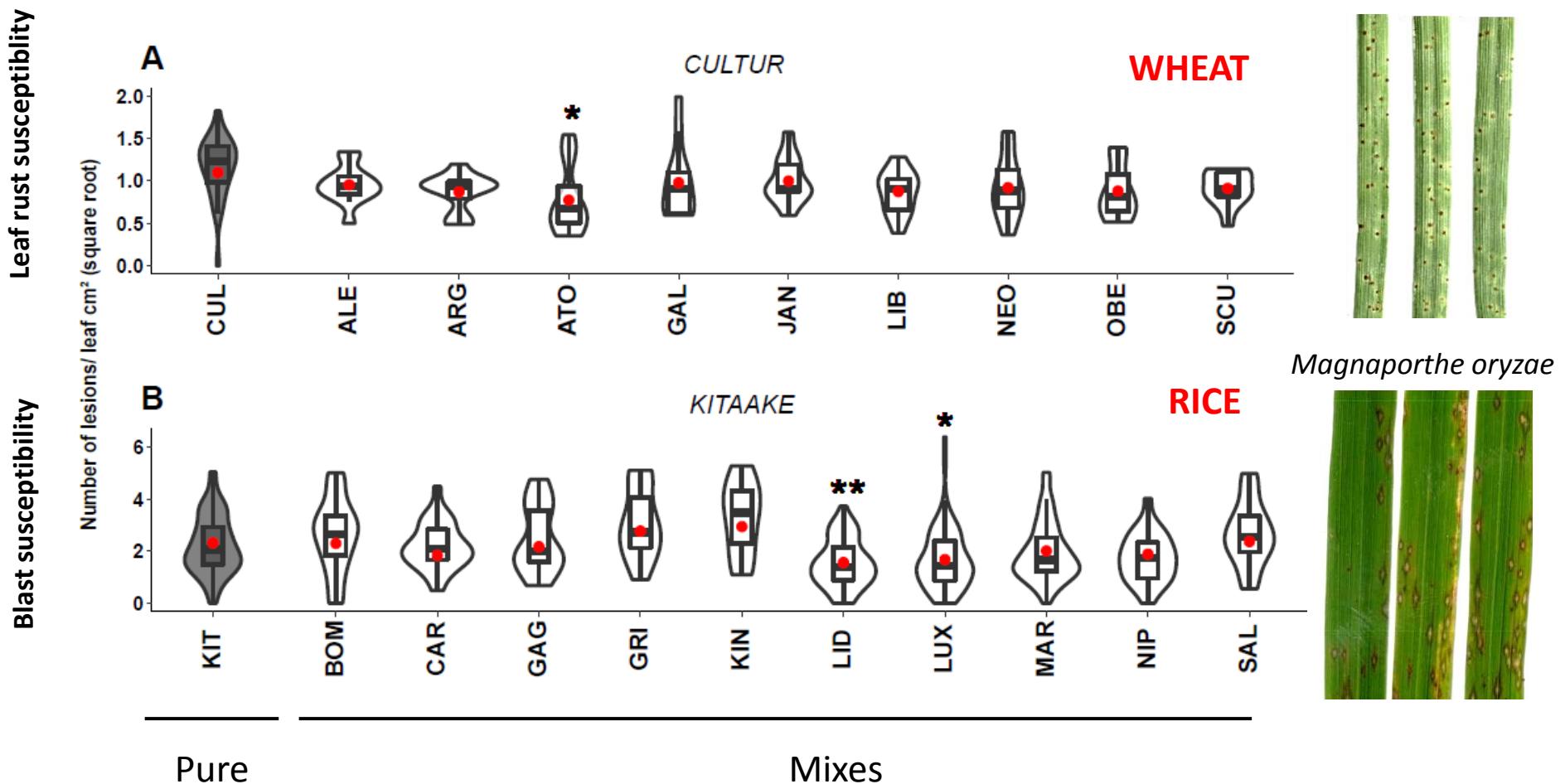


Specific ability
of a given neighbor
to modulate
susceptibility of focal A
(« good » or « bad » neighbor)



