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Biological control methods against plant diseases at the Plant Pathology research unit

Marc Bardin

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Biological control methods against plant diseases

At the Plant Pathology research unit



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Key facts and figures



Our missions

Producing and disseminating **knowledge** to address societal issues

Use this knowledge for **innovation**, expertise and support for public policies



Our major topics

- Climate change and risk
- Agroecology
- Biodiversity
- Food, global health
- Bioeconomy
- Society and Regions



18 centers

1 billion €
budget

10,000 hectares
of Experimental Terrain.

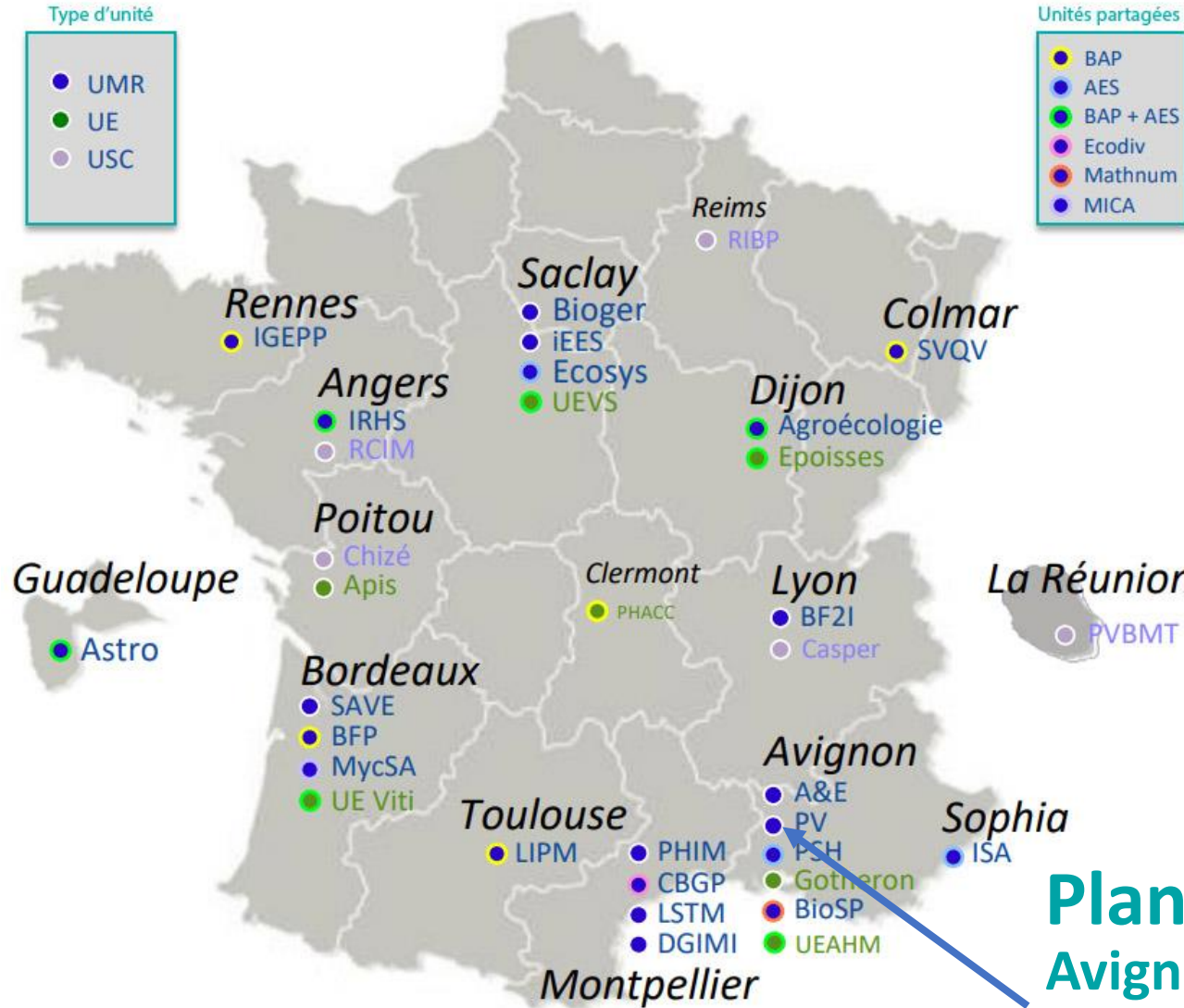
268 Research,
Service and
Experimental units

14
Research
Departments

- **Aim of the department** : protect the health of crops while respecting the environment, from the plant to the landscape.
 - ✓ Explore a wide variety of questions, focusing on understanding the biology of deleterious and beneficial interactions between plants and associated organisms (pests, microbiota, pollinators, symbionts).
 - ✓ Questions addressed at different scales : from the study of molecular interactions to community ecology, epidemiology and population biology.



