endure

diversifying crop protection

Exploitation and durable management of plant genetic resistance for IPM

FOOD QUALITY AND SAFETY

SIXTH FRAMEWORK PROGRAMME

ACTA

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For quality of life

Exploitation and management of plant genetic resistance

Introduction

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

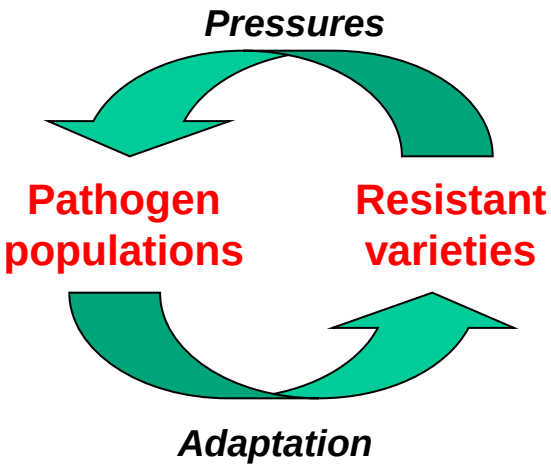
But … :

- **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**

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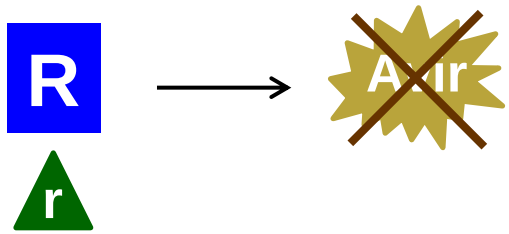
Some definitions :

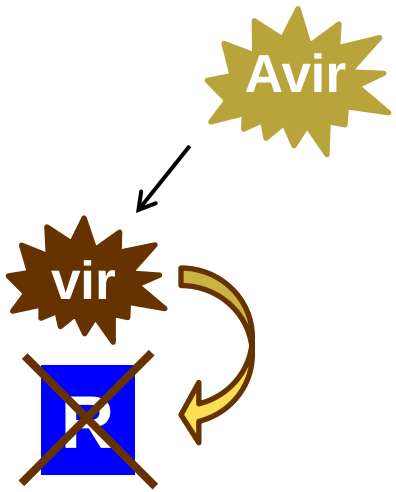
Genetic resistance :

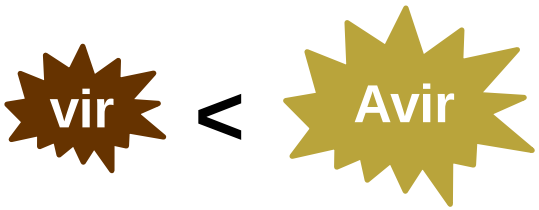
- major resistance gene
- partial resistance gene



Resistance breakdown :

- appearence of a new virulence (race)
- resistance gene no more efficient
- lower fitness ?
  (fitness cost)





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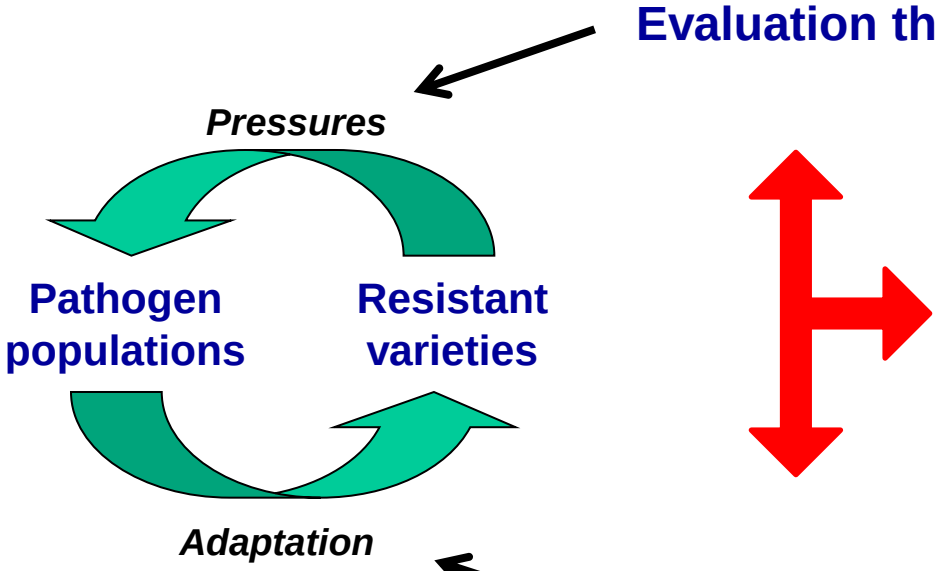
Research activities developed within ENDURE