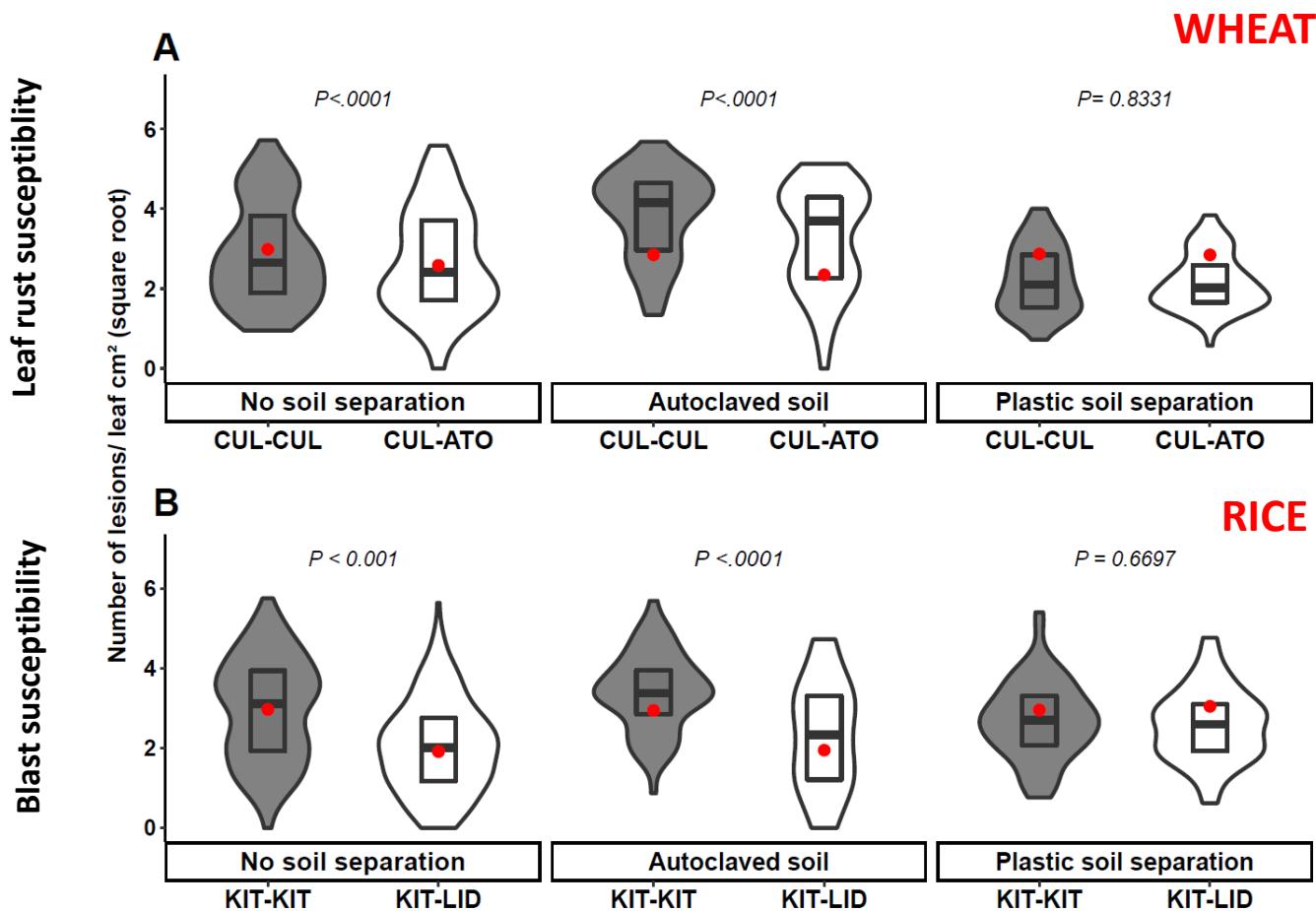
Neighbor-modulated susceptibility (NMS) in rice and wheat