Plant Health and Environment Research Department



2022



724 permanent staff



214 researchers (permanent)



22 research units
6 experimental units (extension services)

**Plant Pathology research unit
Avignon,
Provence-Alpes-Côte d'Azur**

Provence-Alpes-Côte d'Azur center

5th
biggest
Center

12
locations

1300
People

22 Research, Service
and Experimental
units



Research focused on issues specific to the **Mediterranean region** : agroecology and adaptation of agriculture and forests to climate change, water resources, natural risks, human nutrition

A local scientific context very favorable to research on plant health

Very active research community in ecology, biostatistics and modeling



Research conducted:

Plant health research
department

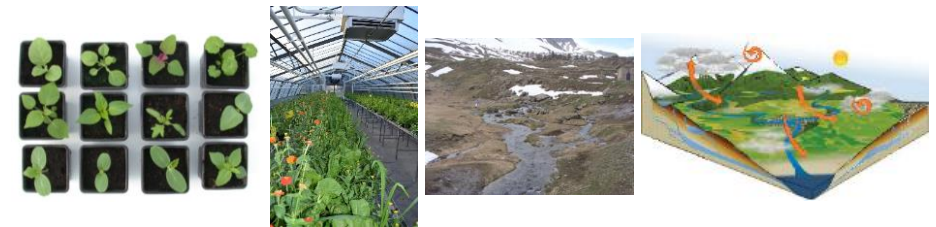
1. Etiology-diagnostics :

to identify emerging threats to crops



2. Ecology of pathogens :

to expand knowledge on the ecology and life history of plant pathogens



3. Epidemiology of diseases :

to identify the main drivers of prevalence, diversity and spatial structure of plant pathogens



4. Plant protection :

to deploy this knowledge to conceive novel, environment-friendly and durable means for protecting plant health

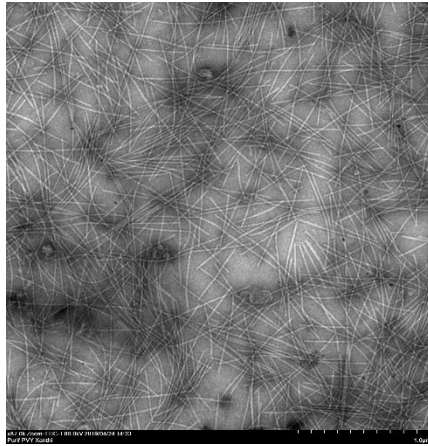


including biocontrol



Main plant pathogens studied

Viruses of vegetable and flower crops

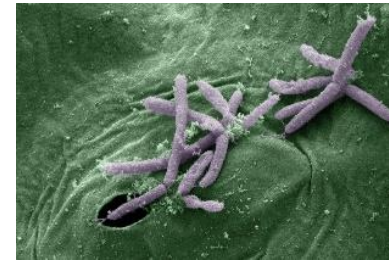


PVY

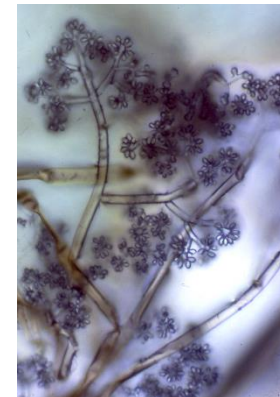
CMV, WMV, ZYMV, CABYV, ENMV...



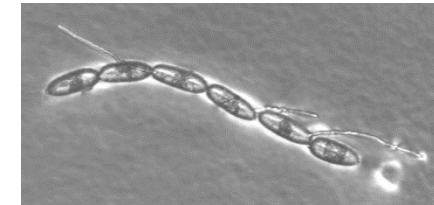
Large collection of isolates



Pseudomonas syringae
Clavibacter michiganensis
Erwinia amylovora



Botrytis cinerea



Powdery mildew fungi



Sclerotinia sclerotiorum



Fusarium proliferatum

Plant Pathology Research Unit

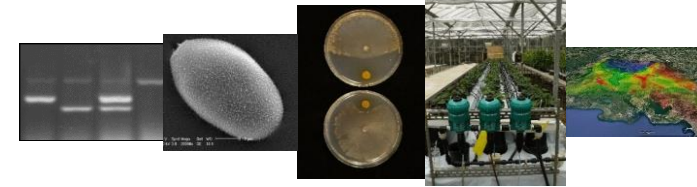
A stimulating environment

- 38 permanent staff
- 15-30 non-permanent/year

Scientific expertise in plant pathology, microbial ecology, epidemiology, biological control

Technical skills from gene to landscape

Plant health research department



Specific facilities and equipment
(mycology, bacteriology, virology laboratories)

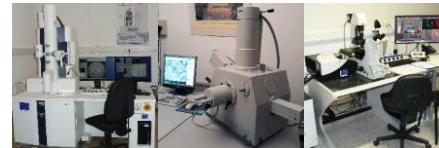


Shared experimental facilities
dedicated to plant production,
including a prototyping workshop



