Optimisation of deployment strategies of plant resistance to pathogens

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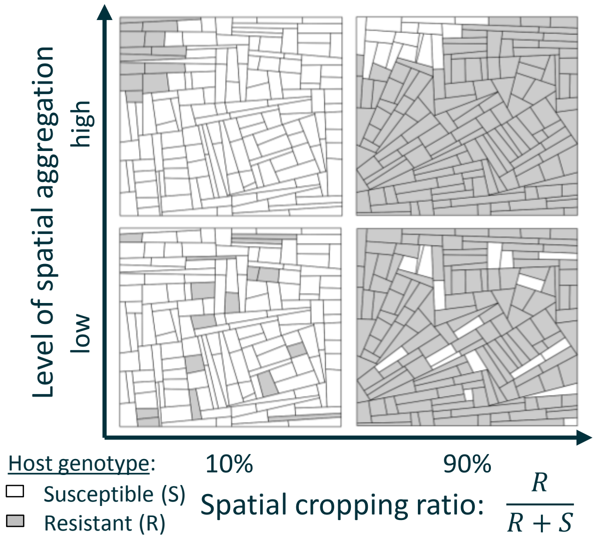
Genetically controlled plant resistance allows reduction of damage caused by pathogens. However, pathogens have the ability to evolve and overcome such resistance, resulting in significant crop losses. We developed a spatially explicit model to investigate the potential for different resistance gene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

Explicit landscape

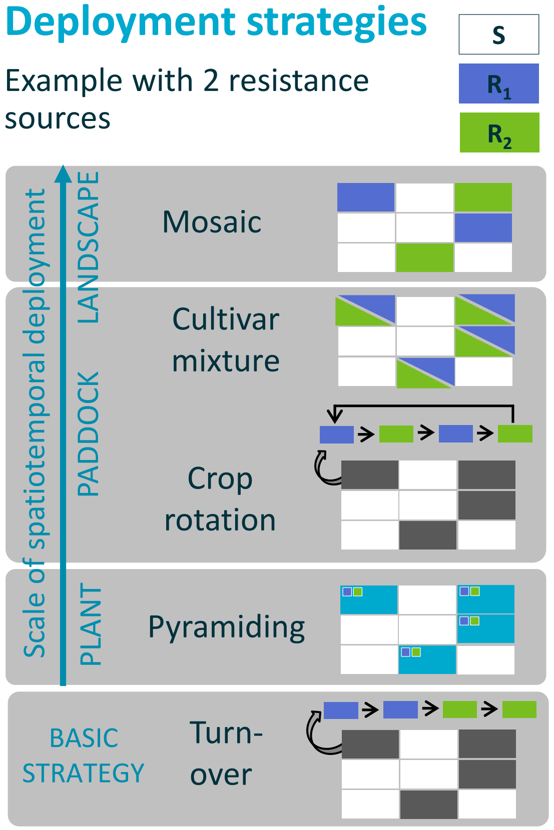
1. Generation of a landscape of 155 paddocks using a T-tessellation algorithm
2. Allocation of different cultivars in controlled proportions and spatial aggregation



Spatial cropping ratio: $\frac{R}{R+S}$

Deployment strategies

Example with 2 resistance sources



Pathogen adaptation

Breakdown of qualitative resistance

Mutation rate τ

Infectivity matrix	Host genotype S	Host genotype R
non-infective	1	1 – ρ
Infective	1 - θ	1

Cost of infectivity (θ); Major gene efficiency (ρ)

Erosion of quantitative resistance

Mutation rate $\tau/2$

Aggressiveness matrix	Host genotype S	Host genotype R
not aggressive	1	1 - η
…	…	…
…	…	…
Fully aggressive	1 - η	1

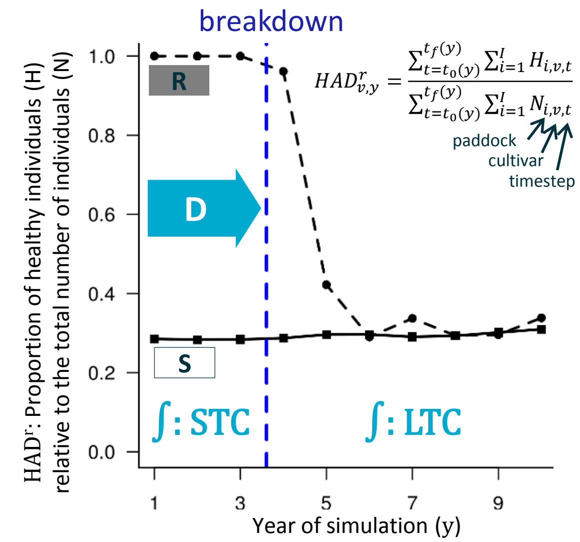
Trade-off strength: β; QR efficiency (η)

Key parameters estimated through literature or laboratory experiments

Evaluation criteria

Example of a mosaic with 1 resistant cultivar[b]

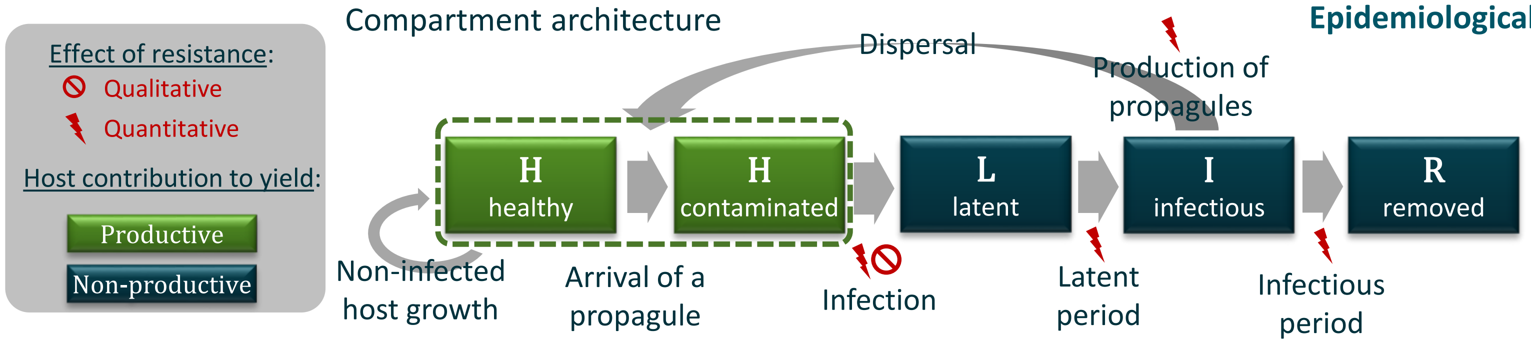
- Evolutionary
  - Durability (D)
- Epidemiological
  - Short-term control (STC)
  - Long-term control (LTC)



$$HAD^r_{v,y} = \frac{\sum_{t=t_0(y)}^{t_f(y)} \sum_{i=1}^{I} H_{i,v,t}}{\sum_{t=t_0(y)}^{t_f(y)} \sum_{i=1}^{I} N_{i,v,t}}$$

Host response to disease

Compartment architecture



FOR FURTHER INFORMATION
Loup RIMBAUD
e loup.rimbaud@csiro.au
w https://research.csiro.au/biotícthreats/

AFFILIATIONS
[1] CSIRO Agriculture & Food, Canberra, ACT 2601, Australia
[2] BioSP, INRA, 84914, Avignon, France

REFERENCES
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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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