Pelissier et al, submitted



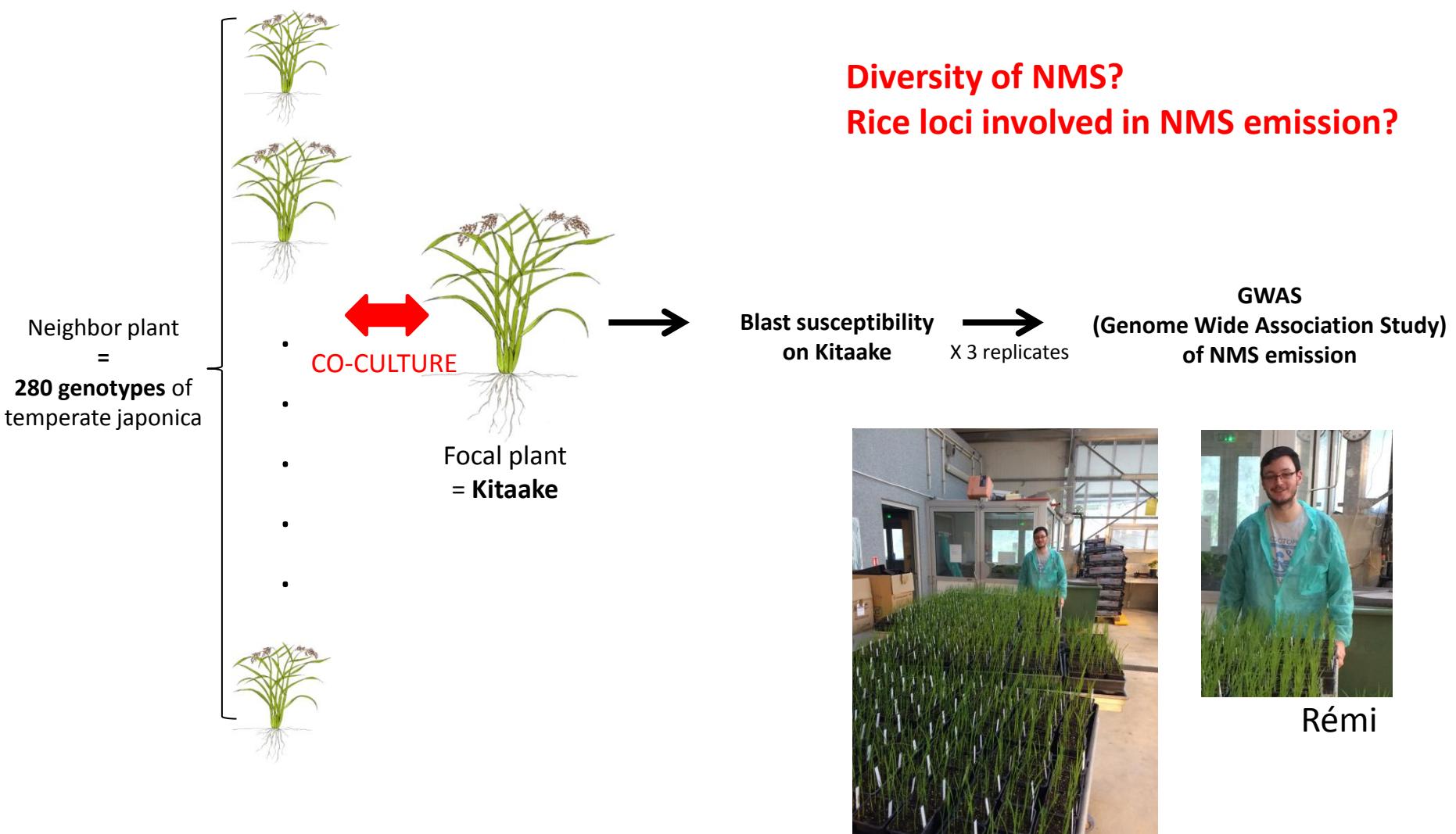
Some kins can modulate susceptibility in their neighborhood (NMS)