Experimental platforms
located nearby

Microscopy



Molecular biology

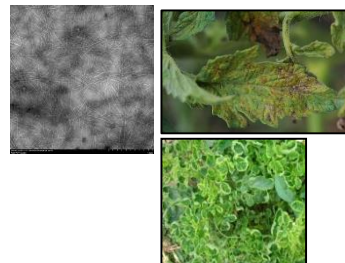


Metabolomics



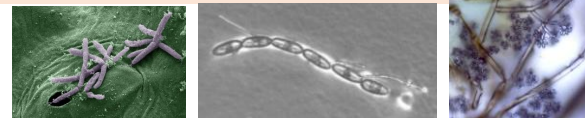
Organised in 2 research teams

Virology



MISTRAL

(Microbiology of agroeco-Systems : TRANslational research from pathogen Life histories)



Biological control methods against plant diseases

Context

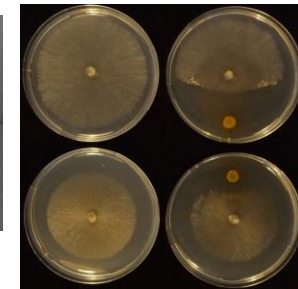
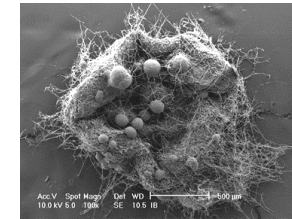
- **Microbial biocontrol:** an essential lever for reducing dependence on chemical pesticides **against plant diseases**

[31 registered products in France, <https://ephy.anses.fr/>]



- Diverse and often poorly understood **modes of action**

[Köhl et al, 2018; Legein et al. 2020]



- Protection tools based on **natural regulations: more complex positioning** than chemical pesticides.

Success of protection depends on **biotic and abiotic** variables

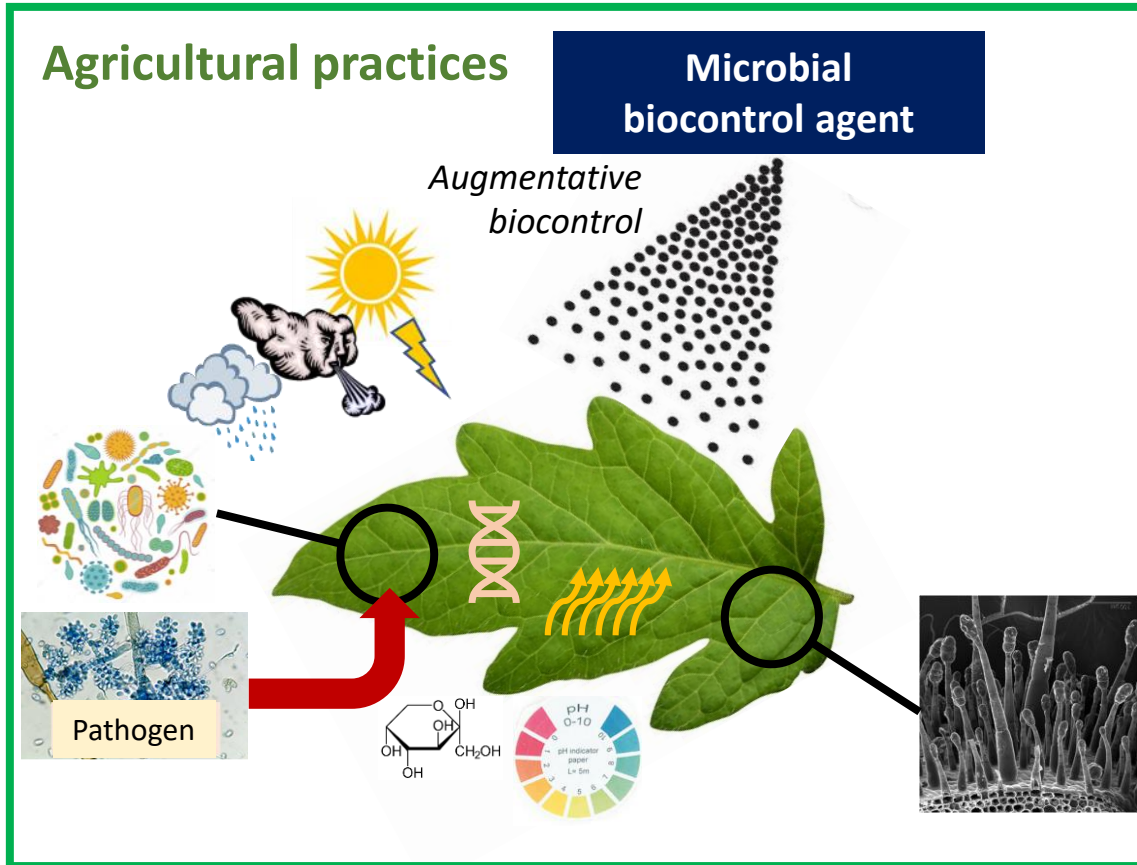
- System in constant **evolution** :
 - ✓ Increasing complexity of farming practices
 - ✓ Global changes

➔ **A situation that promotes variability in their efficacy and hinders their adoption**

