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Towards an ecological view of plant immunity

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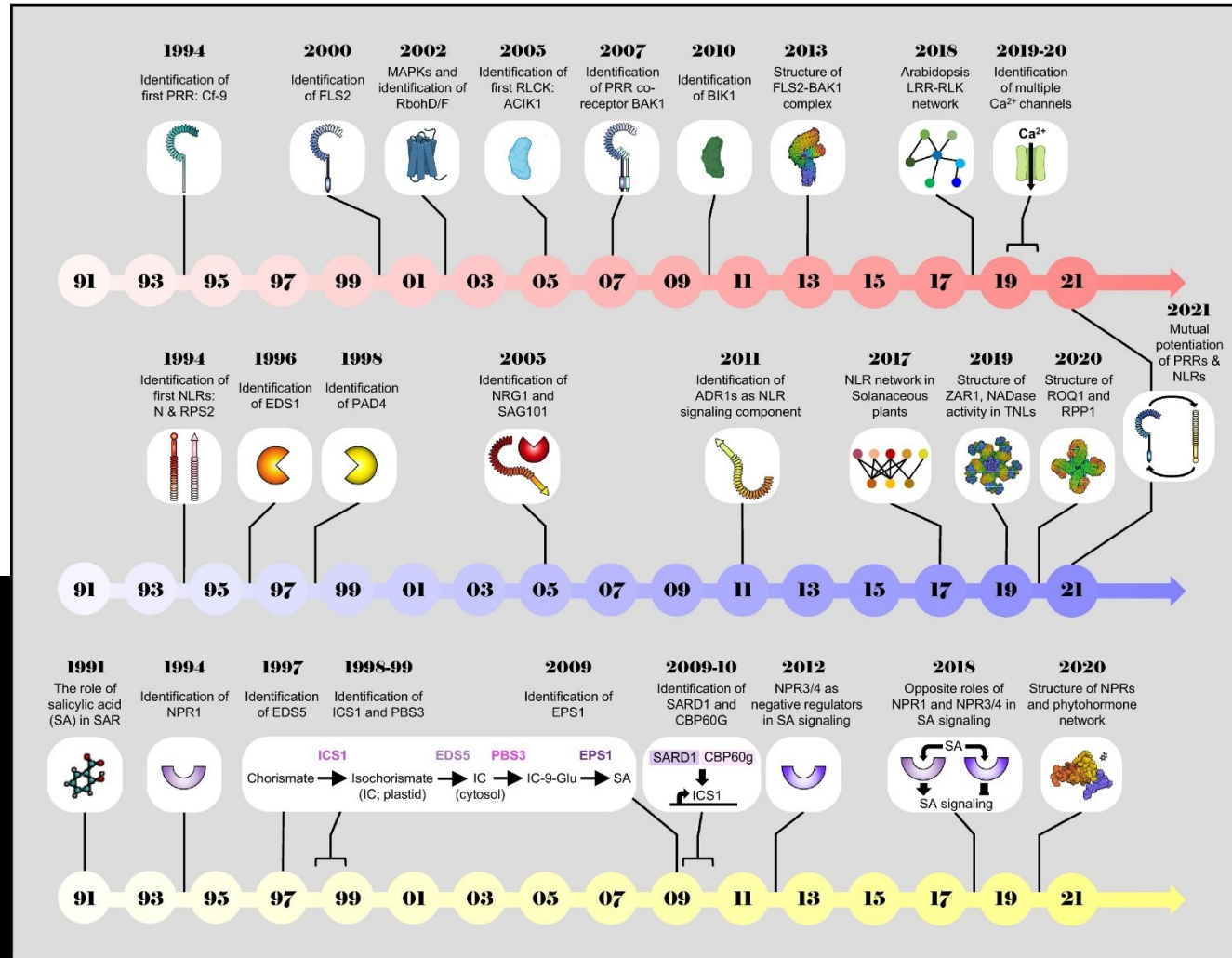
Plant
Health
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An history of plant immunity...

