



HAL
open science

How to manage the complexity of deploying microbial biocontrol agents against plant diseases?

Marc Bardin, Thomas Presseccq, Marc Tchamitchian, Philippe C. Nicot

► To cite this version:

Marc Bardin, Thomas Presseccq, Marc Tchamitchian, Philippe C. Nicot. How to manage the complexity of deploying microbial biocontrol agents against plant diseases?. Third international congress of biological control (ICBC3), IOBC, CABI, Jun 2024, San Jose, Costa Rica. hal-04837568

HAL Id: hal-04837568

<https://hal.inrae.fr/hal-04837568v1>

Submitted on 13 Dec 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License



Third International Congress of Biological Control – 24-27 June 2024 – San José, Costa Rica

www.iobc-icbc.com

➤ How to manage the complexity of deploying microbial biocontrol agents against plant diseases?

Marc Bardin



Plant Pathology Research unit
Avignon, France

Thomas Presseccq



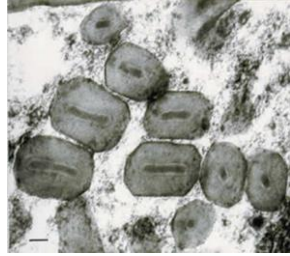
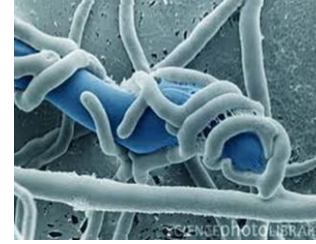
Augmentative biocontrol of diseases with microbials: increasing number of registered products

At world level, against diseases
(virus, bacteria, oomycetes, fungi)

91 microbial strains:

49 fungi/yeast/oomycetes + 37 bacteria/actinomycetes + 5 virus/phages

BioControl
DOI 10.1007/s10526-017-9801-4



**Biological control using invertebrates and microorganisms:
plenty of new opportunities**

Joop C. van Lenteren · Karel Bolckmans · Jürgen Köhl ·
Willem J. Ravensberg · Alberto Urbaneja

41 microbial strains approved in Europe
(EU pesticide database, 07/2023)

➔ **How are these products actually used?**

Use of microbial biocontrol against diseases



Survey of French vegetable farmers and farm advisors

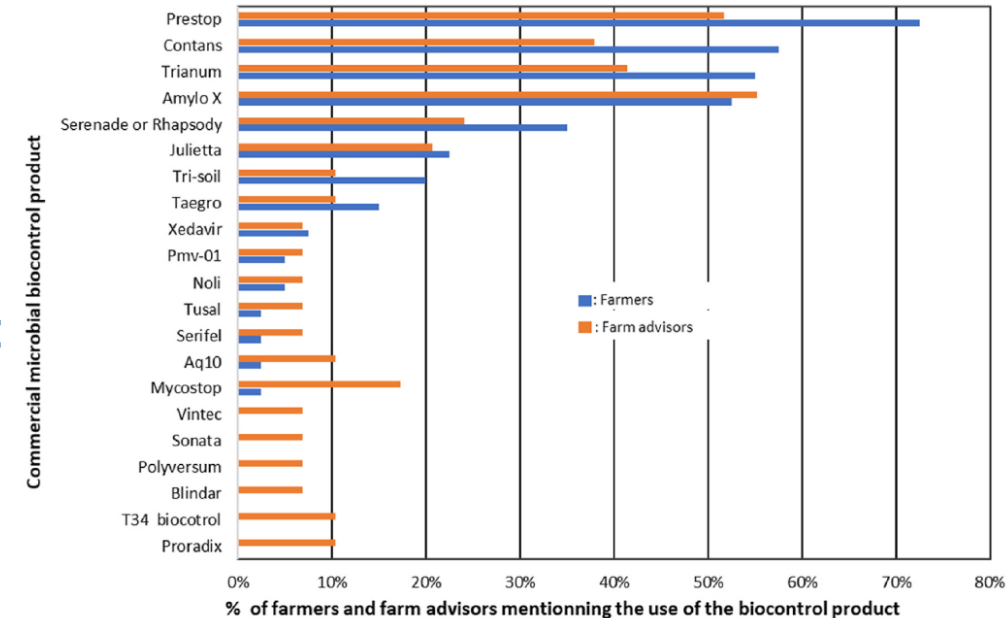
- Online questionnaires disseminated to more than 500 professionals (217 answers):
 - ✓ Only few biocontrol products known (21/32) and used (15)
 - ✓ **Efficacy perceived as low**
 - Face-to-face interviews performed (42 / 217 respondents):
 - ✓ Aware of the benefits of applying biocontrol products to manage plant diseases
- But
- ✓ Difficulties in using biocontrol with other cultural practices
 - ✓ **Unstable efficacy**