Evaluation through pathological tests

Decision support for:

- **breeding** (choice of resistance genes)
- **deploying new resistant varieties**

Modelling pathogen population dynamics and evolution

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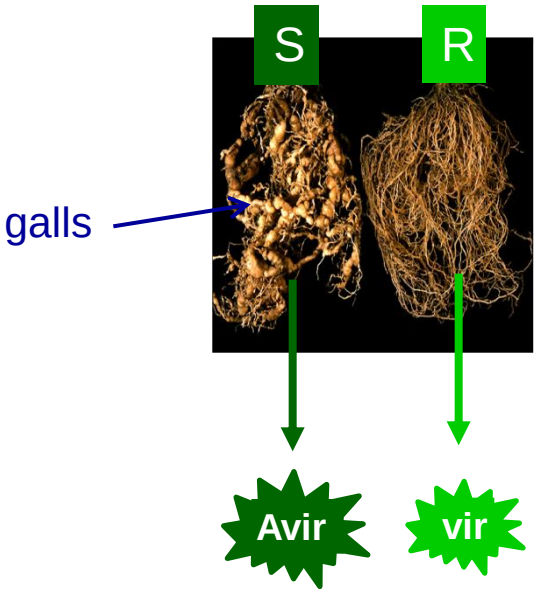
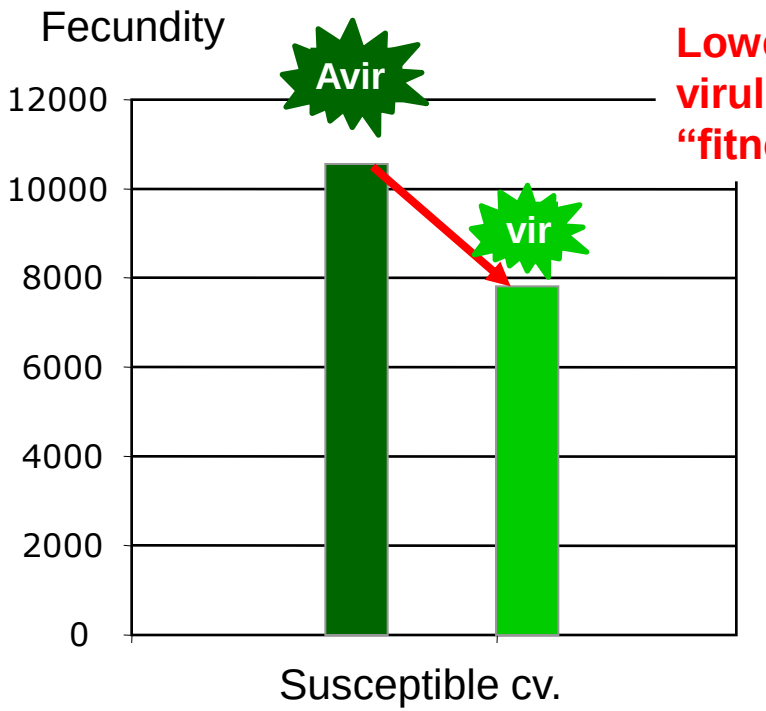
Biological experiments / selection pressures

