Exploitation and durable management of plant genetic resistance for IPM
Introduction

Plant genetic resistance is theoretically a simple and efficient solution to protect plants against pathogens/pests ...

But ... :

- breeding is a long term process (introgression of wild R genes)
- multiple diseases/pests (+ emerging ones)
- resistance sources not always available

and ...

- pathogens/pests evolve ...
Exploitation and management of plant genetic resistance

Major issue:

Durability of genetic resistance

Succession of scales:
- Gene
- Genotype
- Population
- Agrosystem

Integrated approach

→ Durable management of genetic resistance
Exploitation and management of plant genetic resistance

Some definitions:

Genetic resistance:
- major resistance gene
- partial resistance gene

Resistance breakdown:
- appearance of a new *virulence* (race)
- resistance gene no more efficient
- lower fitness? (fitness cost)
Research activities developed within ENDURE

- Evaluation through pathological tests
- Modelling pathogen population dynamics and evolution
- Decision support for:
  - breeding (choice of resistance genes)
  - deploying new resistant varieties
**Biological experiments / selection pressures**

- **Sweet pepper / nematodes**
  - Avir
  - vir

![Image of galls](image)

**Fecundity**

- Lower fecundity of virulent strains: “fitness cost”

(from Caporalino et al., 2008)

**All resistance genes are not equivalent**

- Some R genes more “durable” than others
Combining monogenic resistance and partial resistance

→ extend monogenic resistance efficacy

Major resistance gene + Partial resistance >> Durability

Major resistance gene alone

(Palloix et al., 2008 ; Brun et al., 2009)
Modelling approach to simulate pathogen evolution

**Inputs**: crop growth parameters, pathogen life cycle parameters, genetics of host-pathogen interaction, spatial repartition of host & pathogen, climatic parameters, …

**Models / simulations**

**Outputs**
- Spatial distribution of the pathogen + evolution
- Average relative fitness of the pathogen populations

→ Comparison of different strategies of resistance gene deployment:
  - in space (within or between fields)
  - in time (rotation over years)
Random spatial patterning of varieties carrying monogenic resistance

→ reduce disease severity at the same level as varieties carrying multigenic resistance

Mixing monogenic resistance varieties

Pyramiding major resistance genes
Rotating cultivars with major resistance genes over time or pyramiding several of such genes into single cultivars

⇒ increase the risks of evolution of pathotypes with multiple virulences
Spatial heterogeneity of both resistant and susceptible varieties

- significant decrease of the pathogen density and the rate of spread of new races, IF virulent races exhibit reduced fitness.

Mixing Resistant and Susceptible varieties

However, such reduced fitness is not always observed.
Combining spatial heterogeneity and rotation in time of genetic resistances with other non-genetic IPM methods (sanitation, biocontrol, defense stimulators, reduced spraying …)

→ preserve the efficacy of genetic resistance over time.
Conclusion - Keep home messages

- Resistance genes = a “limited” resource: don’t deploy them without cautious!

- Diversifying the resistance factors (the resistant varieties) at the field / farm / landscape level is a major issue:
  - need for deployment organization (advisors, policy makers)
  - farmer acceptance? … supply chain acceptance?
  - seed companies competition?

- Combining resistance and non-genetic IPM methods
Major contribution

INRA (F) Angers, Antibes, Avignon, Bordeaux, Colmar, Grignon, Rennes

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ACTA (F)

CNR_Bari (I)

IHAR (P)

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Thank you