MAMP triggered immunity

Effector triggered immunity

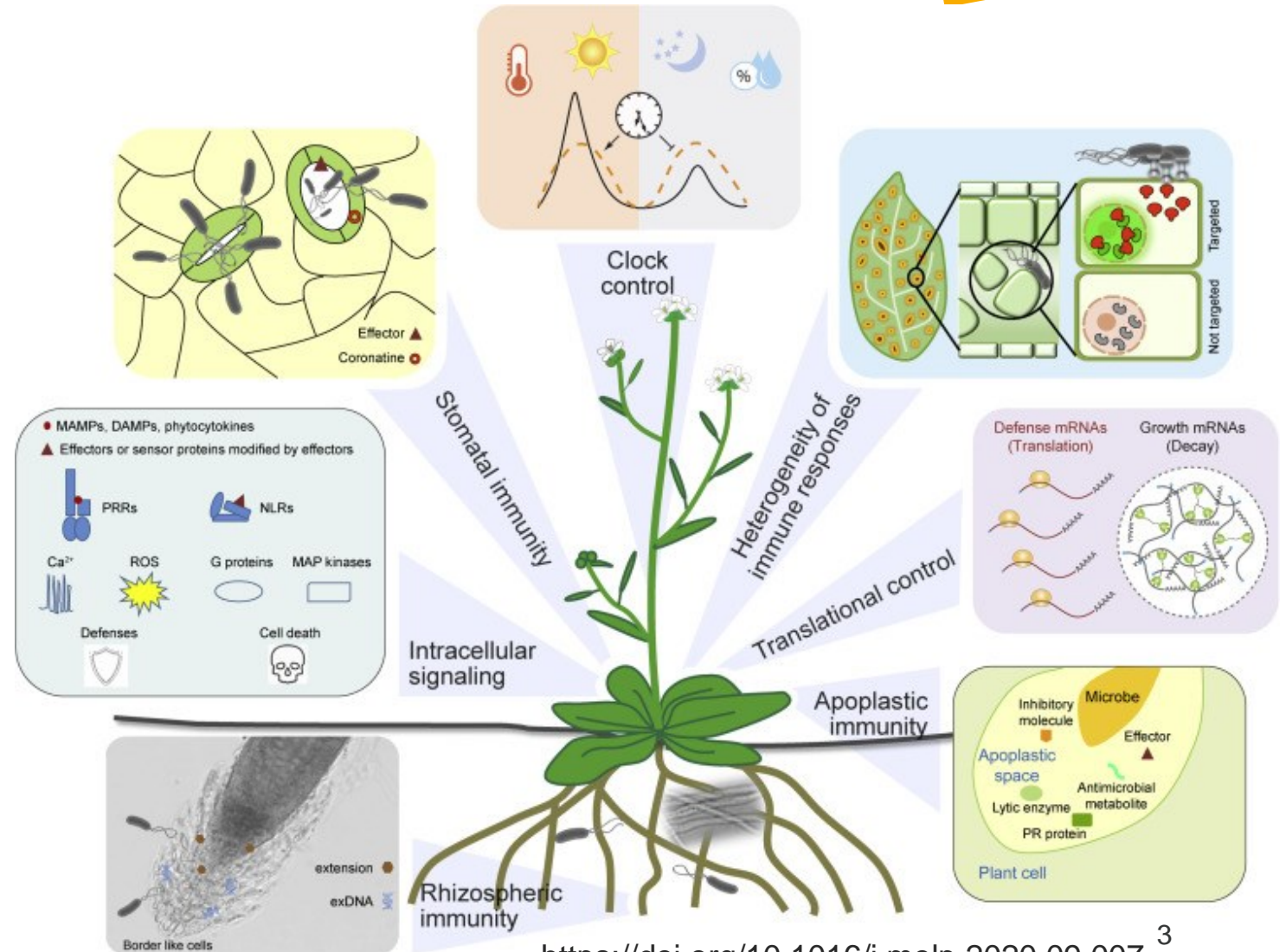
Plant immune Network



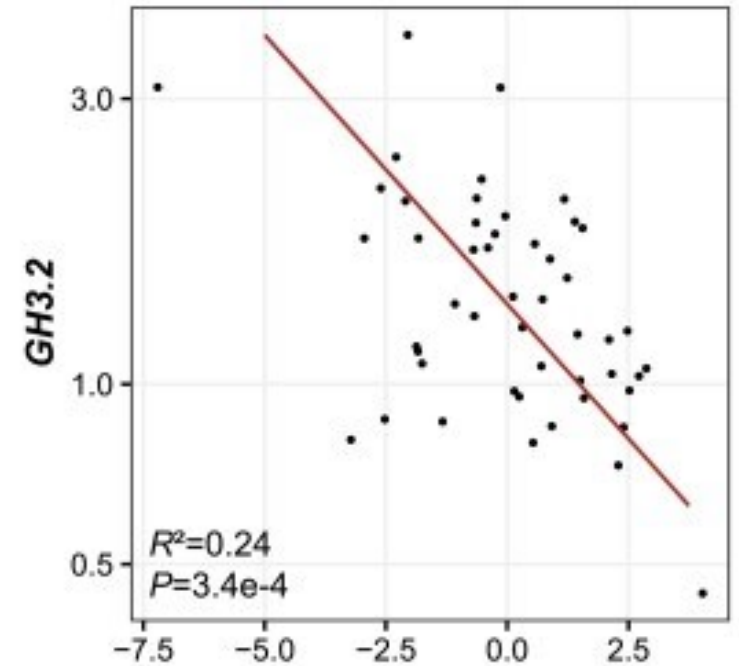
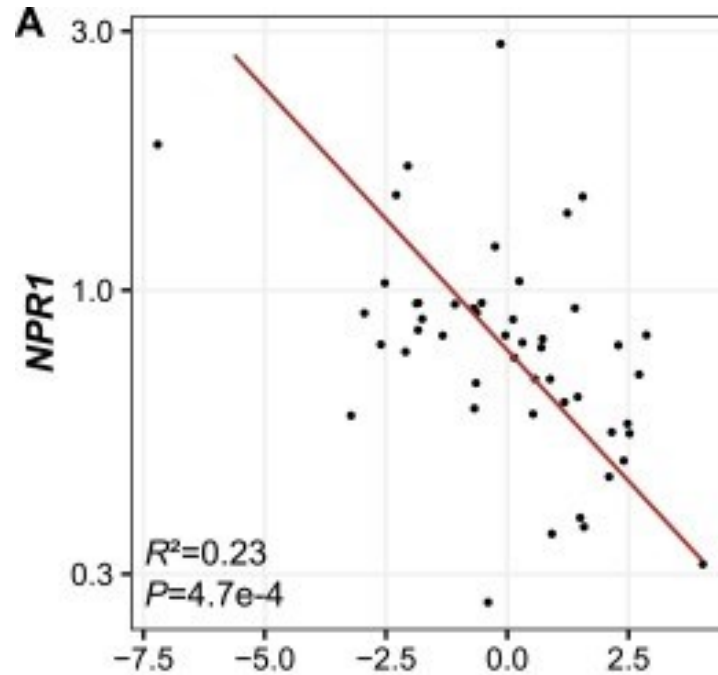
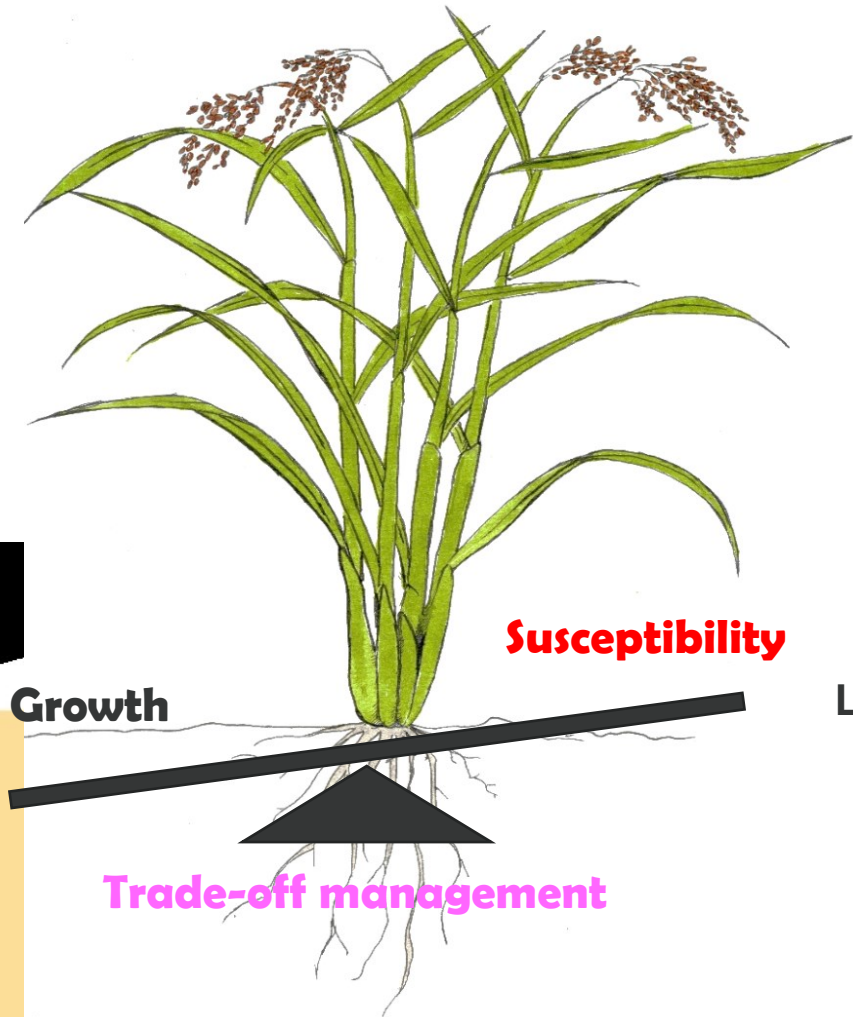
... mostly characterized in the lab