Localization of intra-specific plant-plant interactions leading to NMS

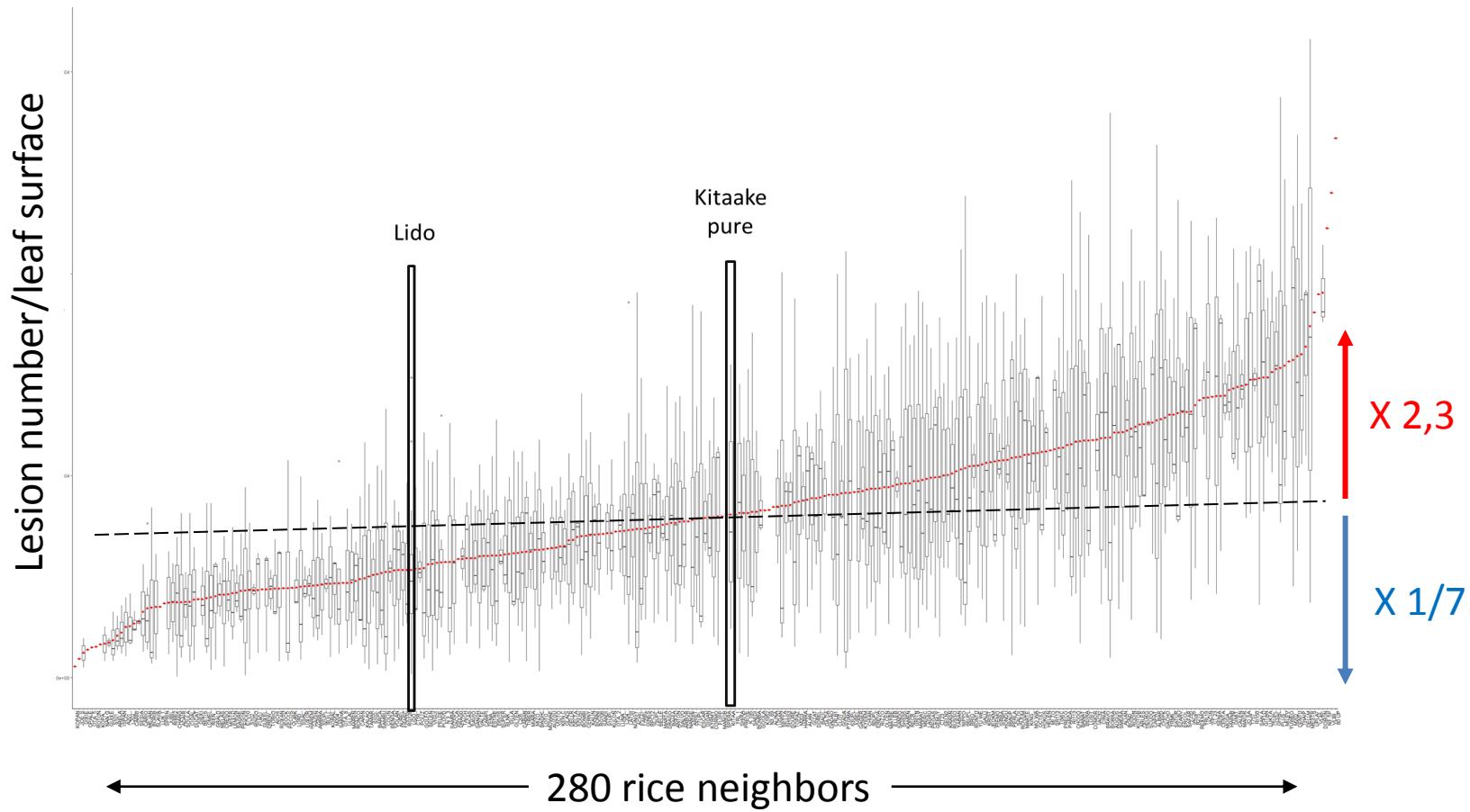


NMS takes place in the soil and does not require microbiome
(nor an infected neighbor)