Using microbial biocontrol for disease control in French vegetable production: An analysis of the perspectives of farmers and farm advisors

Thomas Pressecq^{a,b,*}, Philippe C. Nicot^a, Jean François Bourgeay^a, Aurélie Rousselin^b, Claire Goillon^b, Marc Bardin^a, Marc Tehamitchian^a

^a INRAE, Pathologie Végétale, 94140, Montfavet, France

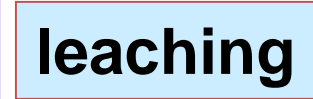
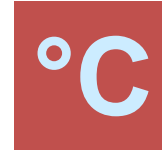
^b Association Provençale de Recherche & d'Expérimentation Légumière – APREL, 13210, Saint-Rémy-de-Provence, France



➔ **What are the possible causes for this instability in the efficacy of protection?**

Example of factors that can modulate the efficacy of biocontrol against plant diseases

Climatic conditions



Cultural practices

Agron. Sustain. Dev. (2014) 34:641–648
DOI 10.1007/s13593-013-0168-3

RESEARCH ARTICLE

Nitrogen fertilization impacts biocontrol of tomato gray mold

Manzoor A. Abro · François Lecompte · Marc Bardin · Philippe C. Nicot



Other phytosanitary treatments including biocontrol

Biological Control 46 (2008) 476–483

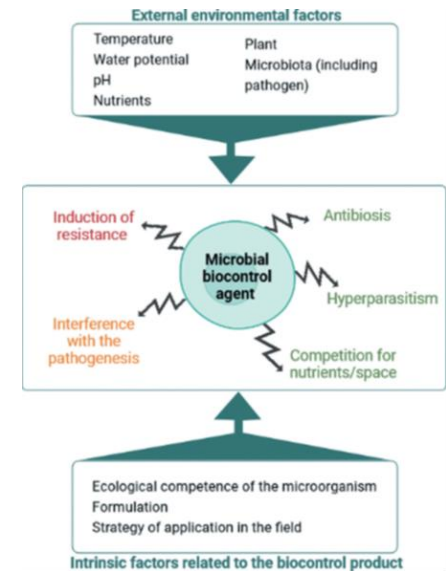
Compatibility between biopesticides used to control grey mould, powdery mildew and whitefly on tomato

M. Bardin^{a*}, J. Fargues^b, P.C. Nicot^a

^aINRA, Unité de Pathologie Végétale, UR 407, F-84140 Montfavet, France

^bINRA, Centre de Biologie et de Gestion des Populations, Campus international de Baillarguet, CS 30 016, 34988 Montpellier-sur-Lez cedex, France

Mode(s) of action and their activation



Resistance of pathogen to biocontrol

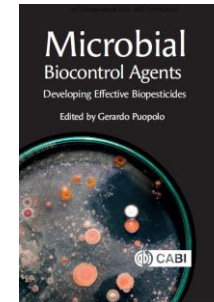
frontiers in Plant Science

published: 27 July 2015
doi: 10.3389/fpls.2015.00566

Is the efficacy of biological control against plant diseases likely to be more durable than that of chemical pesticides?