Plant immune responses

Beyond recognition mechanisms, a broader view of plant immune responses



Trade-offs on plant immune responses



Slow growing
Late flowering
Low leaf nutrients

Fast growing
Early flowering
High leaf nutrients

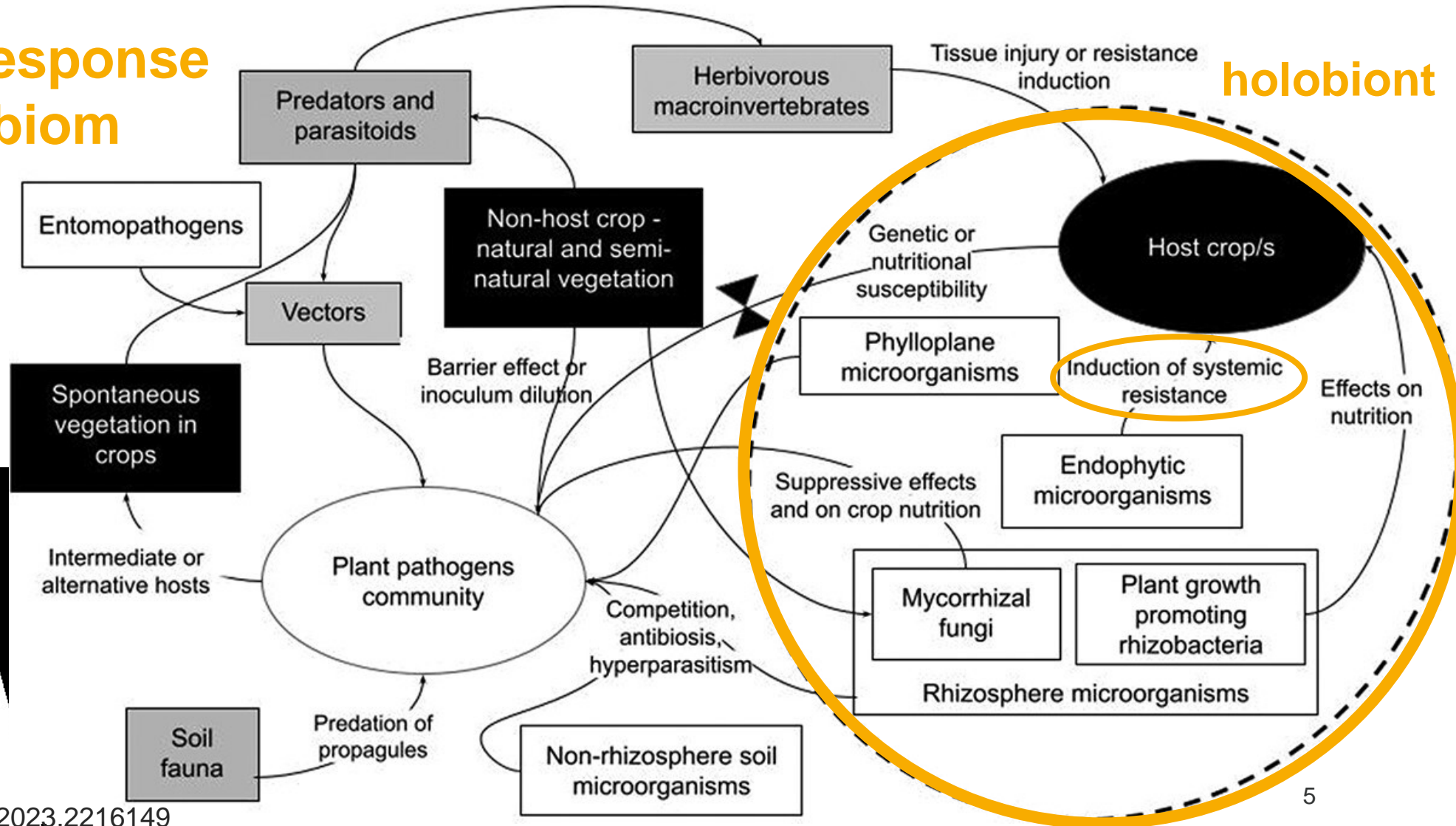


doi: [10.1093/jxb/erad071](https://doi.org/10.1093/jxb/erad071)

fast-growing and acquisitive rices have lower expression of genes involved in immunity

Plant immune responses in an agroecosystem

Plant immune response in the phytobiom



Plant immune response from lab to field

- Model organism
- High availability of tools
- Genetic modification
- Standardised, controlled



- Genetic diversity
- Population dynamics, epidemiology
- Environmental variation
- Agricultural practices



Control conditions



Mesocosme experiments



Control Field experiment



On Farm experiment

Stimulating plant health in agroecological systems

How to promote cropping systems immunity against pathogen and pest populations in an agroecological environment ?

FACTORS

EXTERNAL

PRI, pathogen pressure, cultural practices, Nutrition, Climat, Soil

INTERNAL

Host plant, microbiota

CROPPING SYSTEM



An immune response under influence

Landscape

Climatic epidemiological parameters,
Decision support tools, landscape
management

Host biology

Heritable resistance, constitutive
basal defense, inducibility, ontogenic
resistance

Biotic environment

Microbiome, Pest, vectors,
Neighboring plants, banker plants,
microfaune



Pathogen

Adaptation, co-evolution,
agressivity

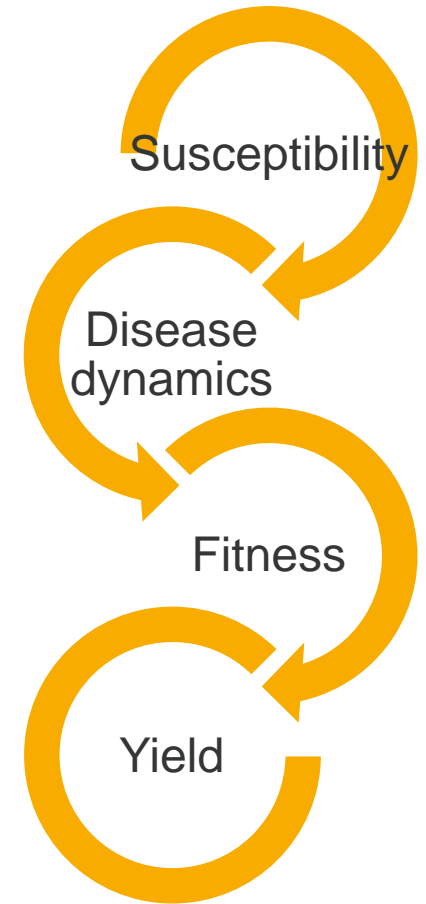
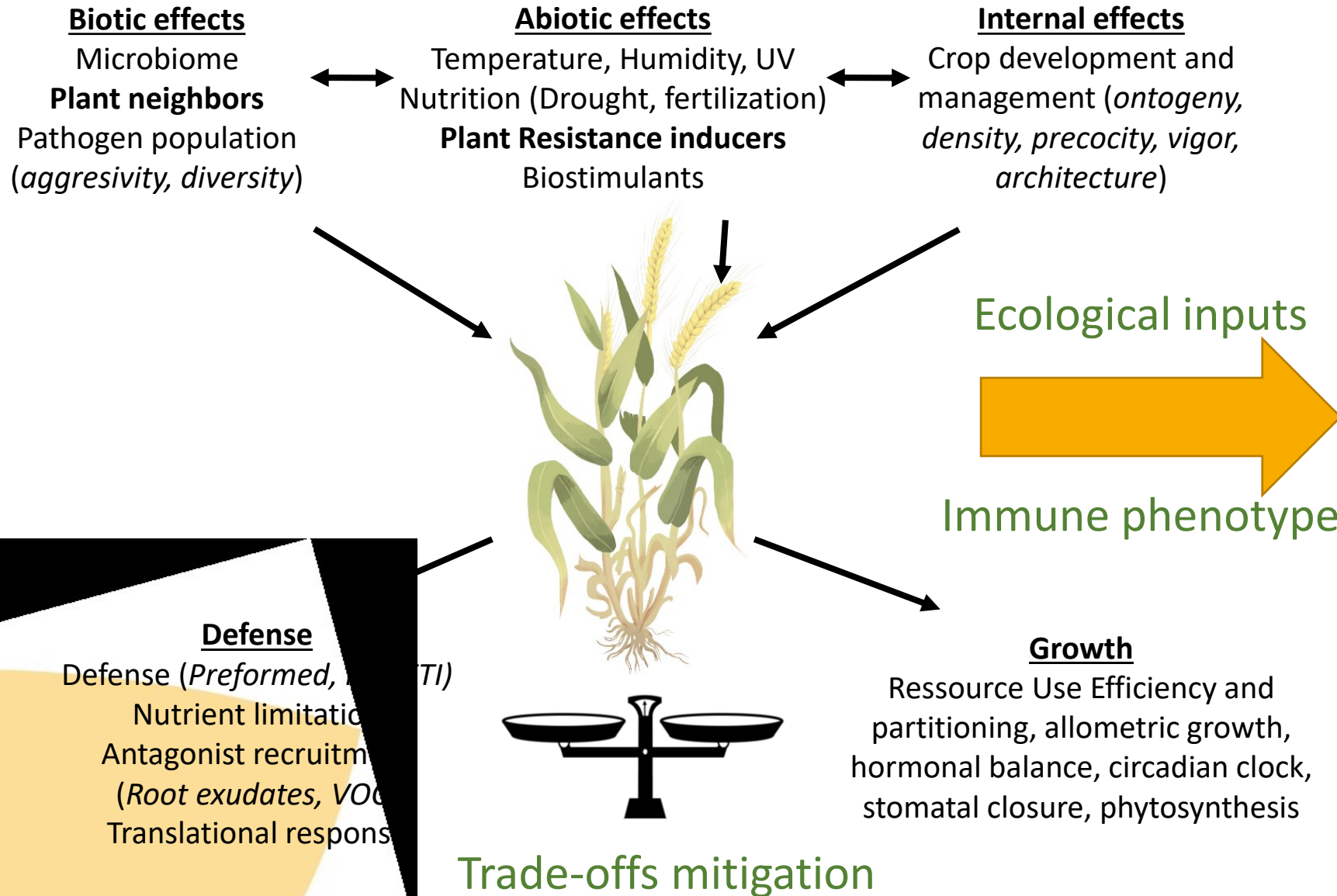
Nutrition