Mapping rice ability to modulate susceptibility in its neighborhood

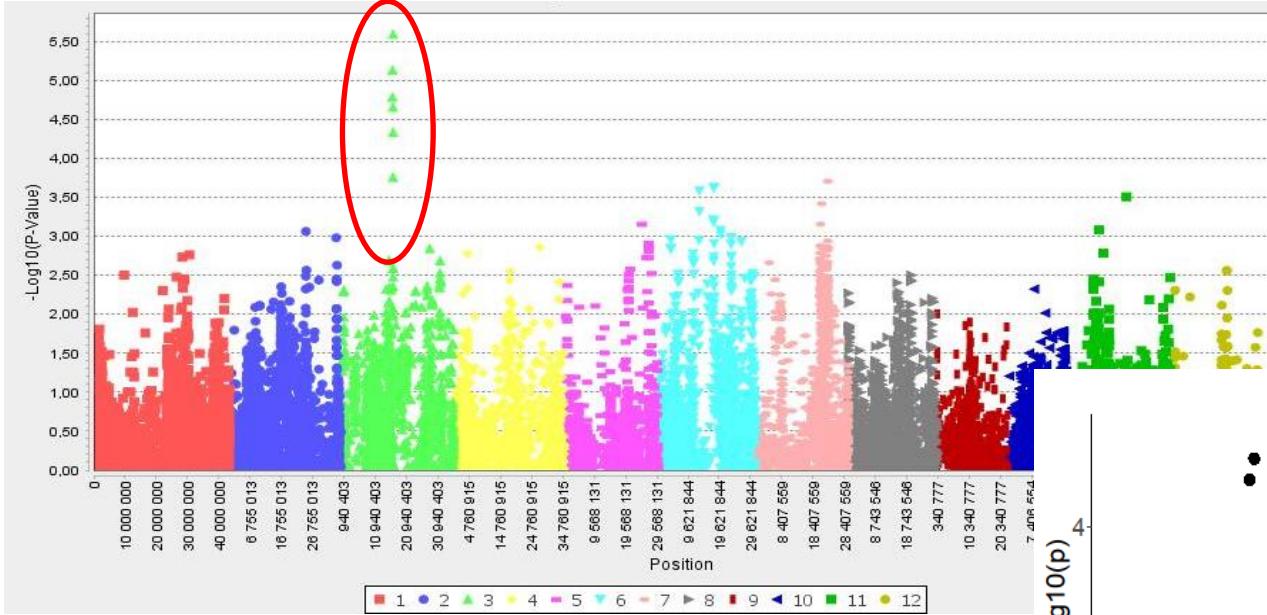


Blast susceptibility of Kitaake cultivated with 280 differents neighbors

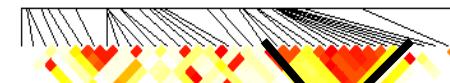
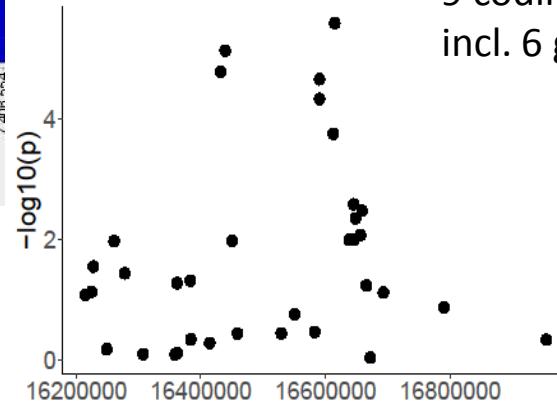


Neighbors can reduce but also increase disease susceptibility of Kitaake

GWAS of the emission of NMS



LD block= 250kb
9 coding sequences,
incl. 6 genes



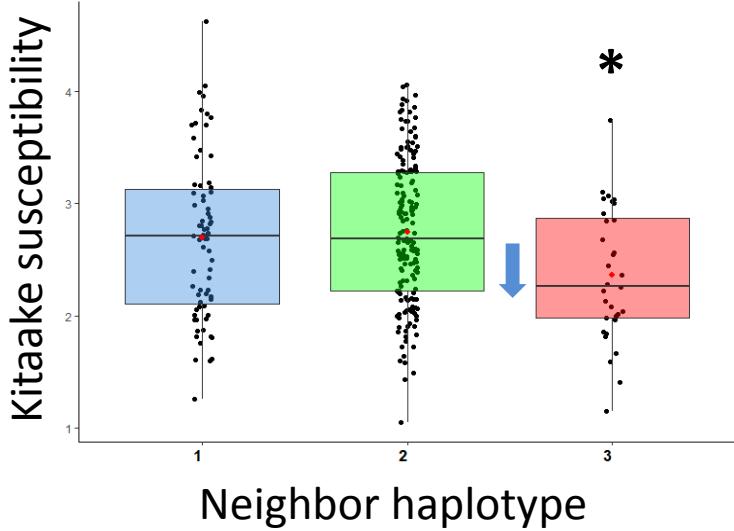
One region on rice chromosome 3 controls NMS emission