Marc Bardin^{1*}, Sakhr Ajouz¹, Morgane Comby², Miguel Lopez-Ferber³, Benoit Grallot^{2,5}, Myriam Slegwart⁴ and Philippe C. Nicot¹

¹Plant Pathology Unit, Institut National de la Recherche Agronomique, UR407, Montfavet, France, ²Laboratoire de Génie de l'Environnement Industriel, Ecole des Mines d'Alès, Institut Mines-Teccom, Alès, France, ³Natural Plant Protection, Arysta LifeScience Group, Pau, France, ⁴Plantes et Systèmes de Culture Horticoles Unit, Institut National de la Recherche Agronomique, UR1115, Avignon, France



Modes of Action of Microbial Biocontrol Agents against Plant Diseases

ESTELLE TURC^{1,2}, THOMAS PRESSECO^{1,3}, PHILIPPE C. NICOT¹ AND MARC BARDIN^{1*}

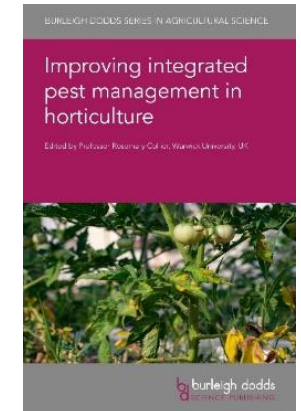
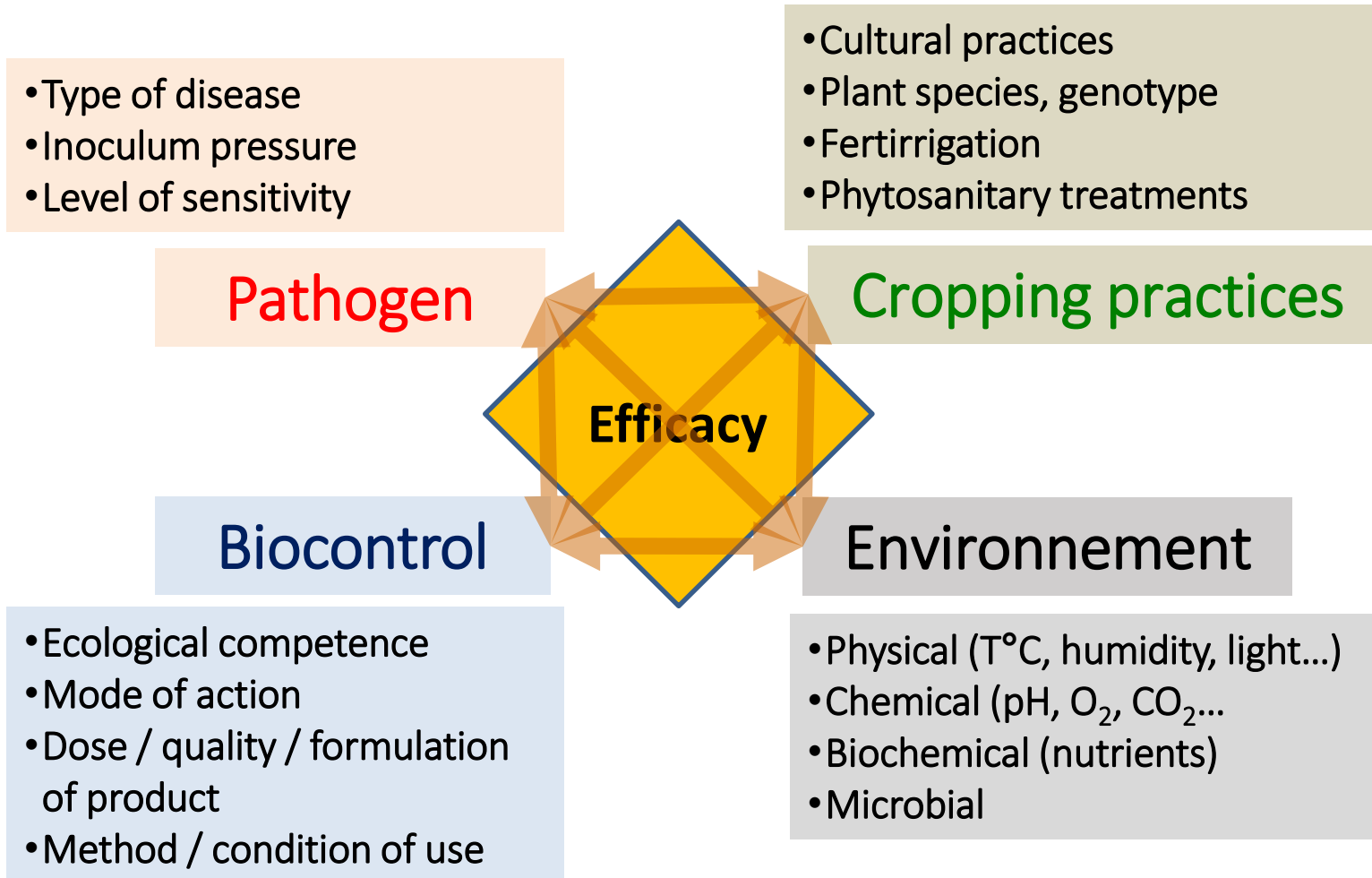
¹INRAE, Pathologie Végétale, Montfavet, France