Sweet pepper / nematodes





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

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Combining

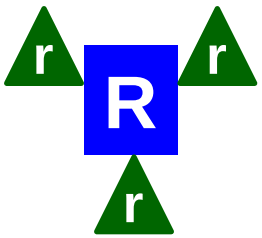
monogenic resistance and partial resistance

➔ extend monogenic resistance efficacy

Major resistance gene

+

Partial resistance



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Durability

Major resistance gene alone

(Palloix et al., 2008 ; Brun et al., 2009)

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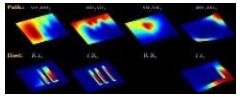
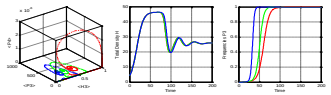
Modelling approach to simulate pathogen evolution

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)

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Random spatial patterning

of varieties carrying monogenic resistance

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

Mixing monogenic resistance varieties

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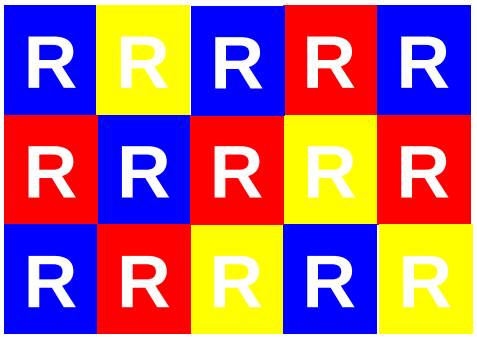
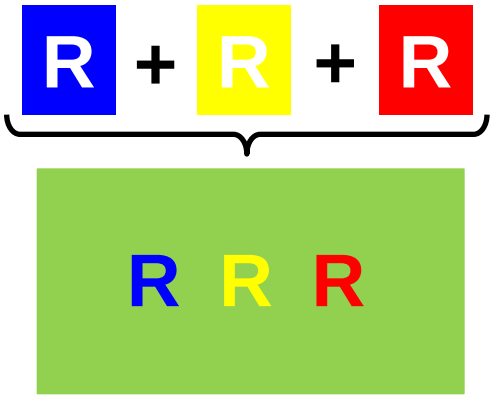
Pyramiding major resistance genes





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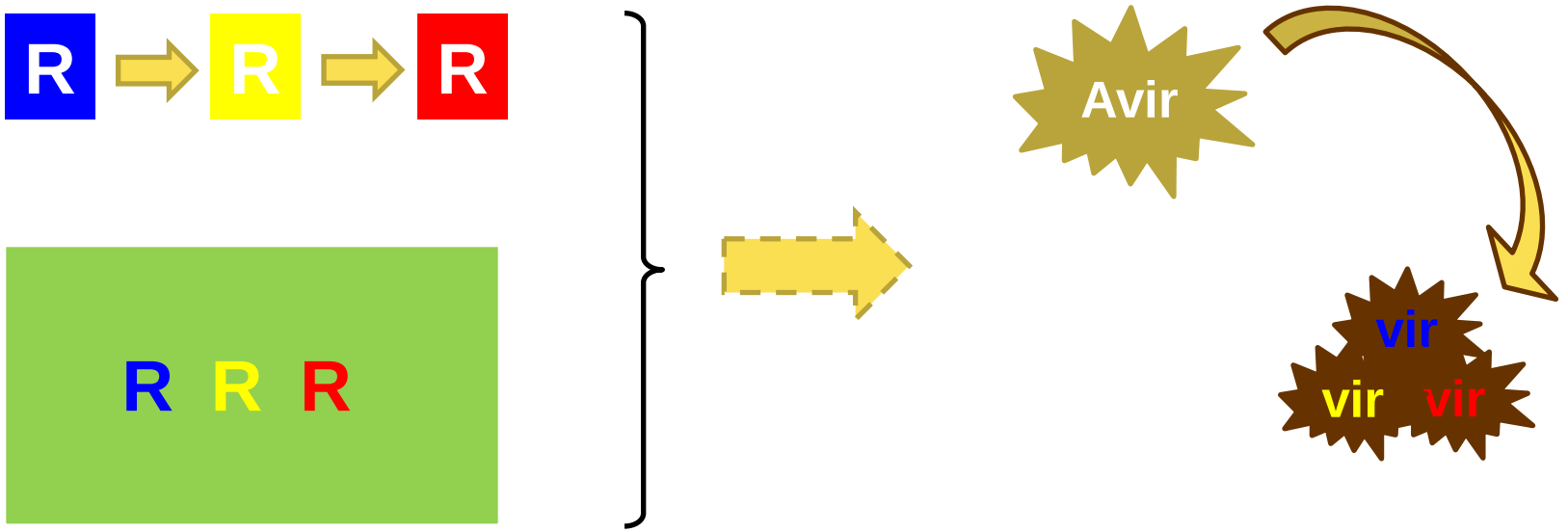
Rotating cultivars with major resistance genes over time or pyramiding several of such genes into single cultivars