Test of GWAS prediction for emission of NMS

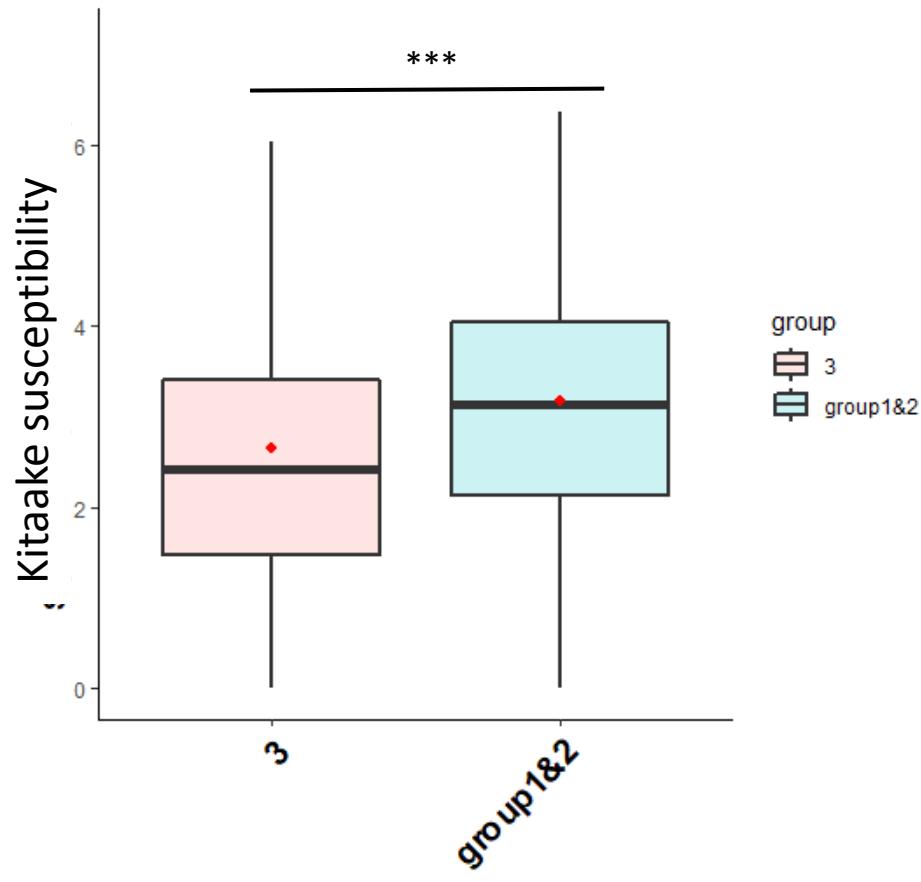
Susceptibility data from GWAS

20% reduction of susceptibility

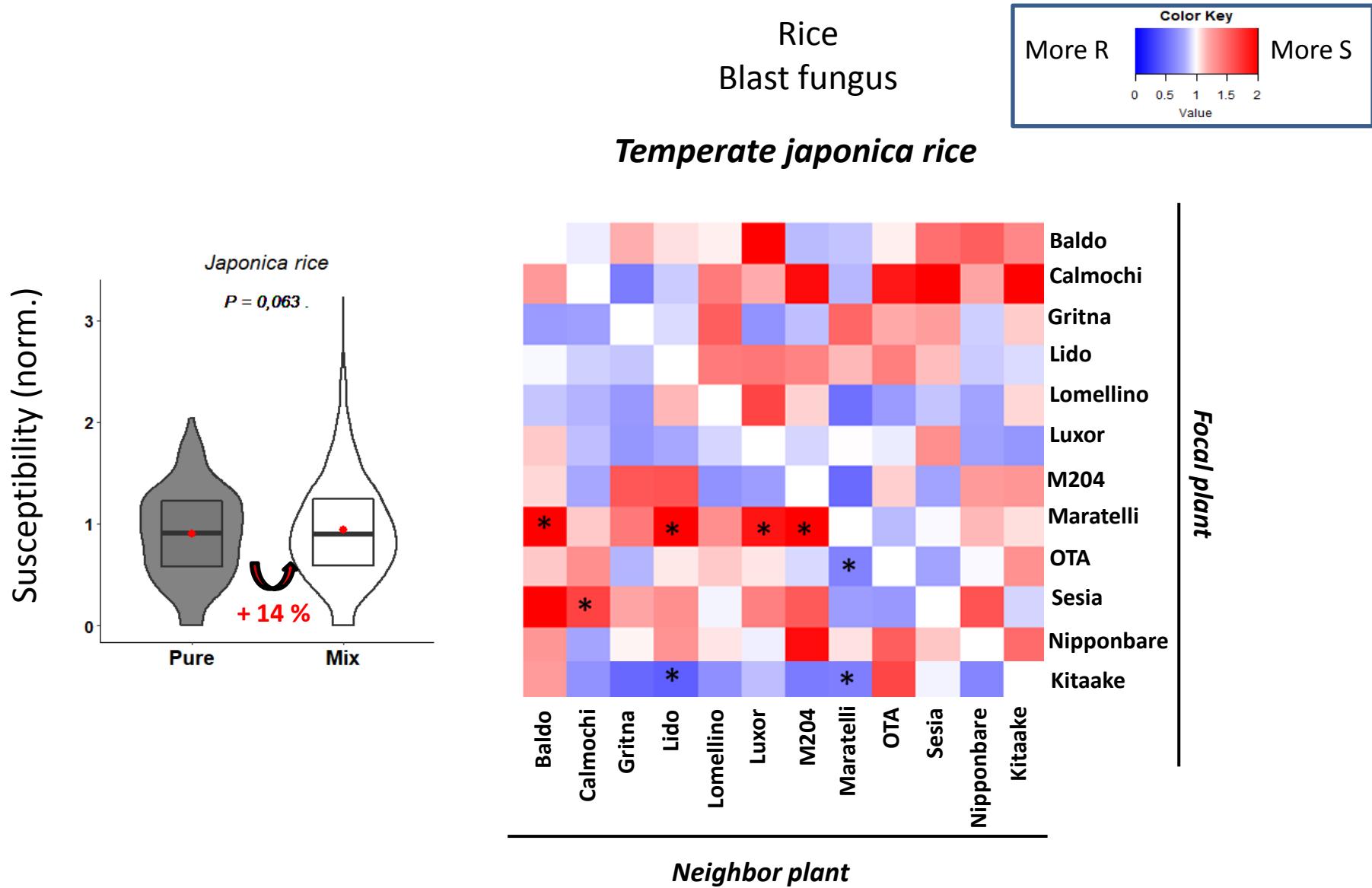


GWAS predicts that neighbors with haplotype 3 reduce susceptibility in focal kitaake