Cultural practices, fertilization, abiotic
stress, plant physiological status,
supplemental food or biocontrol
agents, etc.

Product

Biodisponibility, formulation,
application, survival,
reinforcement

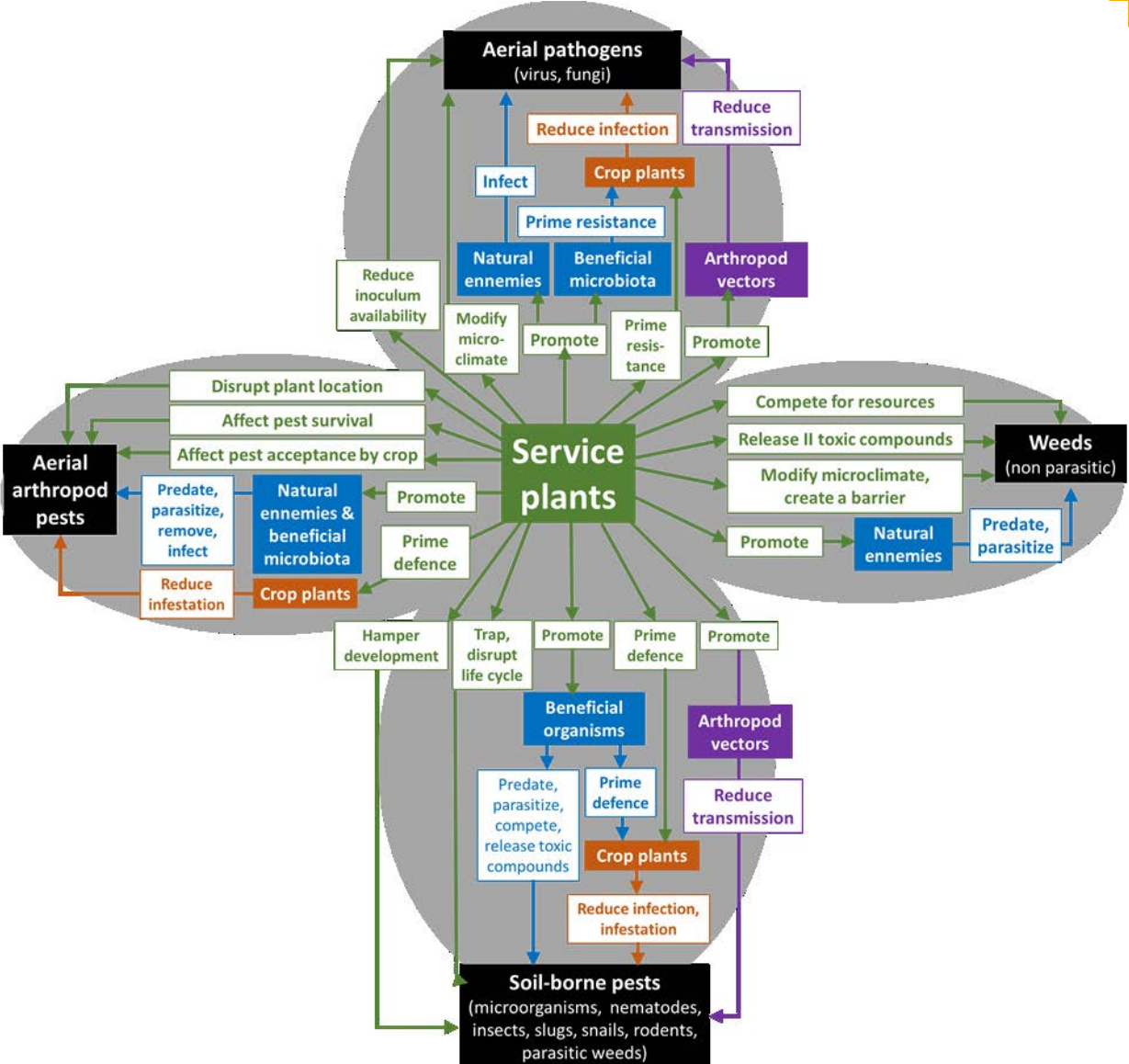
Towards agroecological immunity



Plant plant interactions as a model for modulation of the immune response in an ecological context