➔ increase the risks of evolution of pathotypes with multiple virulences



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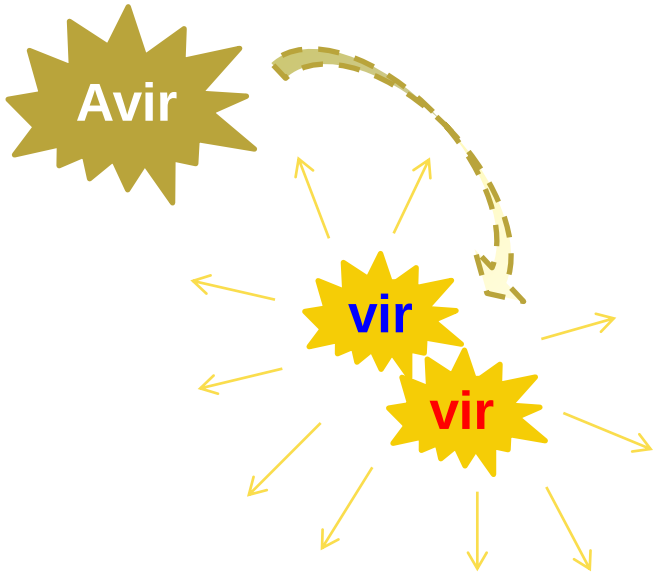
Spatial heterogeneity of both resistant and susceptible varieties

➔ **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

R	S	R	R	R
S	R	R	S	R
R	R	S	R	S



However, such reduced fitness is not always observed.

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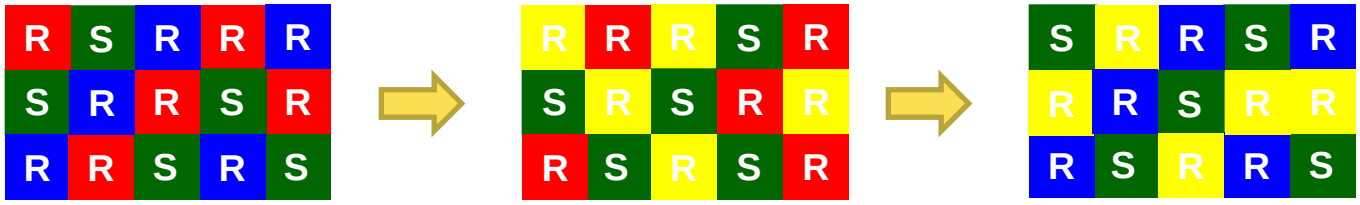
Combining

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.**



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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**

Exploitation and management of plant genetic resistance

- **Major contribution**

INRA (F)	Angers, Antibes, Avignon, Bordeaux, Colmar, Grignon, Rennes
Aahrus Univ.	(DK)
ACTA	(F)
CNR_Bari	(I)
IHAR	(P)
RRES	(UK)
WUR_PRI	(NL)

Thank you