Independent validation
(6 haplotype 3 vs 6 haplotypes 1 or 2)



NMS at the species level: the case of temperate japonica rice

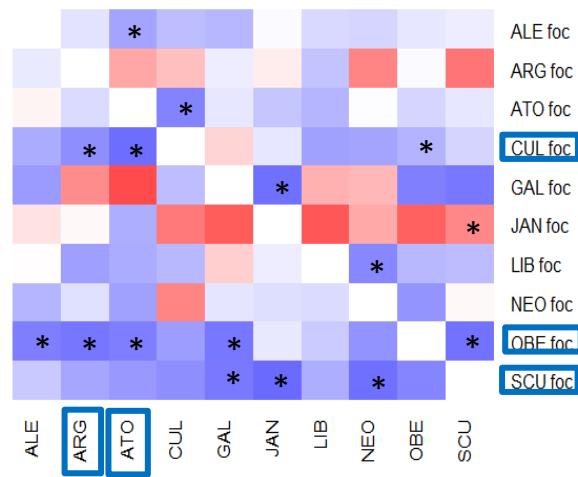


Intra-specific interactions are not favorable to rice blast resistance

NMS: good neighbor and good focal plants

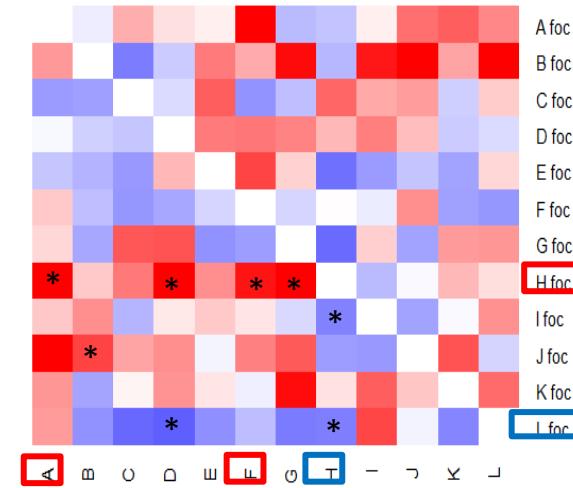
Wheat X leaf rust

Cultivated durum wheat

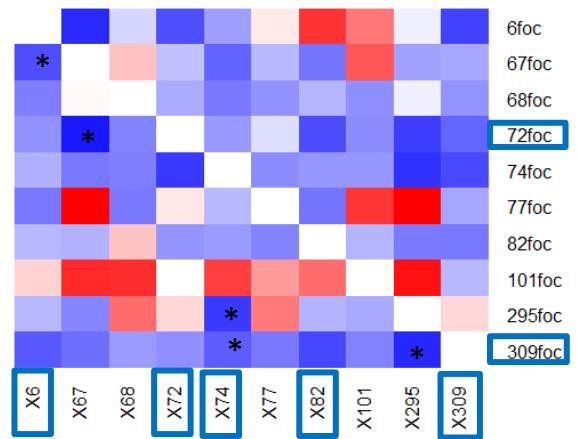


Rice X Blast fungus

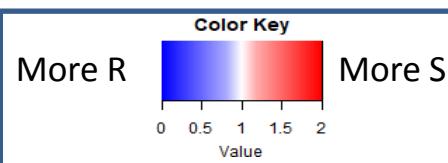
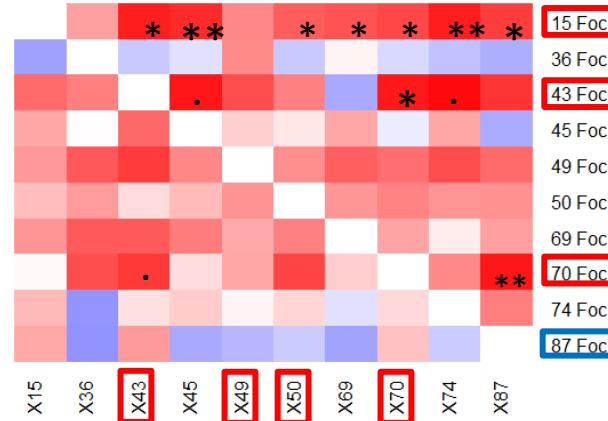
Japonica Rice