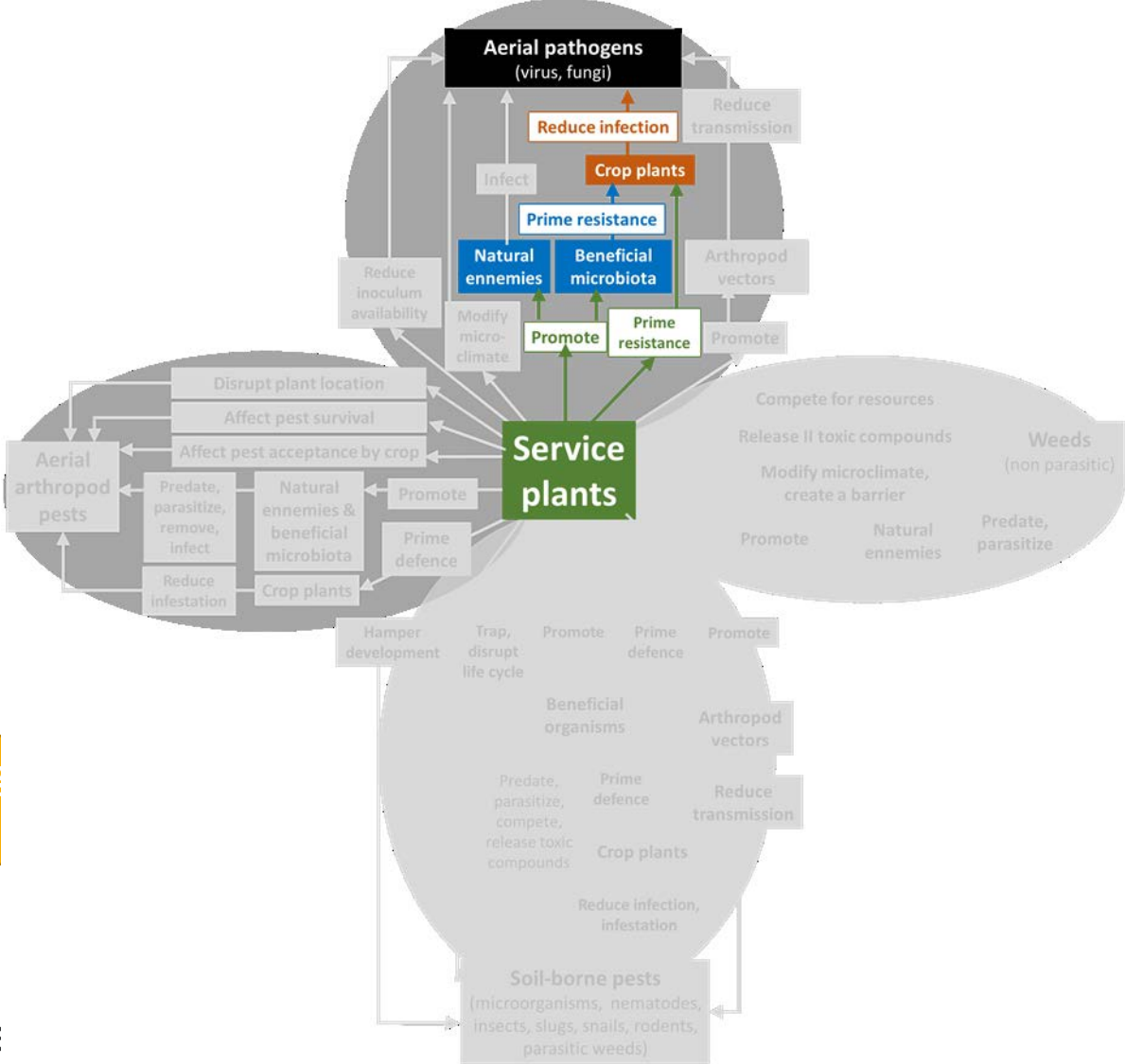


Services plant a neglected biocontrol agent



Which potential of service plants for 'm regulation in agroecosystems?

Services plant a neglected biocontrol agent



Service plant can prime resistance through plant interactions

Neighbor mediated susceptibility



Neighbor

Focal



Shade

Shade avoidance

VOC

odorant-binding proteins (OBPs)
olfactory receptors (ORs)

Physiological adaptation

Hormone homeostasis

Defense response

Allometric growth

Root exudates

Competition for nutrients

Perception of available resources

Microbiota

Neighbor recognition?
Root alteration (DAMP) ?

Signal integration

Nutrient assimilation

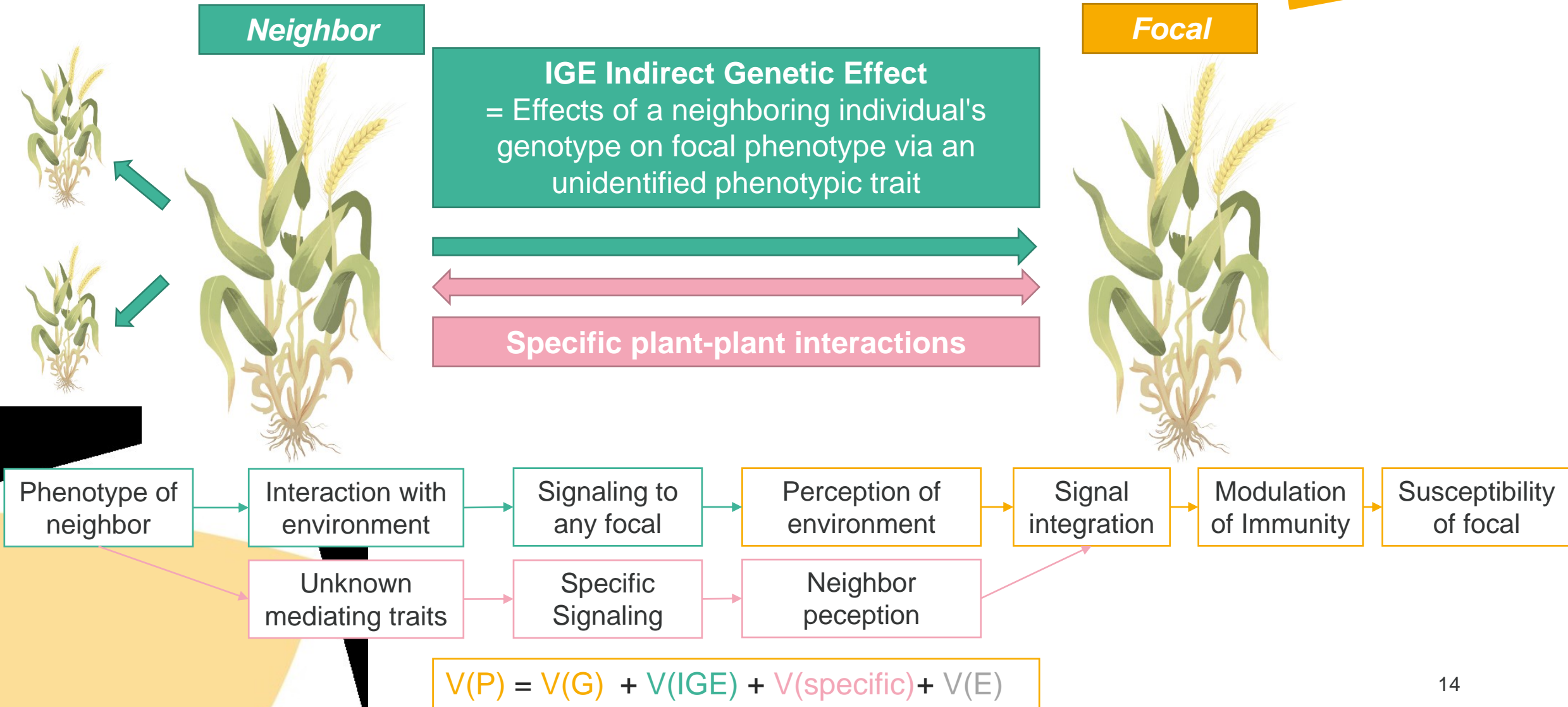
Microbiota recruitment

Neighbor signaling

Perception by focal plant

Focal plant response

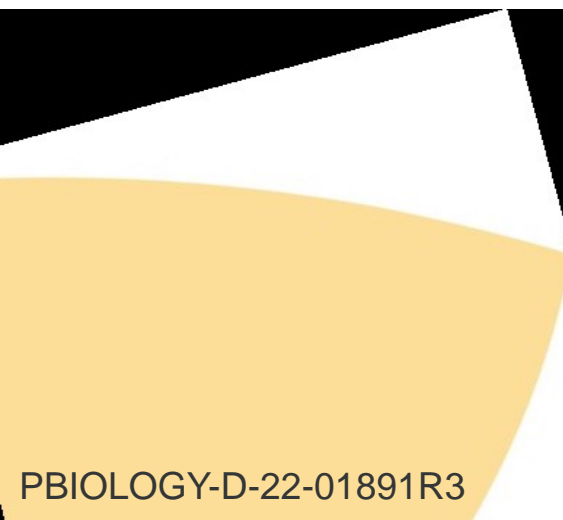
Towards genetics of plant-plant interactions



