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

Marc Bardin

Biological control methods against plant diseases

At the Plant Pathology research unit

Marc BARDIN
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INRAE
science for people, life & earth

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

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14 Research Departments

18 centers

268 Research, Service and Experimental units

1 billion € budget

10,000 hectares of Experimental Terrain.

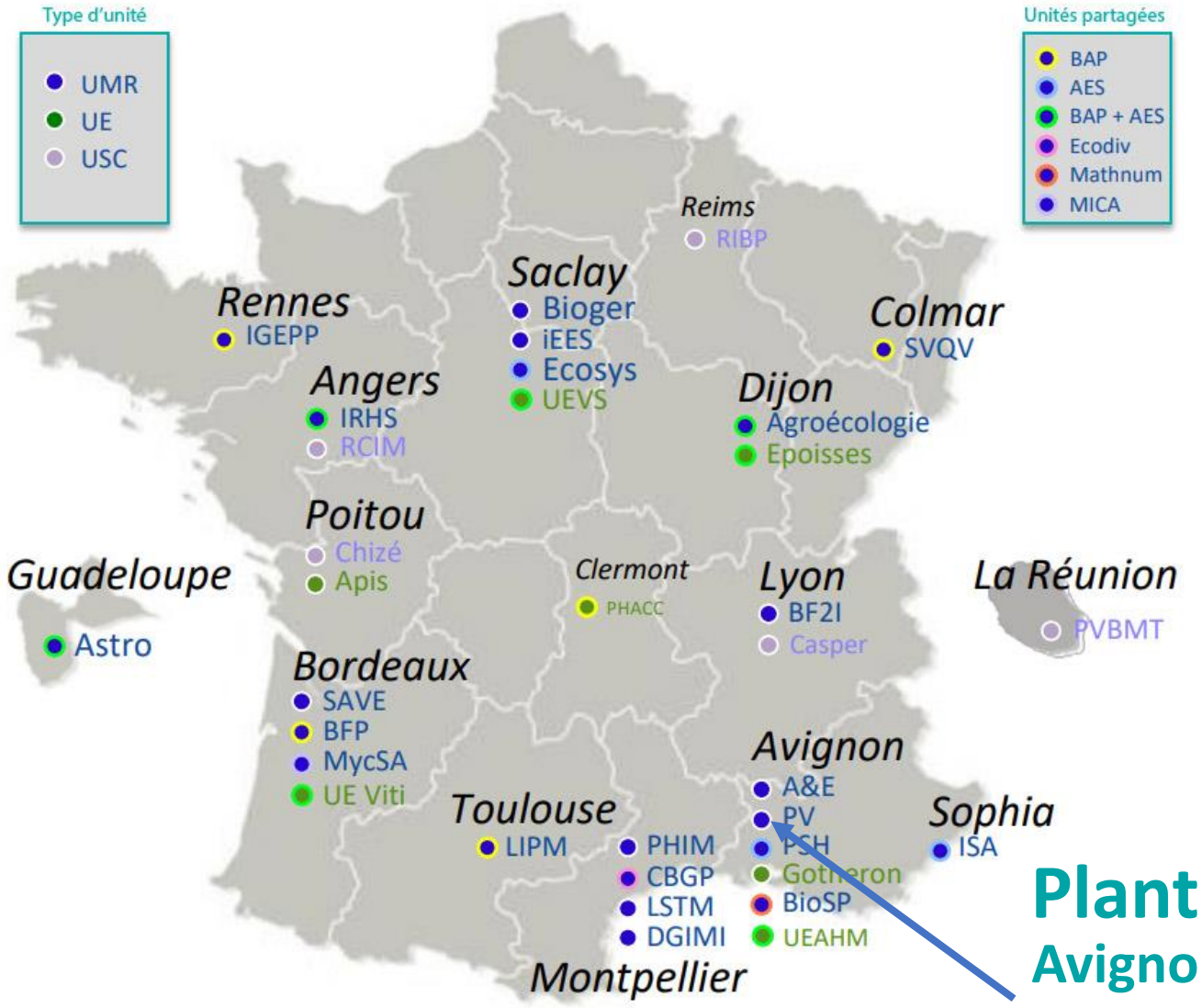
Plant Health and Environment Research Department