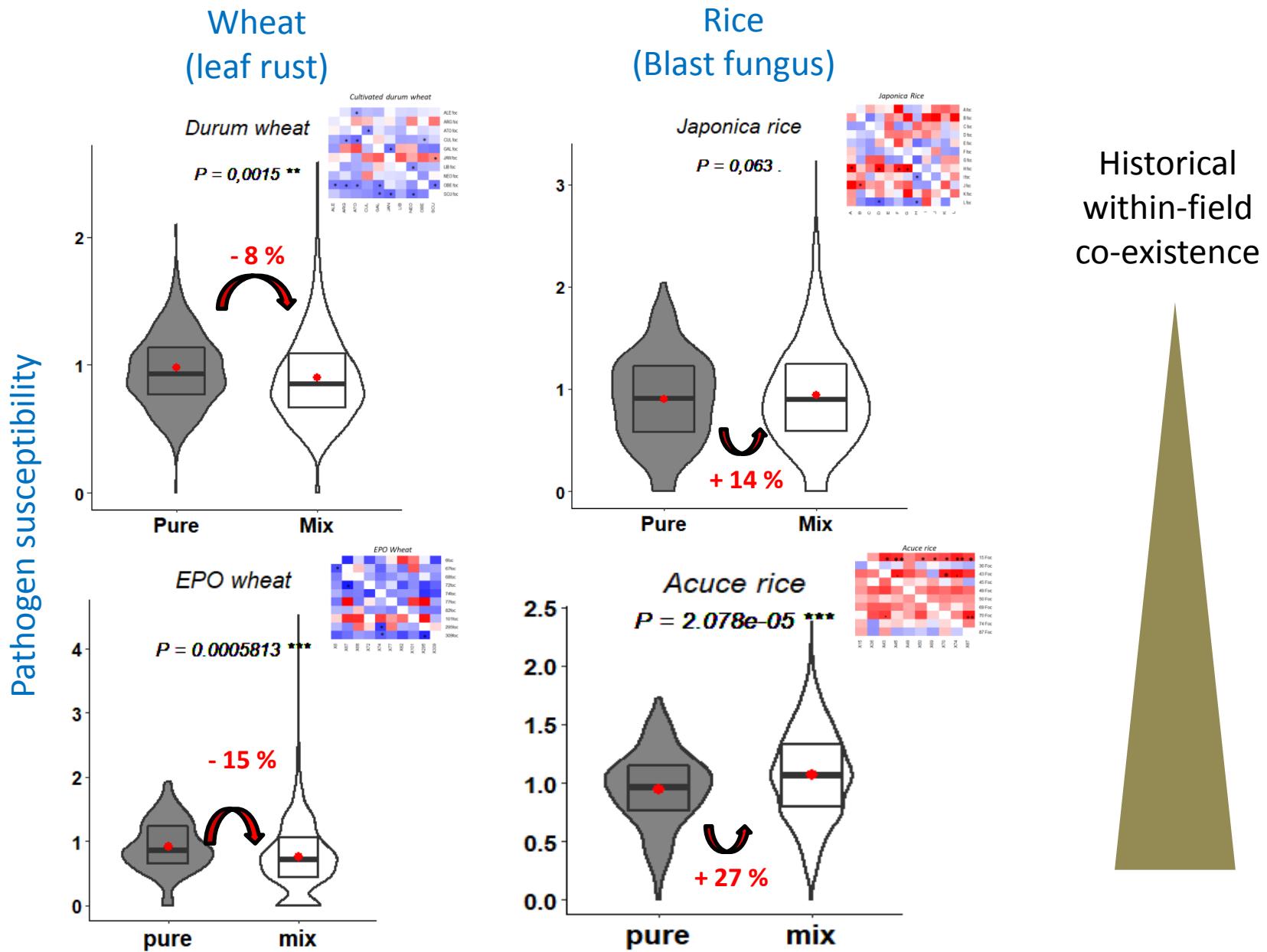


EPO Wheat



Acuce rice







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Xiahong He
Chenyung Li
Youyong Zhu



QUESTIONS?

+ projet thèse (Inrae-ANR MobiDiv)
Génétique et physiologie des interactions blé-blé
modulant la sensibilité aux agents pathogènes
(Sept 2021-2024)

Cyrille Viole

CENTRE D'ECOLOGIE
FONCTIONNELLE
& EVOLUTIVE

Hélène Fréville

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