Effect sizes of neighbor effect



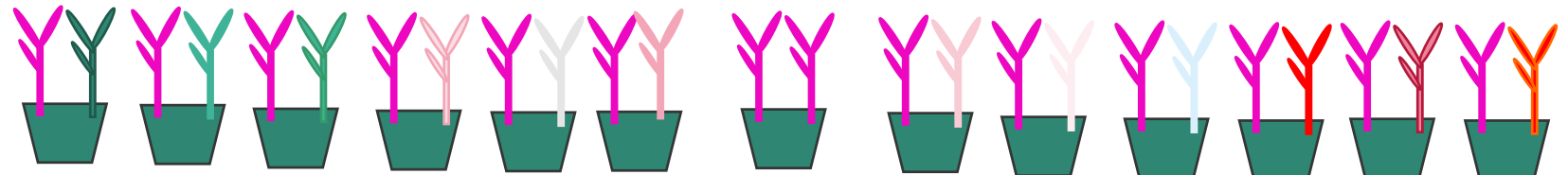
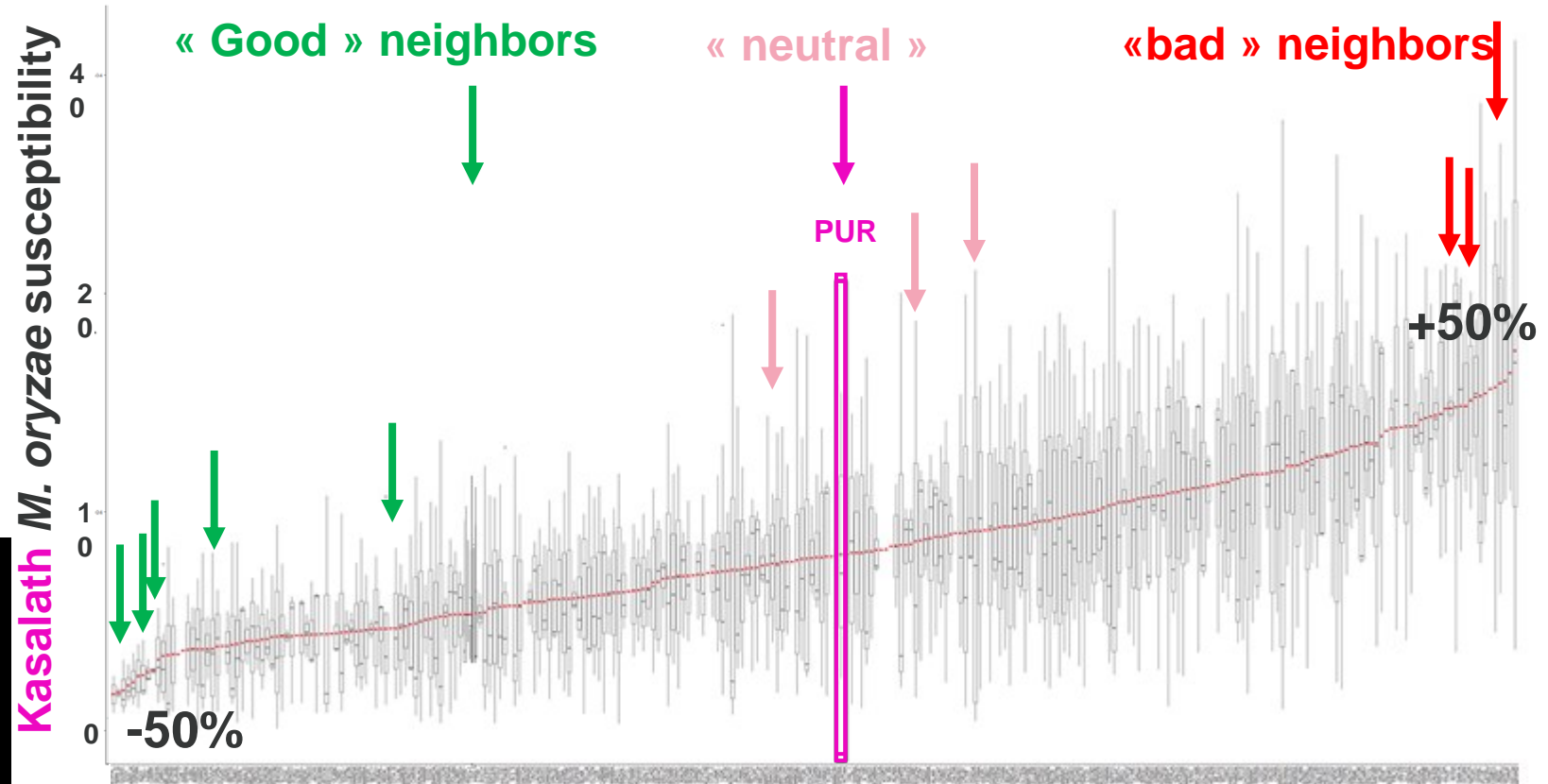
Set of genotypes	Species	Effect of basal immunity (DGE)
JAP_{rice} (elites varieties)	Rice (<i>Oryza sativa</i> <i>spp. temperate japonica</i>)	15.3 % ***
ACU_{rice} (Lines from landrace)	Rice (<i>Oryza sativa</i> <i>spp. Indica</i>)	0.6 %
ELI_{wheat} (elites varieties)	Durum Wheat (<i>Triticum turgidum</i>)	4.4 % ***
EPO_{wheat} (inbred lines)	Durum Wheat (<i>Triticum turgidum</i>)	8.6 % ***