- **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

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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

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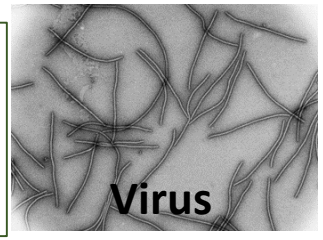
tersys
l'intelligence du vivant
structure fédérative de recherche INRAE

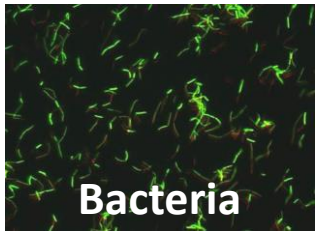
IMPLANTEUS
SUSTAINABLE MEDITERRANEAN AGRICULTURE FOR HEALTH | GRADUATE SCHOOL

Plant Pathology Research Unit

General scientific objective :

Contribute to the development of rational, efficient and durable protection against plant diseases





Fruits and vegetables produced in the Mediterranean basin

Oilseed rape

Ornamentals and plane tree

Plant Pathology Research Unit

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AVIGNON PATHOLOGIE VEGETALE

Plant health research department

Research conducted:

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

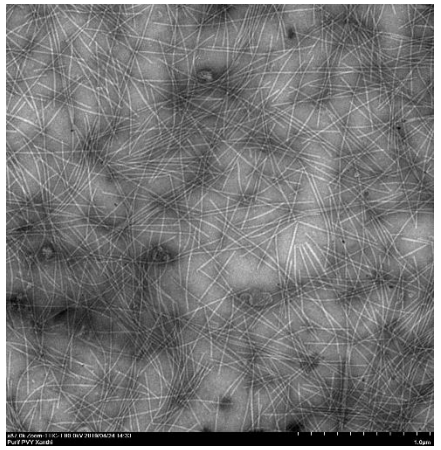
3. **Epidemiology of diseases :**
   to identify the main drivers of prevalence, diversity and spatial structure of plant pathogens