Towards effective microbial biocontrol of pathogens

Research interest: improve the field efficacy of biocontrol

1. Gain better understanding of complex interactions taking place at plant level

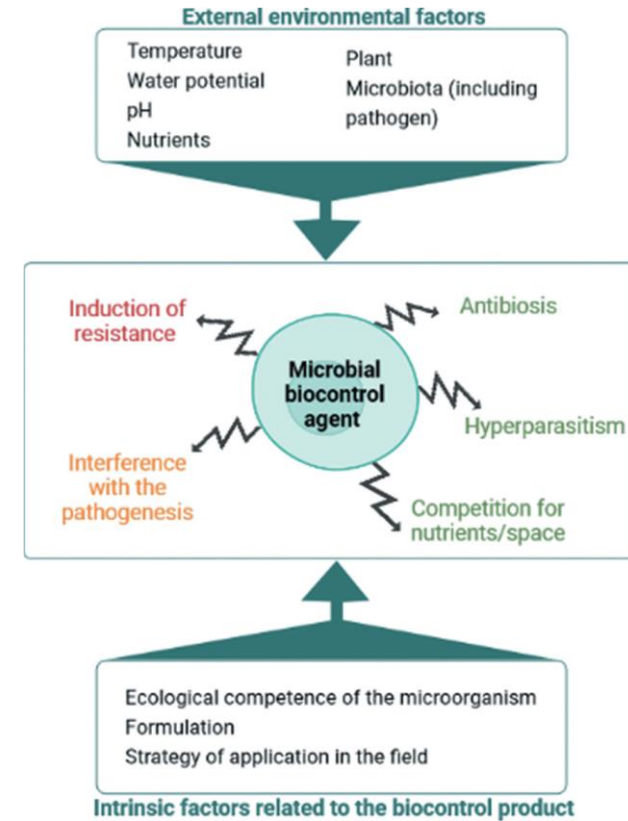


Conditions for survival, installation, colonization ?

Develop models to predict population fluctuations according to main external environmental factors

Conditions for the activation of the mode(s) of action ?

Models to predict the activation of mechanisms of action according to main external environmental factors



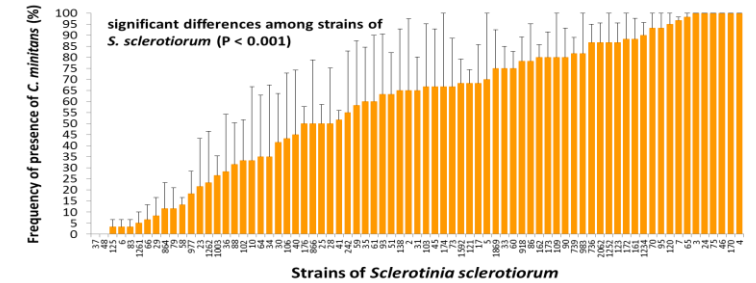
Turc et al, 2023. CABI.

Research interest: improve the field efficacy of biocontrol

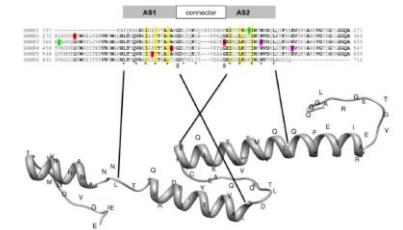
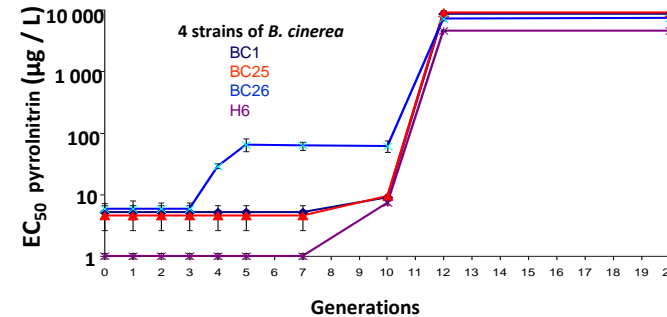
2. Take into account the durability of protection efficacy

Risk for biocontrol protection to be overcome by plant pathogens ?

1. Demonstrated diversity in the susceptibility to biocontrol agents in populations of several plant pathogens



2. Demonstrated adaptation potential of certain pathogens to the action of biocontrol agents



- Probability of resistance outbreak according to the mode(s) of action of the biocontrol agent and the targeted pathogen ?
- Link between lack of consistency in field efficacy of biocontrol and the diversity in susceptibility within populations of the pathogen ?