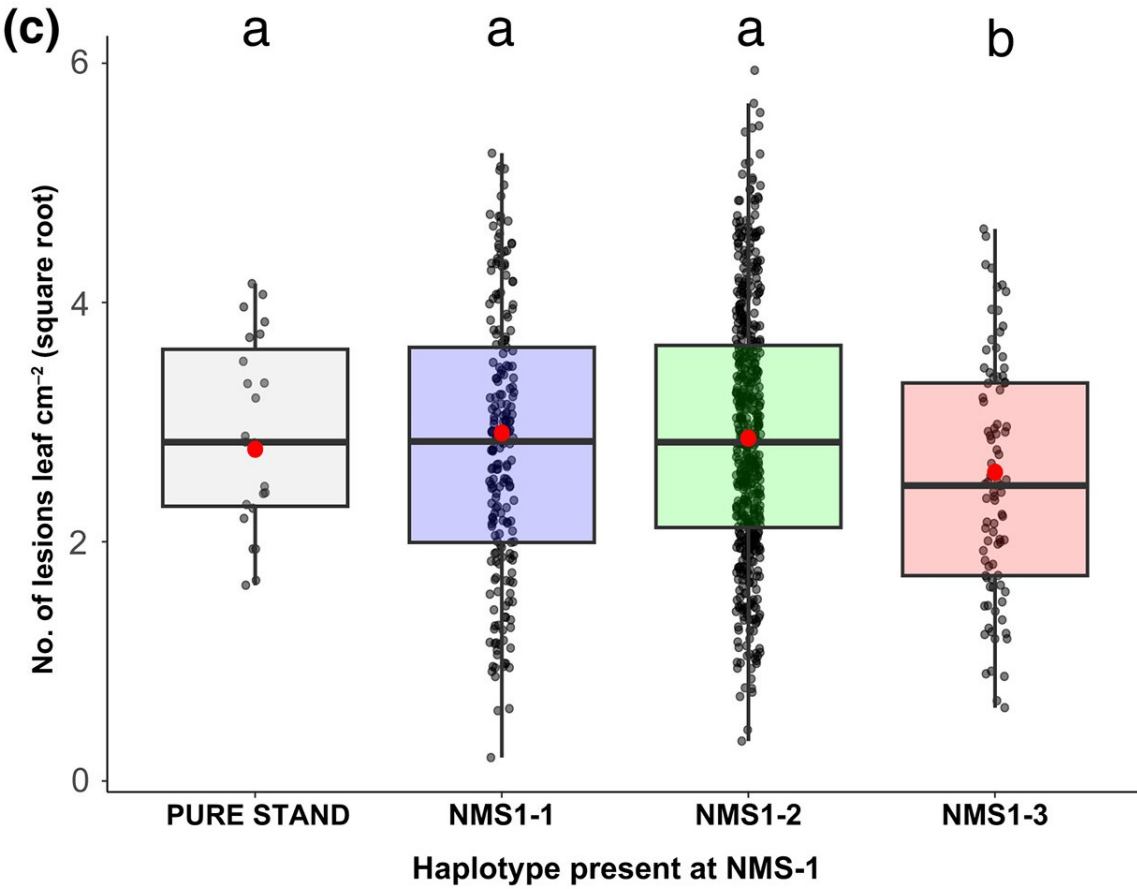
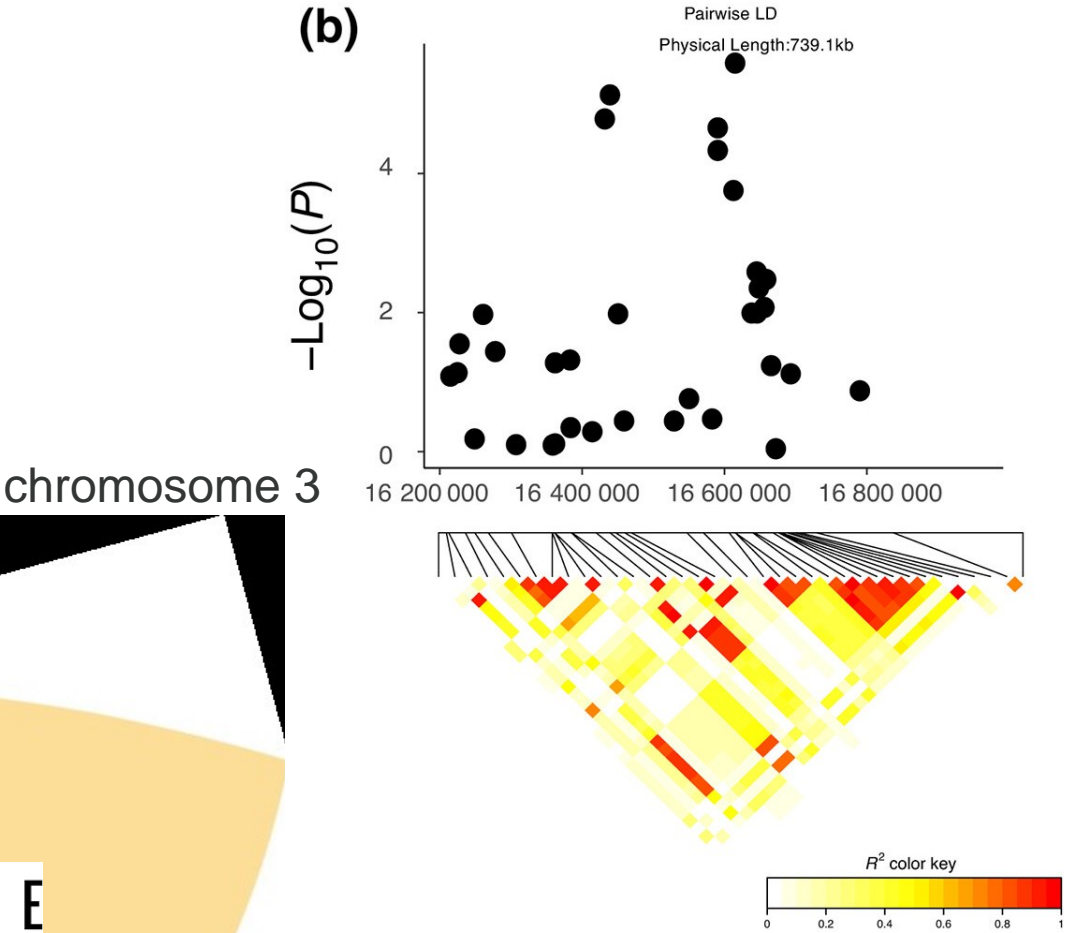
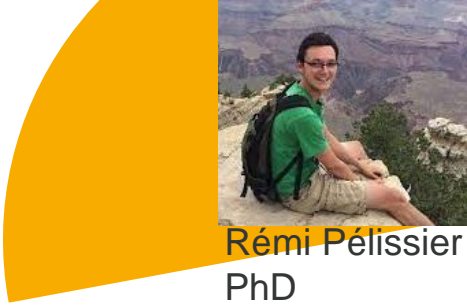
Neighbor mediated susceptibility



Kasalath variety



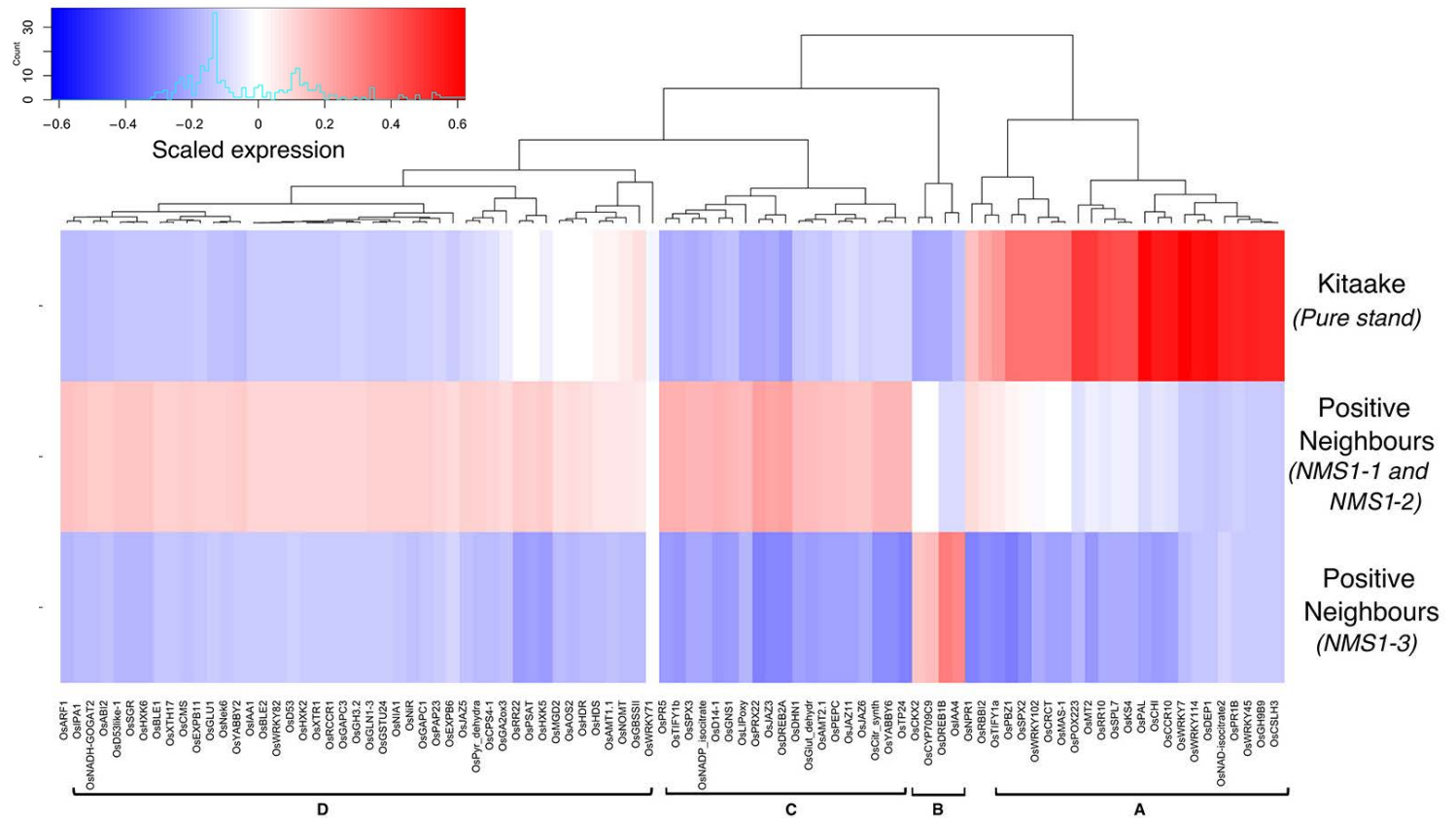
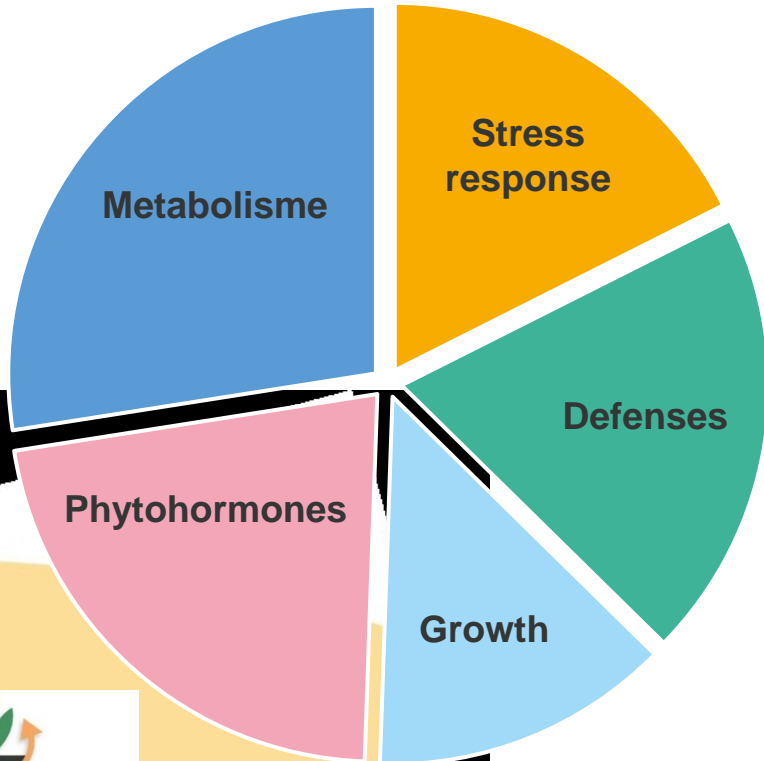
A major genetic locus in neighbors controls focal susceptibility