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

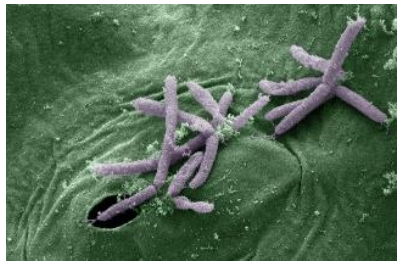
Viruses of vegetable and flower crops



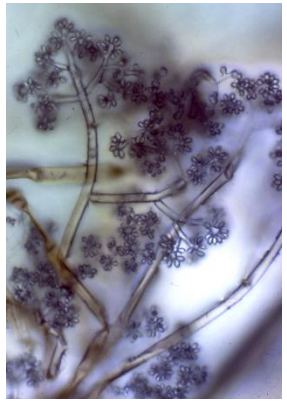
PVY

CMV, WMV, ZYMV, CABYV, ENMV…

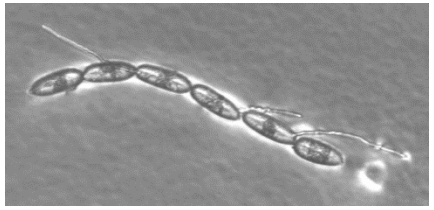
Large collection of isolates



Pseudomonas syringae
Clavibacter michiganensis
Erwinia amylovora



Botrytis cinerea



Powdery mildew fungi

Sclerotinia sclerotiorum

Fusarium proliferatum

Plant Pathology Research Unit

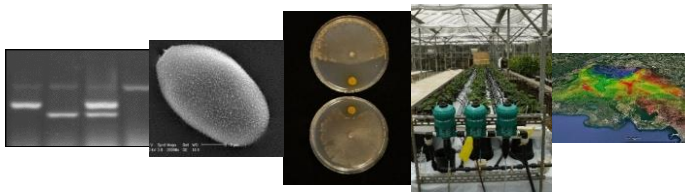
A stimulating environment

- 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

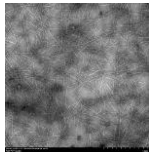
Microscopy

Molecular biology

Metabolomics

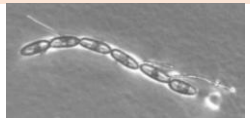
Organised in 2 research teams

Virology



MISTRAL

(MIcrobiology of agroeco-Systems : TRAnslational research from pathogen Life histories)



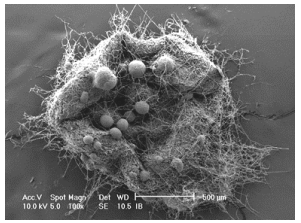
Biological control methods against plant diseases

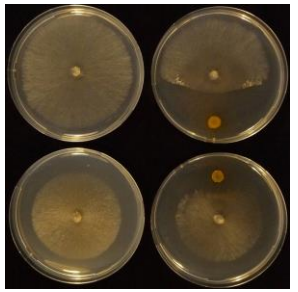
Context

- **Microbial biocontrol:** an essential lever for reducing dependence on chemical pesticides **against plant diseases**
  [31 registered products in France, https://ephy.anses.fr/]

ÉCOPHYTO
RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

- 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

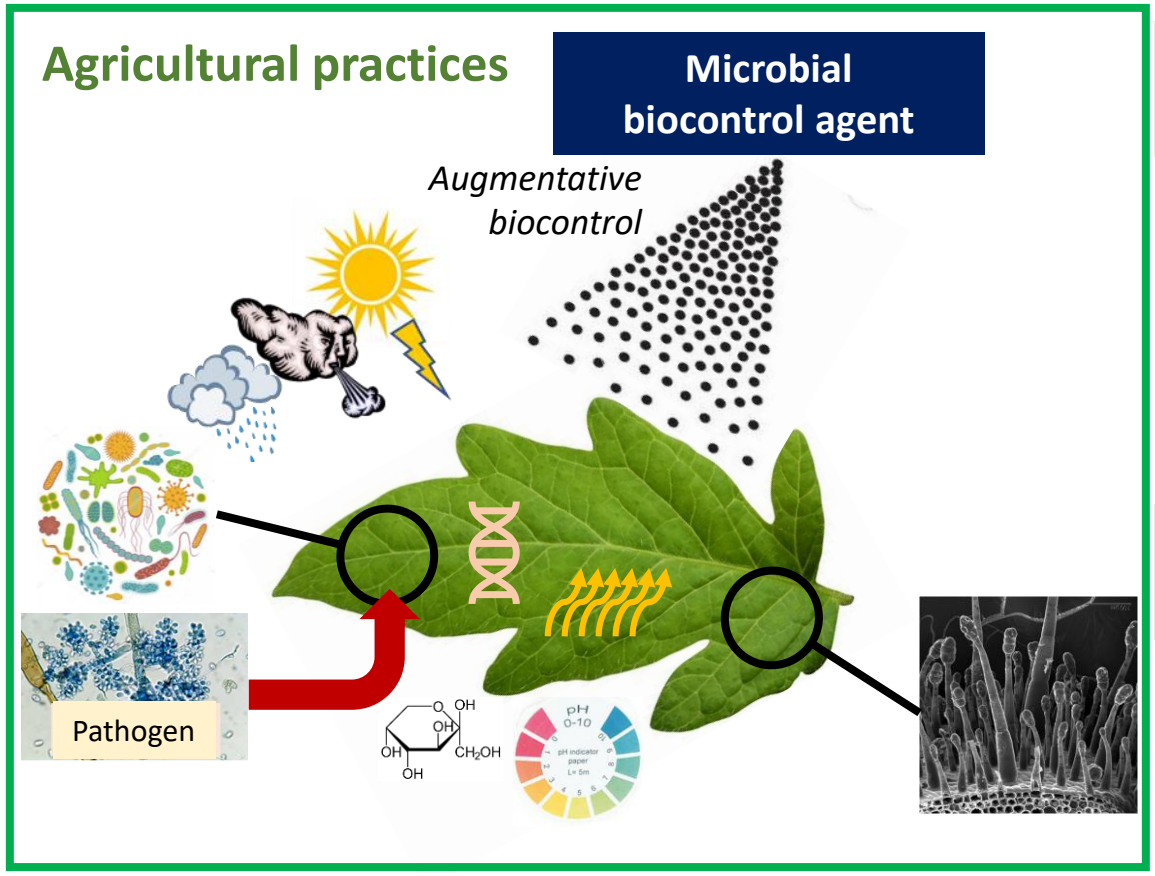
➔ **A situation that promotes variability in their efficacy and hinders their adoption**