Research interest: improve the field efficacy of biocontrol

3. Combine biocontrol with other protection methods

Plant resistance

X

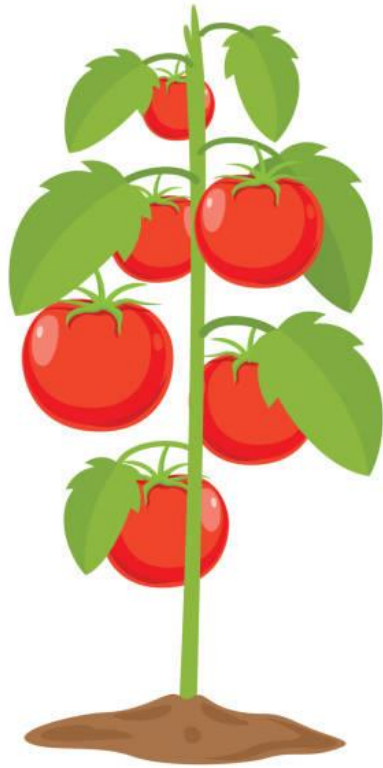
Biocontrol agent

X

Flashes of UV-C

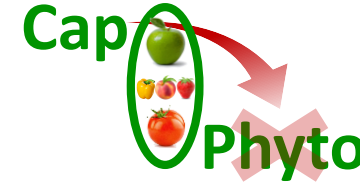
X

Nitrogen fertilization



Plant pathogens

Botrytis cinerea
Oidium neolycopersici
Phytophthora infestans

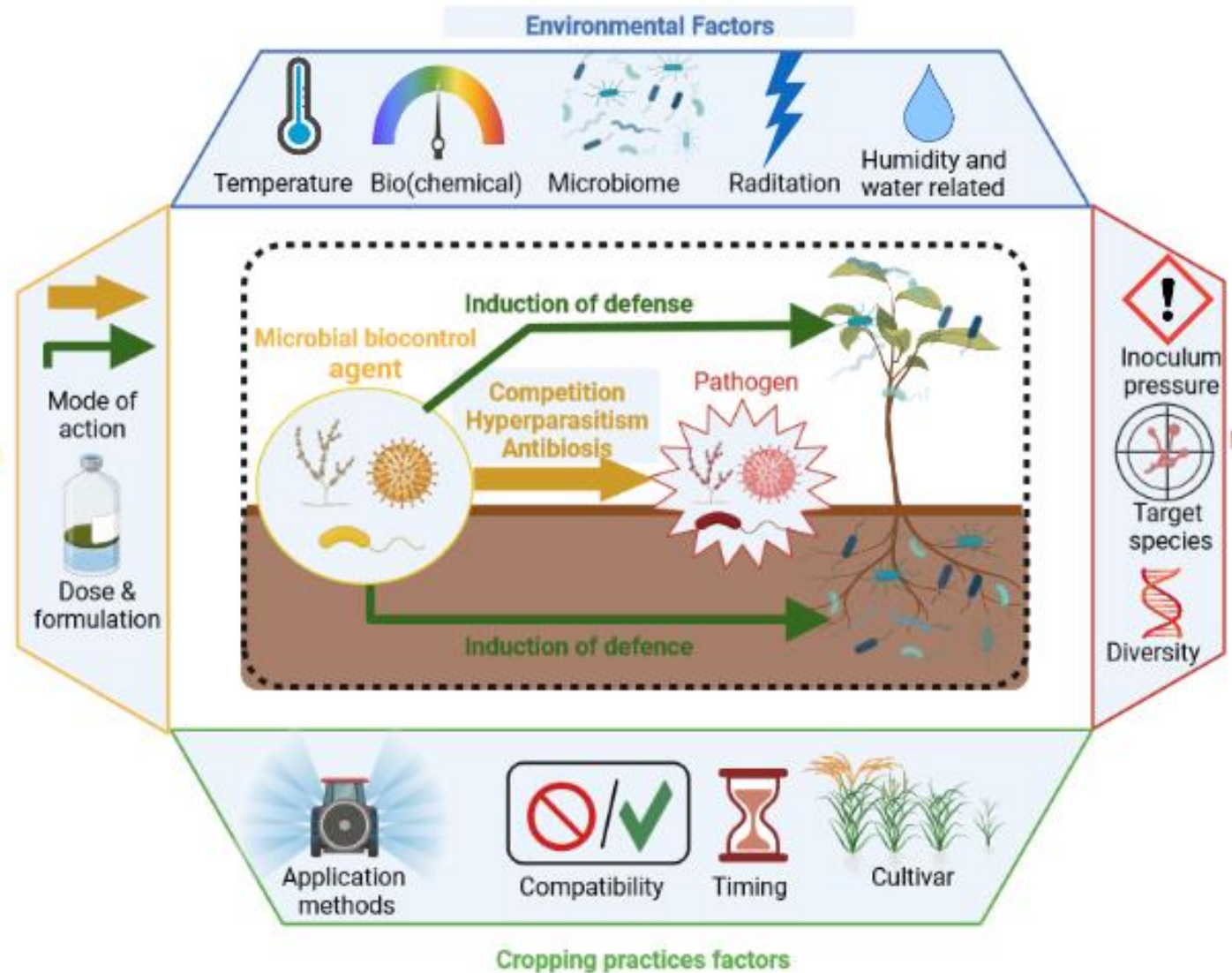


- Efficacy of biocontrol modulated by other protection methods ?
- Genes (QTL) implicated in plant response to biocontrol agents ?
- Mechanisms implicated in plant defense induction (transcriptomic and metabolomic analyses)
- Is it possible to rely on indigenous plant microbiota ?