Neighbor mediated immunity



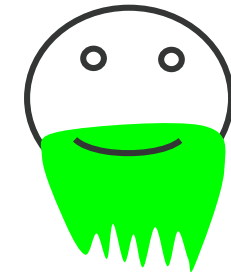
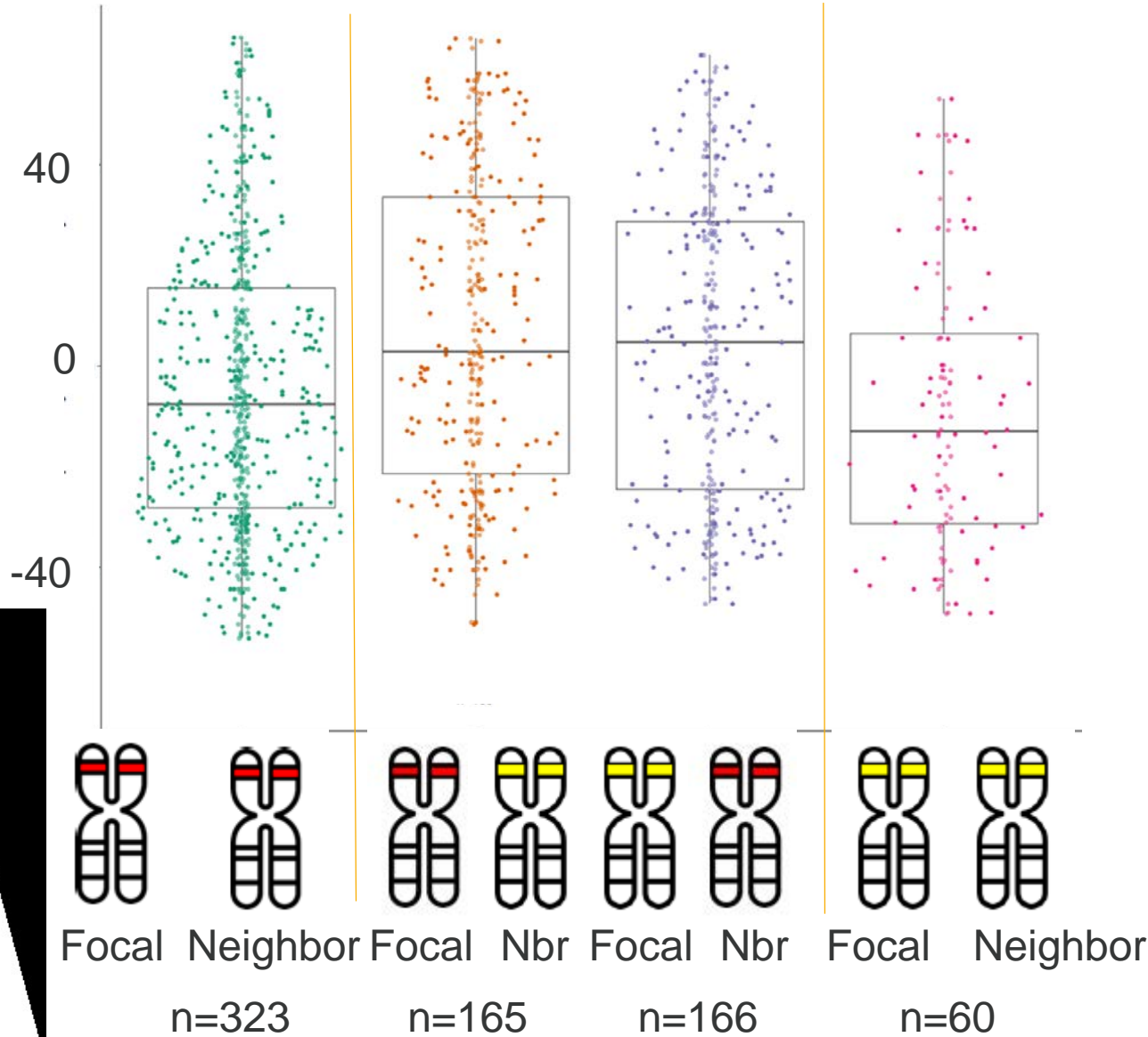
93 marker genes



From cultivar mixtures to allelic mixtures



Focal susceptibility
(% necrosis)
Deviation from average phenotype



green beard theory

Hamilton 1964

714 focal evaluated in mixtures





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MOMIE: MOdulation of plant-Microbe Interactions by the Environment

An application of Agroecological immunity



Elsa
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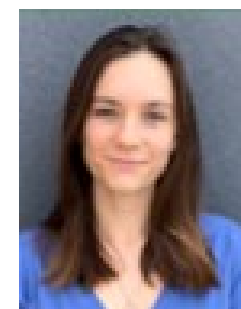
Jean-Benoît
MOREL



Laura
MATHIEU



Claire
BENEZECH



Valentine
FONTAINE



Amandine
CHLOUP

Sunday 12 am:
Plant-plant interactions modulate
wheat susceptibility to Septoria