Towards effective microbial biocontrol of pathogens

INRAE

Research interest: improve the field efficacy of biocontrol

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

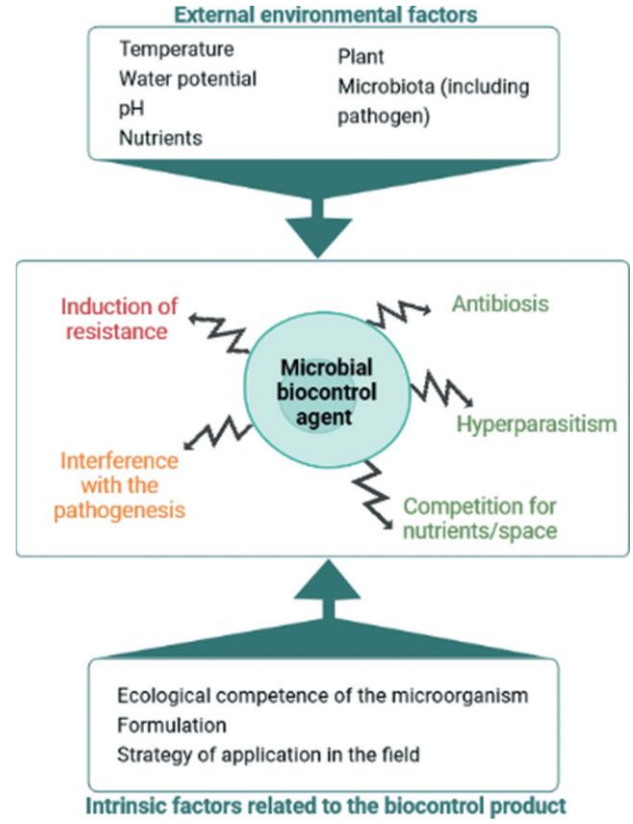


Conditions for survival, installation, colonization ?

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.

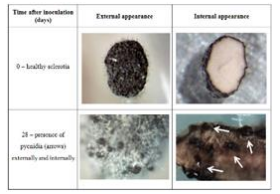
PIA-ADEME SCLEROZA, HORIZON-EU ADOPT-IPM, SPE-IMMIC

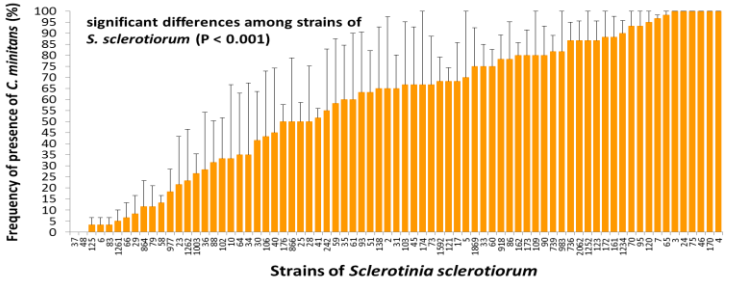
Research interest: improve the field efficacy of biocontrol