²Groupe Eléphant Vert France, Serris, France

³INRAE, Ecodéveloppement, Avignon, France

Classification of efficacy factors for a biocontrol microbial strain

- Efficacy factors organized into 4 groups
- Each group includes a number of related factors
- Possible interactions between factors



Advances in bioprotectants for plant disease control in horticulture

Philippe C. Nicot, Thomas Pressecq and Marc Bardin, INRAE, Pathologie Végétale, France

➔ **How to deal with this complexity and help farmers use biocontrol correctly?**

How to deal with this complexity and help farmers?



- Develop practical guidelines helping to choose the most adequate products for specific situations
- Obtain information about the most efficient way to use a biocontrol solution

→ Where to find this information ?



→ the data available in scientific articles will make it possible to obtain this information

✓ Is there a substantial amount of published knowledge on the factors governing the efficacy of microbial biocontrol agents?

✓ Is it possible to gather suitable information to develop guidelines for the practical application of these products by farmers?



Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Using microbial biocontrol for disease control in French vegetable production: An analysis of the perspectives of farmers and farm advisors

Thomas Pressecq^{a,b}, Philippe C. Nicot^a, Jean François Bourgeay^a, Aurélie Rousselin^b, Claire Goillon^b, Marc Bardin^a, Marc Tchamitchian^a

^a INRAE, Pathologie Végétale, 04140, Manosque, France
^b Association Provence de Recherche et d'Expérimentation Légumière - APREL, 13210, Saint-Rémy-de-Provence, France

Analysis of published knowledge on the factors governing the efficacy of microbial biocontrol agents

- Collect relevant peer-reviewed articles

All publications on the **41 biocontrol microbial strains registered in Europe**
(excluding reviews)

Research equation : Full name of biocontrol agent (**species + strain name**)
OR current (and possibly previous) **commercial name**



- ✓ 808 publications collected on European registered microbial strains
- ✓ Great majority of publications concerned strains in species *Bacillus* (255) and *Trichoderma* (263)
- ✓ Most studied strains: *B. amyloliquefaciens* QST 713 (133 publications) and *T. afroharzianum* T-22 (115)

Analysis of published knowledge on the factors governing the efficacy of microbial biocontrol agents

- Collect relevant peer-reviewed articles
- Review of scientific information on the efficacy factors
 - ✓ 37% of articles with information on efficacy factors (296)
 - ✓ Certain articles can include results for different factors of efficacy
 - ✓ No information for 13 of the 41 strains registered in Europe

Analysis of published knowledge on the factors governing the efficacy of microbial biocontrol agents

- Collect relevant peer-reviewed articles
- Review of scientific information on the efficacy factors
- In-depth analysis of publications: extraction of data on efficacy factors

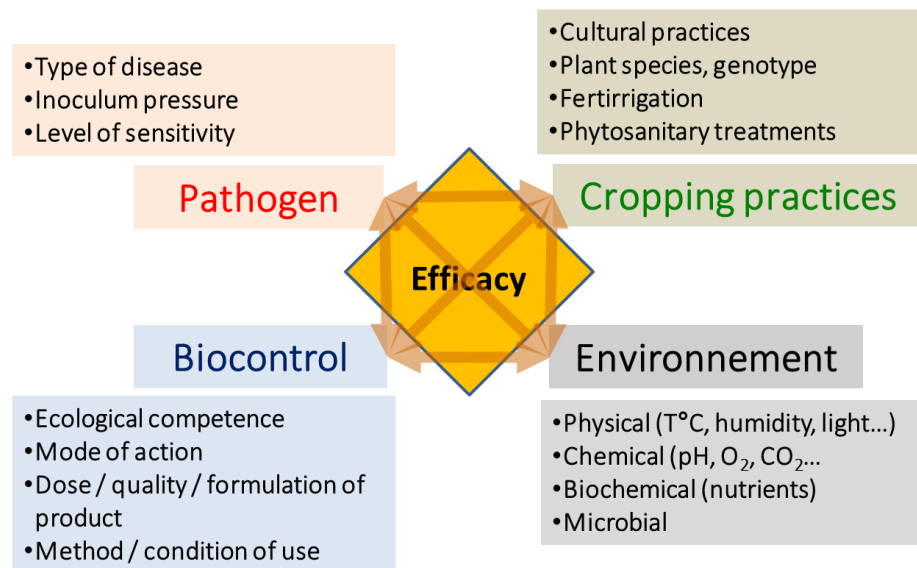
Every publication analyzed according to the following framework:

Context	Experimental conditions	Data on efficacy factors
<ul style="list-style-type: none">• Biocontrol name (strain, commercial product)• Crop• Pathogen targeted• ...	<ul style="list-style-type: none">• Experimental method (<i>in vitro</i>, controlled condition, in field...)• Biocontrol treatment (type, dose, timing, frequency)• Pathogen inoculation (natural or artificial, conditions)• ...	

Analysis of published knowledge on the factors governing the efficacy of microbial biocontrol agents

- Collect relevant peer-reviewed articles
- Review of scientific information on the efficacy factors
- In-depth analysis of publications: extraction of data on efficacy factors

Every publication analyzed according to the following framework:



Data on efficacy factors

- Efficacy factor(s) tested (group and sub-group)
- Protective efficacy value
- Effect of factor(s) tested on efficacy (quantitative data if available)
- ...

✓ For a given article, several relevant information can be obtained

Analysis of published knowledge on the factors governing the efficacy of microbial biocontrol agents

- Collect relevant peer-reviewed articles
- Review of scientific information on the efficacy factors
- In-depth analysis of publications: extraction of data on efficacy factors

Every publication analyzed according to the following framework:

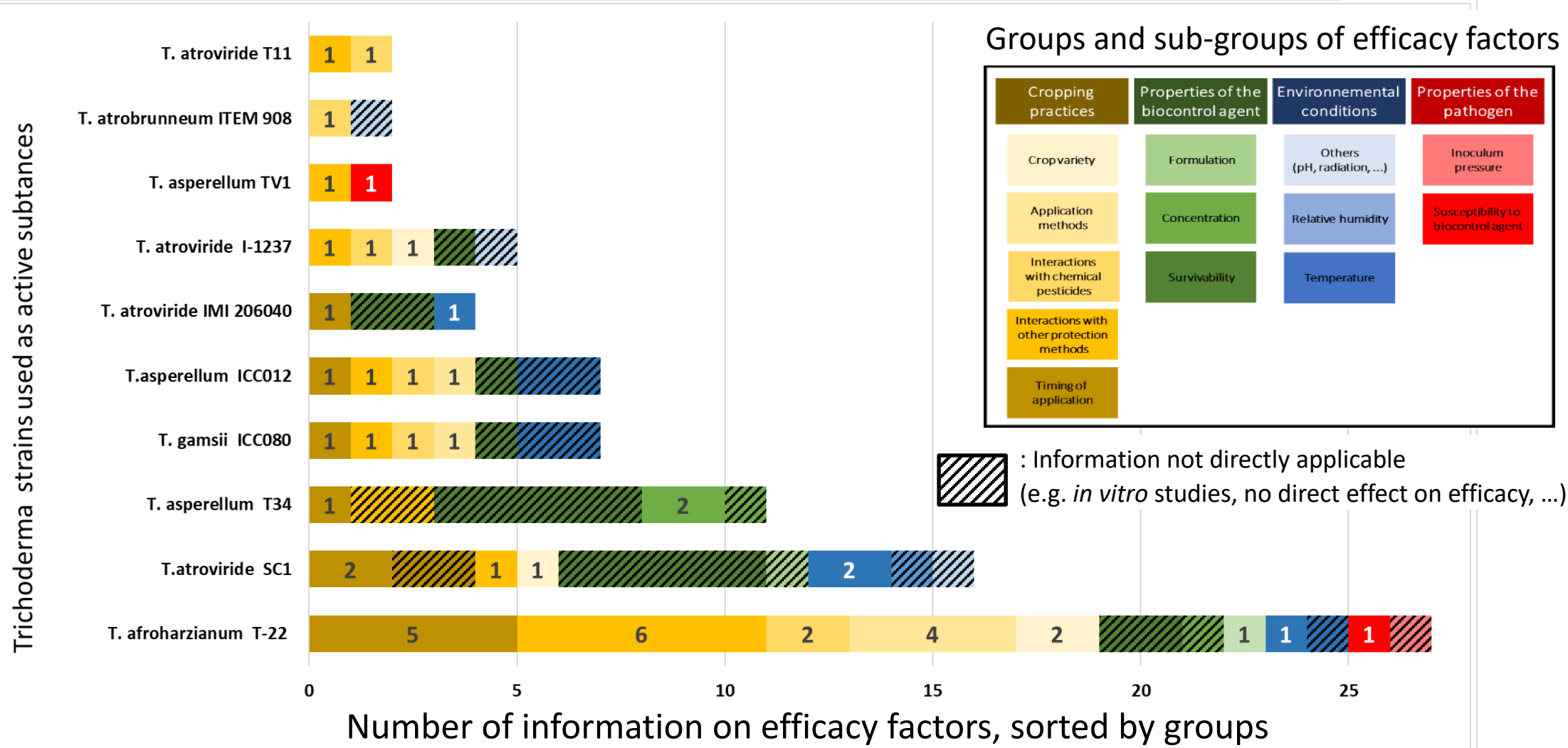
Context	Experimental conditions	Data on efficacy factors
<ul style="list-style-type: none">• Biocontrol name (strain, commercial product)• Crop• Pathogen targeted• ...	<ul style="list-style-type: none">• Experimental method (<i>in vitro</i>, controlled condition, in field...)• Biocontrol treatment (type, dose, timing, frequency)• Pathogen inoculation (natural or artificial, conditions)• ...	<ul style="list-style-type: none">• Efficacy factor(s) tested (group and sub-group)• Protective efficacy value• Effect of factor(s) tested on efficacy (quantitative data if available)• ...