Research interest: improve the field efficacy of biocontrol



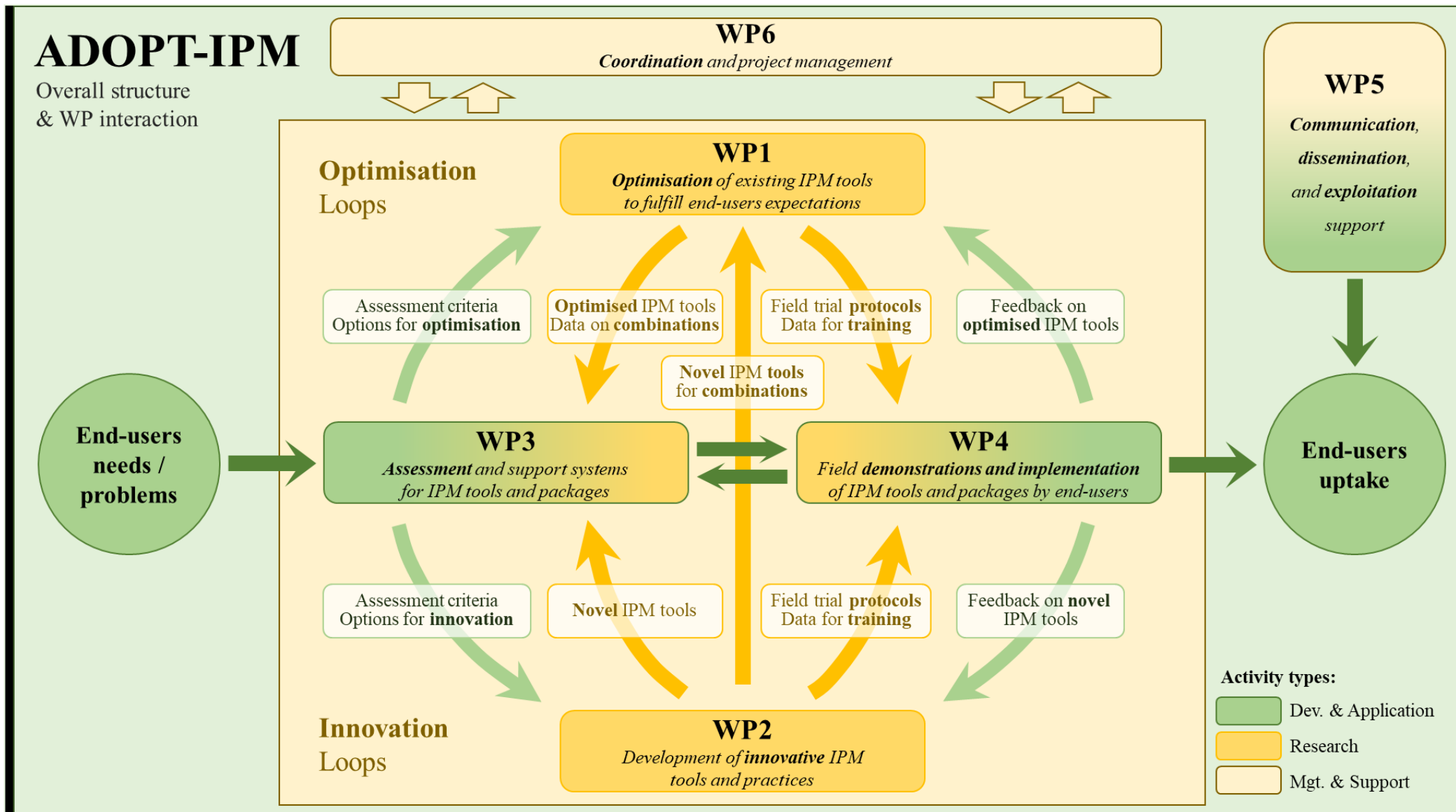
4. Translate complex scientific knowledge into practical and operational information for farmers



- The protective effect of biocontrol agents is modulated by multiple interconnected factors
- Farmers need advice to use biocontrol agents most effectively for disease management

Develop Decision Support tools for better implementation of biocontrol by farmers in the field





tomato



leafy vegetables



wheat



maize



EU-China joint action
to increase the development
and adoption of IPM tools

2022-2026



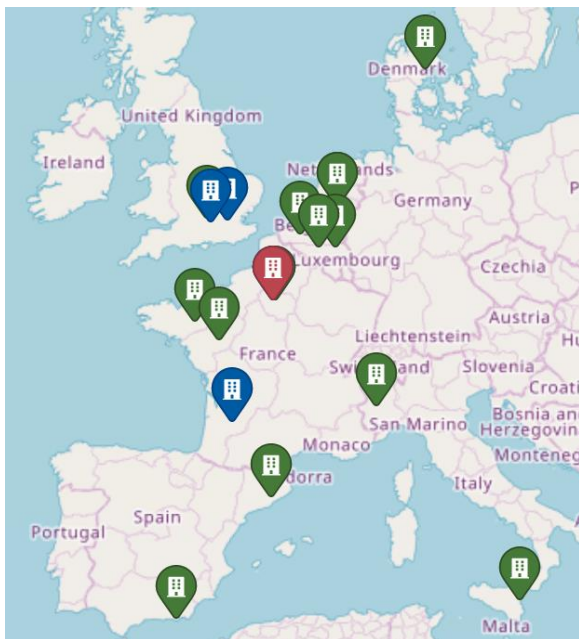
Funded by
the European Union

TOPIC:

HORIZON-CL6-2021-FARM2FORK-01-19 - EU-China international cooperation on integrated pest management in agriculture

Coordinated by Nicolas DESNEUX, INRAE

19 partners from  + 



Belgium
Denmark
France
Italy
Spain
The Netherlands
UK

13 partners from 



Beijing
Anhui
Guizhou
Shandong
Sichuan
Yunnan
Zhejiang

Partners from academia, companies, growers' associations + other key stakeholders

<https://cordis.europa.eu/project/id/101060430>

SCLEROZA

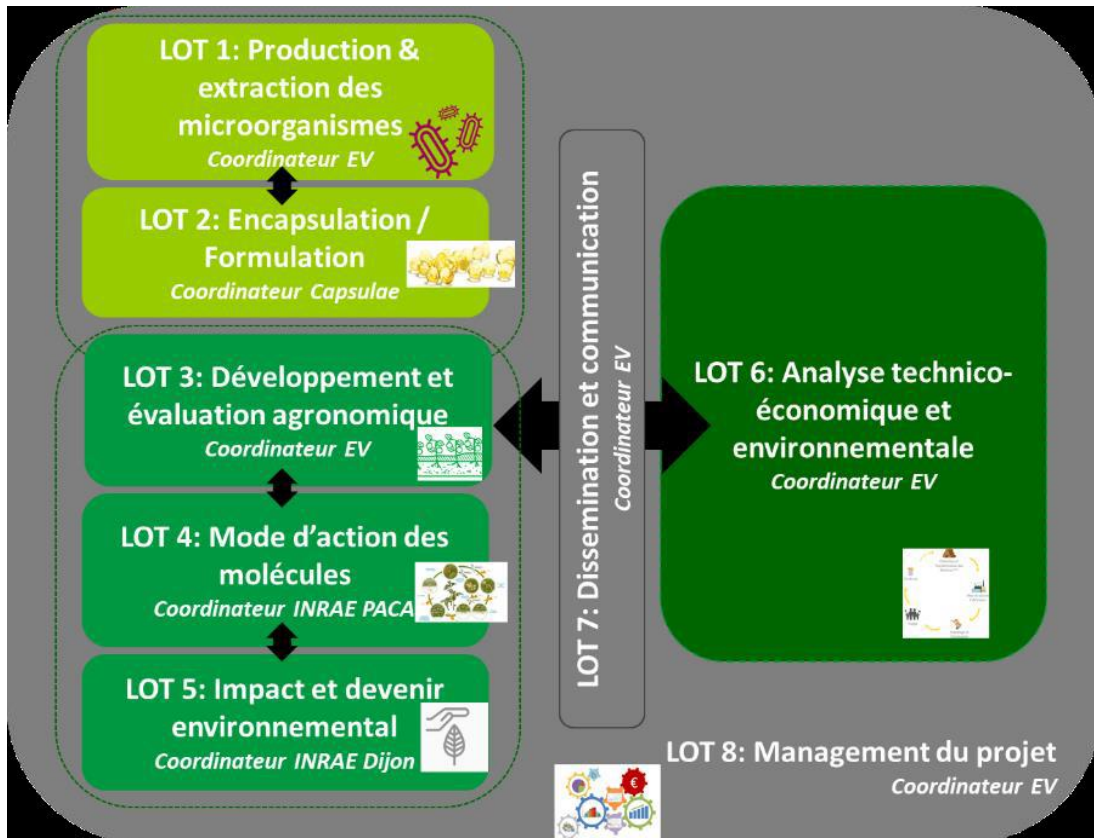
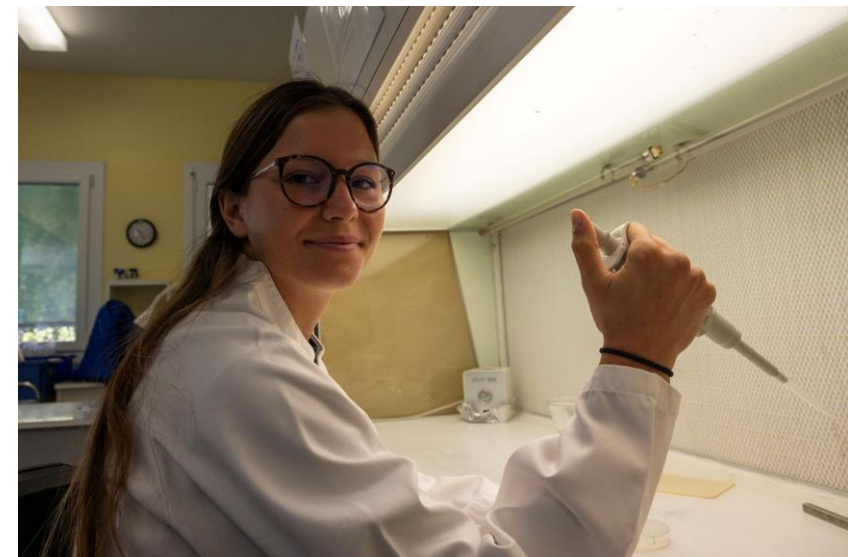
2022-2026