2. Take into account the durability of protection efficacy

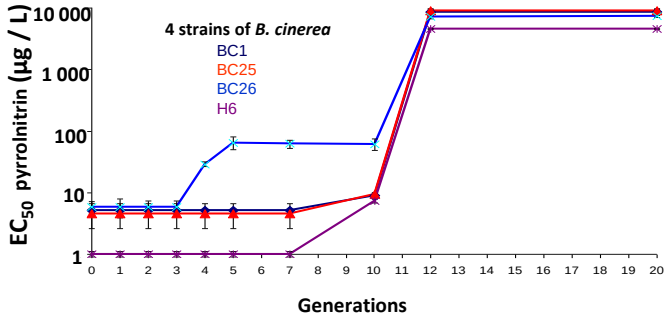
Risk for biocontrol protection to be overcome by plant pathogens ?

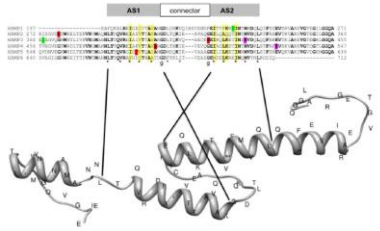
1. Demonstrated diversity in the susceptibily to biocontrol agents in populations of several plant pathogens





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 ?

ANR CERES, CASDAR GARLIC, PIA-ADEME SCLEROZA, SPE-IMMIC

Research interest: improve the field efficacy of biocontrol

3. Combine biocontrol with other protection methods

Plant resistance

X

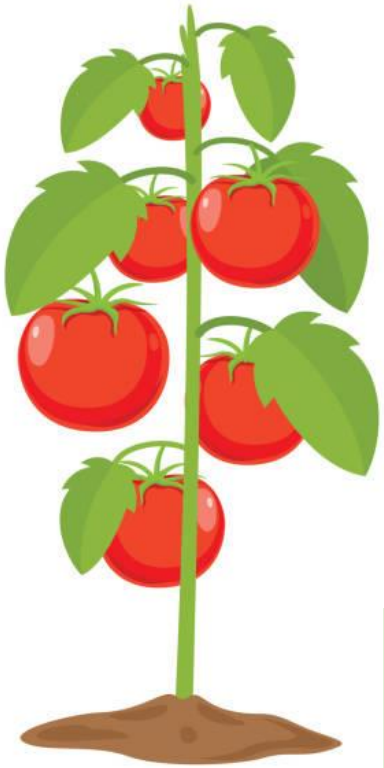
Biocontrol agent

X

Flashes of UV-C

X

Nitrogen fertilization



Cap Phyto

Plant pathogens

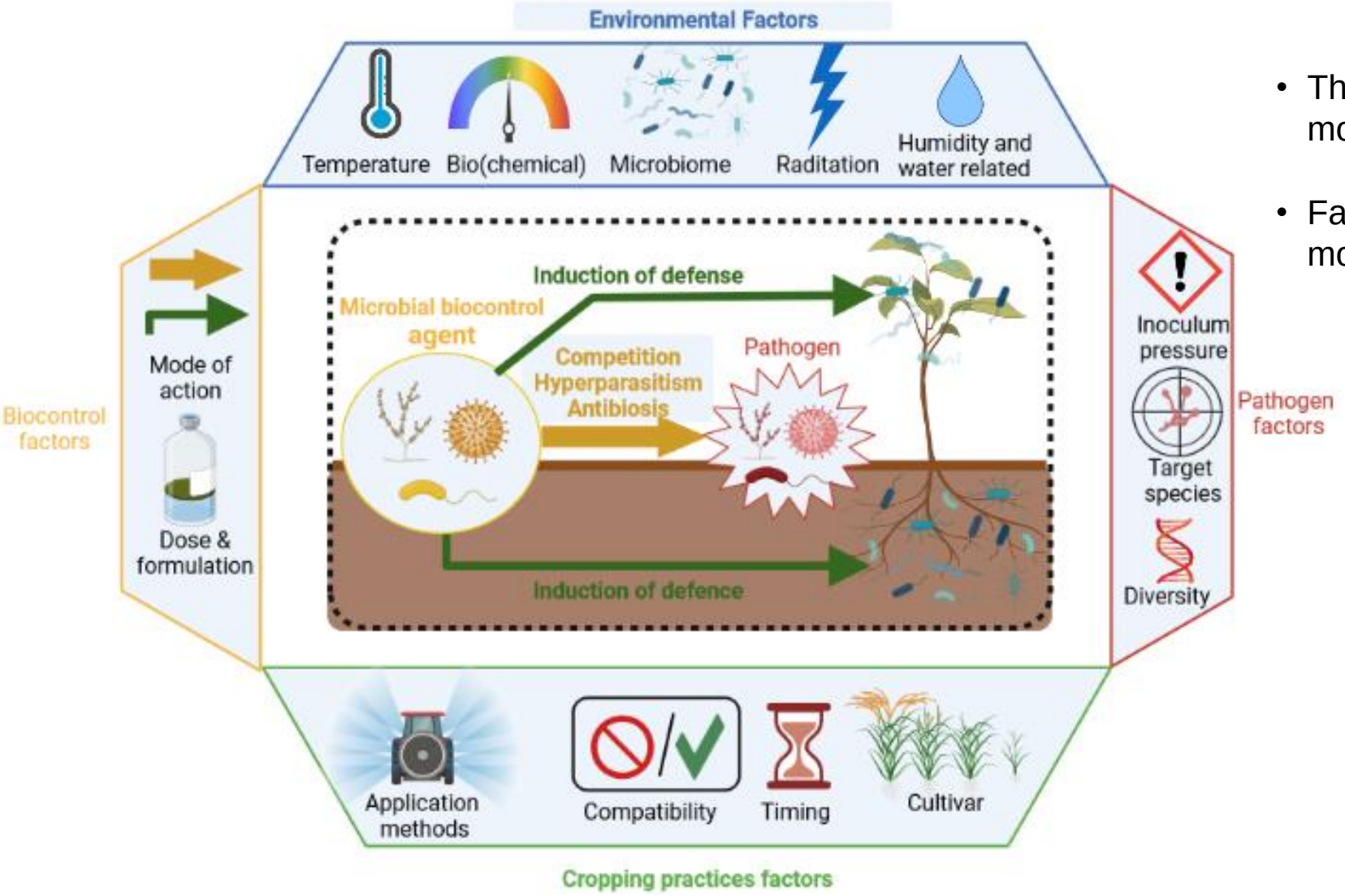
Botrytis cinerea
Oidium neolycopersici
Phytophthora infestans

- 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 ?

ANR CapZeroPhyto, HORIZON-EU ADOPT-IPM, SPE-IMMIC, CASDAR PRICE

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

DeciControl

ephytia

Consortium Biocontrôle DECICONTROL+, HORIZON-EU ADOPT-IPM, CASDAR Bioc'App

ADOPT IPM

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

2022-2026

Funded by the European Union

ADOPT-IPM

Overall structure & WP interaction

WP6
Coordination *and project management*

WP5
Communication, dissemination, *and* ***exploitation*** *support*

End-users needs / problems

Optimisation Loops

WP1
Optimisation *of existing IPM tools to fulfill end-users expectations*

Assessment criteria Options for **optimisation**

Optimised IPM tools Data on **combinations**

Field trial **protocols** Data for **training**

Feedback on **optimised** IPM tools

Novel IPM **tools** for **combinations**

WP3
Assessment *and support systems for IPM tools and packages*

WP4
Field ***demonstrations and implementation*** *of IPM tools and packages by end-users*