Build a database on efficacy factors of microbial biocontrol agents against plant diseases

- ✓ Few quantitative data available
- ✓ Very heterogenous distribution of information among strains and among types of efficacy factors

Example of *Trichoderma* strains: lot of data but...

- Some data not relevant (e.g. strain name not indicated)
- Little information available / commercial strain / efficacy factor
- Information not directly applicable (e.g. data obtained under artificial conditions)



Conclusion

- Is there a substantial amount of published knowledge on the factors governing the efficacy of microbial biocontrol agents?

→ Most of the data currently published on microbial biocontrol agents in scientific journal do not involve commercial strains or efficacy factors

- Is it possible to gather suitable information to develop guidelines for the practical application of these products by farmers?

→ Tremendous amount of additional data required for the development of guidelines for farmers

What's next ?

- **Increase the availability of data in future published articles for integration into the database**
 - ✓ Clearly indicate the strain name of the biocontrol agent used in the study
 - ✓ Share data more widely, including “negative” results
- **Obtain more data on biocontrol agent efficacy factors**
 - ✓ Make agreements with companies (in progress)
 - ✓ Carry out experiments under production conditions, recording as many variables as possible (climatic conditions in particular)
- **Translate this scientific knowledge into decision rules**
 - ✓ Transform the data collected in the database into operational information
 - ✓ Integrate this information into a decision support system useful to farmers

DeciControl



http://ephytia.inra.fr/fr/P/175/Deci_Control





IOBC-WPRS

XVII

Meeting of the Working Group

**Biological and
integrated control
of plant pathogens**

From single microbes
to microbiomes targeting
One Health

<https://www.iobctorino2025.org/>



SAVE THE DATE
June 11-14, 2025

Università degli Studi di Torino

Thank you !



Thomas
PRESSECQ



Philippe
NICOT



Marc
TCHAMITCHIAN



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



CULTIVER
PROTÉGER
autrement



MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE ET SOLIDAIRE

MINISTÈRE
DE L'AGRICULTURE
ET DE L'ALIMENTATION

The project has received funding from the Horizon Europe Framework Programme of the European Union under grant agreement No 101060430