Optimisation of deployment strategies of plant resistance to pathogens

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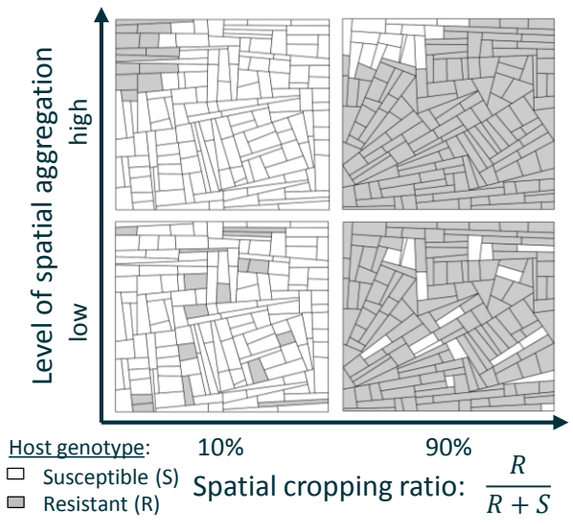
Genetically controlled plant resistance allows reduction of damage caused by pathogens. However, pathogens have the ability to evolve and overcome such resistance, resulting in significant crop losses. We developed a spatially explicit model to investigate the potential for different resistance gene deployment strategies to provide both efficient (ability to reduce disease impact) and durable (ability to limit pathogen adaptation) disease control[a].

Explicit landscape

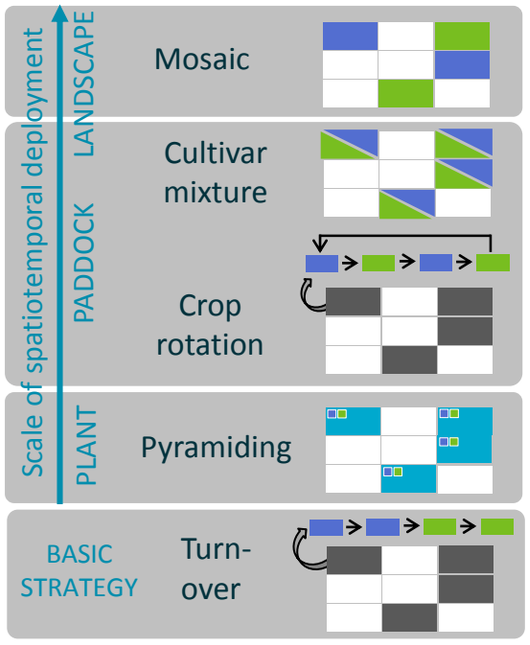
1. Generation of a landscape of 155 paddocks using a T-tessellation algorithm
2. Allocation of different cultivars in controlled proportions and spatial aggregation



Deployment strategies

Example with 2 resistance sources

S
R_1
R_2



Pathogen adaptation

Breakdown of qualitative resistance (🚫)

Infectivity matrix	Host genotype: S	Host genotype: R
non-infective	1	$1 - \rho$
Infective	$1 - \theta$	1

Mutation rate τ

Cost of infectivity

Major gene efficiency

Erosion of quantitative resistance (⚡)

Aggressiveness matrix	Host genotype: S	Host genotype: R
not aggressive	1	$1 - \eta$
...	...	...
...	...	...
Fully aggressive	$1 - \eta$	1

Mutation rate $\tau/2$ $\tau/2$

Trade-off strength: β

QR efficiency

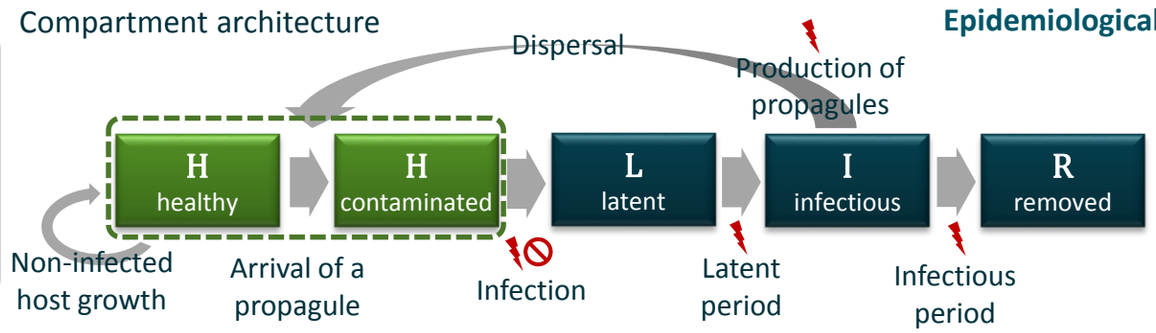
Key parameters estimated through literature or laboratory experiments

Host response to disease

Effect of resistance:
- Qualitative
- Quantitative

Host contribution to yield:
- Productive
- Non-productive

Compartment architecture

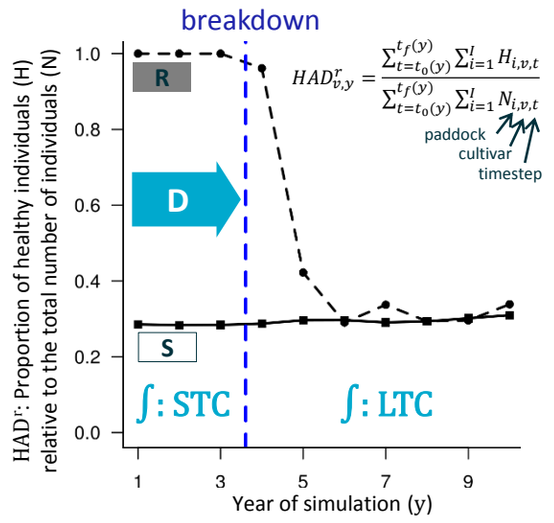


Evaluation criteria

Example of a mosaic with 1 resistant cultivar[b]

Evolutionary
- Durability (D)

Epidemiological
- Short-term control (STC)
- Long-term control (LTC)



FOR FURTHER INFORMATION
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REFERENCES
a. Burdon JJ, Zhan J, Barrett LG, Papaïx J, Thrall PH (2016). Addressing the challenges of pathogen evolution on the world's arable crops. *Phytopathology* 106: 1117-27
b. Papaïx J, Rimbaud L, Burdon JJ, Zhan JS, Thrall PH (submitted). Differential impact of landscape-scale strategies for crop cultivar deployment on disease dynamics, resistance durability and long-term evolutionary control. *Evol. Appl.*

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