End-users uptake

Assessment criteria Options for **innovation**

Novel IPM tools

Field trial **protocols** Data for **training**

Feedback on **novel** IPM tools

Innovation Loops

WP2
Development of ***innovative*** *IPM tools and practices*

Activity types:
- Dev. & Application
- Research
- Mgt. & Support

tomato

leafy vegetables

wheat

maize

ADOPT IPM

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

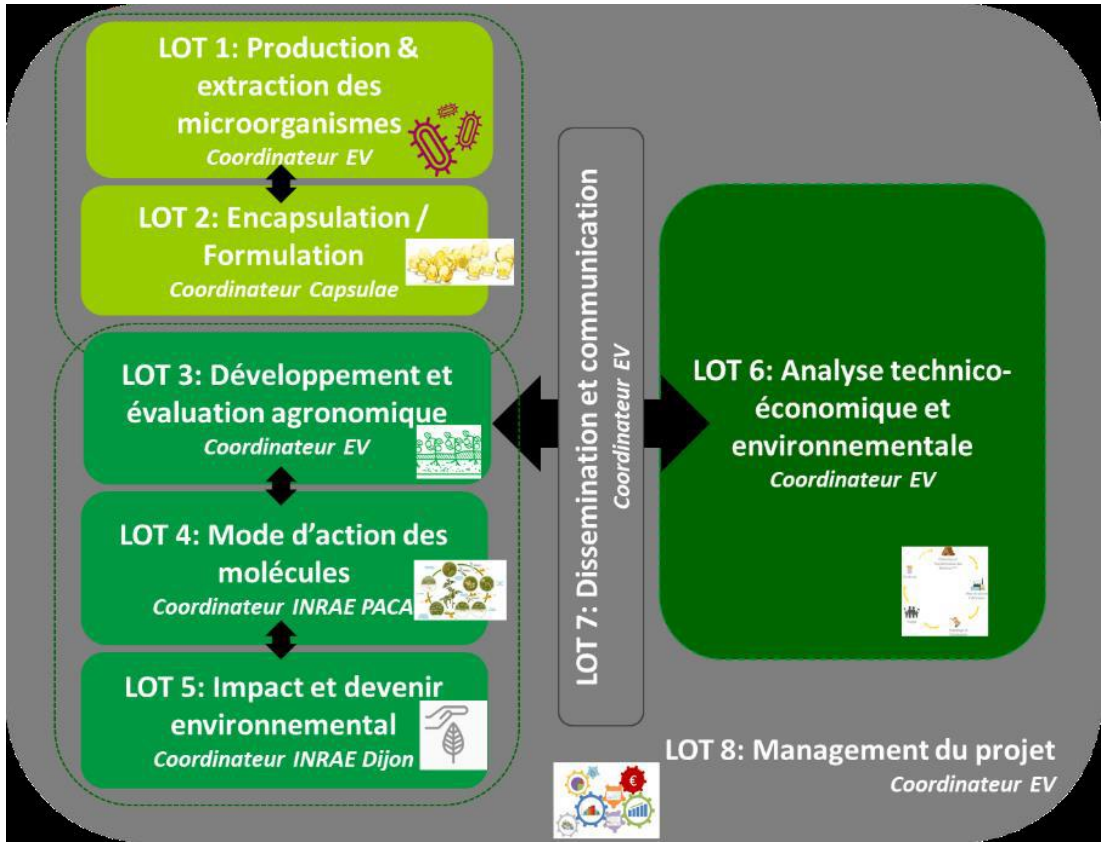
https://cordis.europa.eu/project/id/101060430