Develop and test a unique biocontrol solution for rapeseed on a pre-industrial scale

4 partners



Identify the modes of action of selected micro-organisms



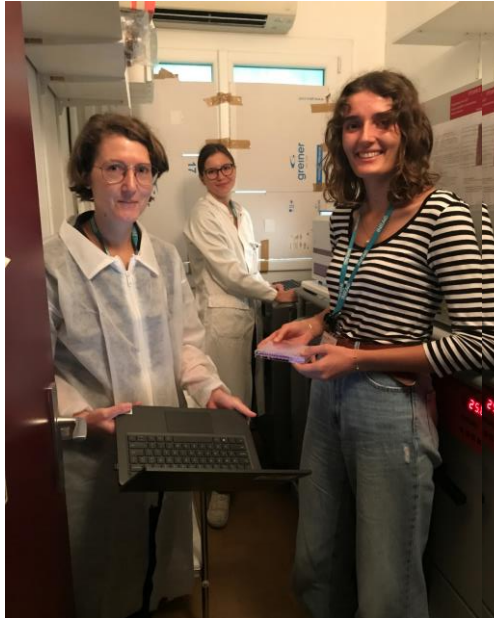
Why are we at CSIRO this week?

- **Expression of Interest for INRAE-CSIRO linkage proposals 2022**
- **Proposal** : Exploring biocontrol traits to optimise the resilience and durability of crop protection

@INRAE

Evaluation of the durability of biocontrol agents

Screening of a genetically diverse subset of the INRAE collections of *Sclerotinia sclerotiorum* (100 strains) and *Botrytis cinerea* (50 strains) against a CSIRO biofungicide

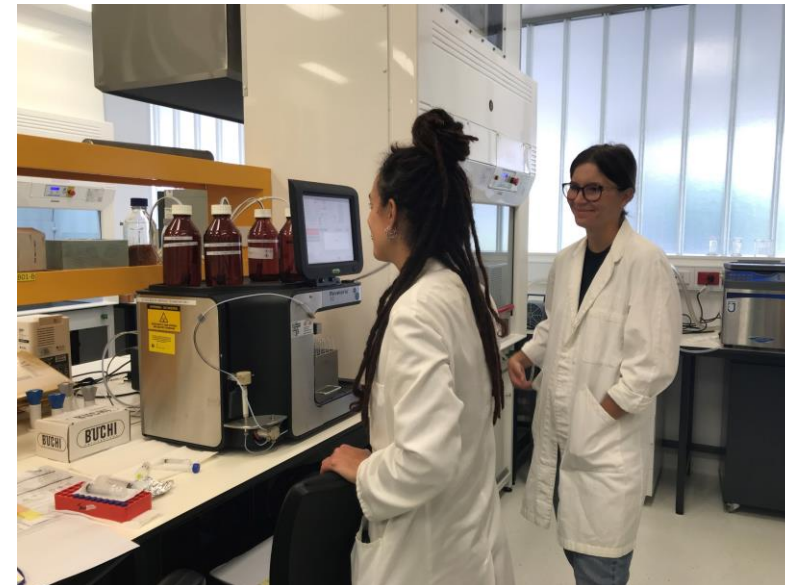


INRAE,
October 2023

@CSIRO

Use of metabolomics tools for biocontrol mode of action studies.

Sharing of CSIRO biochemistry/metabolomics analysis for functional biocontrol MOA studies of 2 bacteria.



CSIRO,
November 2023

Thank you !

Plant Pathology research unit Avignon, Provence-Alpes-Côte d'Azur

INRAE



Clémentine
LEPINAY



Philippe
NICOT



Jean-François
BOURGEAY



Magali
DUFFAUD



Thomas
PRESSECQ



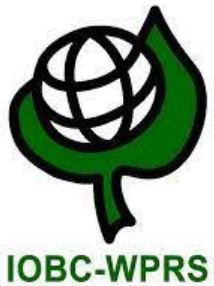
Margot
GRIMONPONT



Awa
SANGARE



Marjorie
JACQUIN



EU-China joint action
to increase the development
and adoption of IPM tools



AGENCE NATIONALE DE LA RECHERCHE
ANR



**RÉGION
SUD**



ÉCOPHYTO
RÉDUIRE ET AMÉLIORER
L'UTILISATION DES PHYTOS



MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE ET SOLIDAIRE

MINISTÈRE
DE L'AGRICULTURE
ET DE L'ALIMENTATION