SCLEROZA

2022-2026

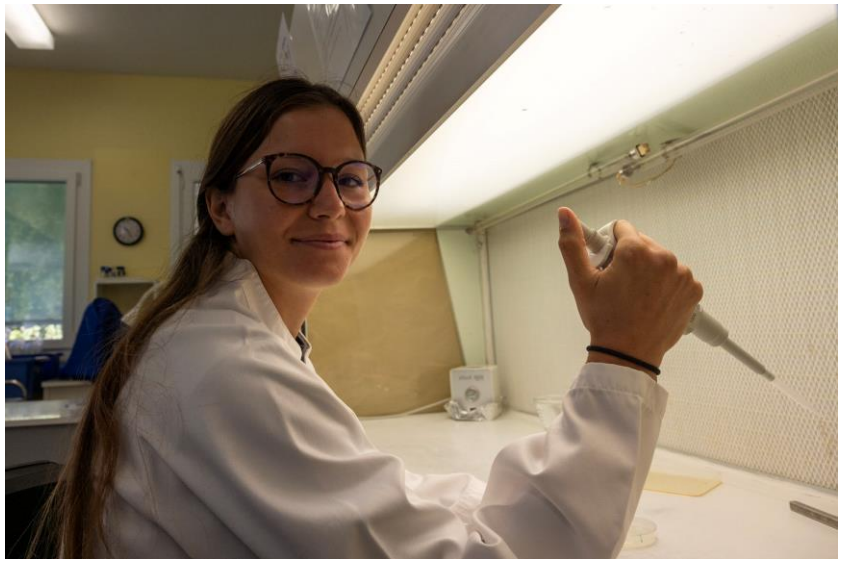
Develop and test a unique biocontrol solution for rapeseed on a pre-industrial scale

4 partners



INRAE
la science pour la vie, l'humain, la terre

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

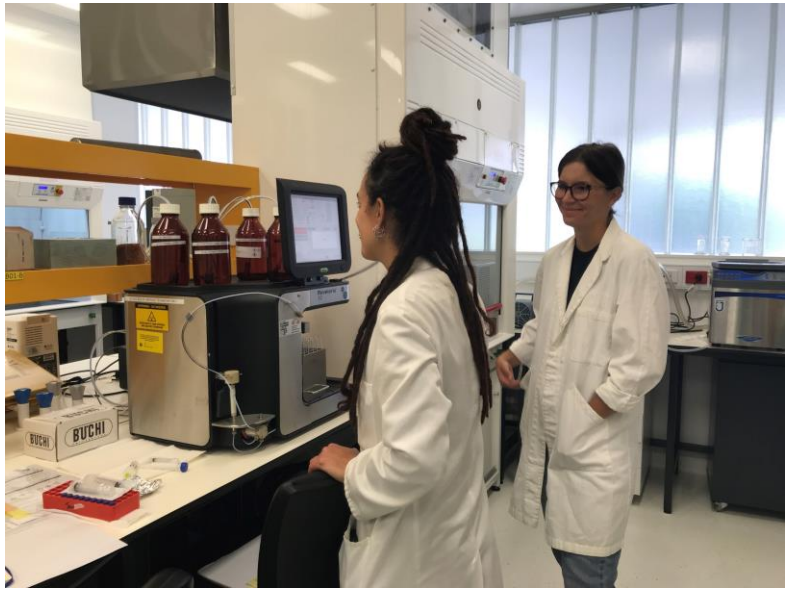
Screening of a genetically diverse subset of the INRAE collections of *Sclerotinia sclerotiorum* (100 strains) and *Botrytis cinereal* (50 strains) against a CSIRO biofungicide

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


Clémentine LEPINAY


Philippe NICOT


Jean-François BOURGEAY


Magali DUFFAUD


Thomas PRESSECQ


Margot GRIMONPONT


Awa SANGARE


Marjorie JACQUIN

IOBC-WPRS

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

Cap Phyto

RÉGION SUD

PtCléo

ÉCOPHYTO RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

Liberté • Égalité • Fraternité RÉPUBLIQUE FRANÇAISE

MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE ET SOLIDAIRE

MINISTÈRE DE L'AGRICULTURE ET DE L'ALIMENTATION