



Digibiocontrol & Biocontrol 4.0 : Two projects pioneering sustainable agriculture for healthier futures

General Assembly Belplant, May,26 2026

Pr. Philippe Jacques

Co-Head of Digibiocontrol and Biocontrol 4.0
Chair of Terra Teaching and Research Centre
Gembloux Agro-Bio Tech/University of Liege



Plants in the Environment: Navigating and Adapting to Stressors

Abiotic stresses



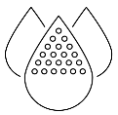
Temperature (cold, warm)



Light (UV)



Nutrient access (deficiency or excess)



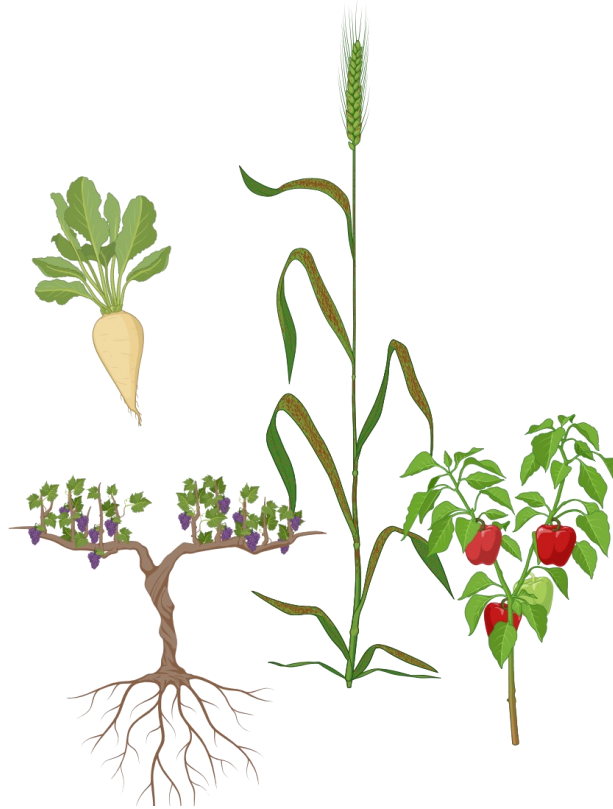
Salinity



Hydric (drought, flooding)



Mechanical (wind, hail, human)



Biotic stresses

Weeds



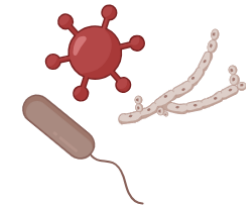
Pests



Nematodes

Microorganisms

- Bacteria
- Fungi
- Virus



Some definitions

Biostimulant

A plant biostimulant is a product that stimulates plant nutrition processes independently of the nutrients it contains, with the sole purpose of improving one or more of the following characteristics of plants or their rhizosphere:

- Nutrient use efficiency;
- Tolerance to abiotic stress;
- Qualitative characteristics;
- Availability of nutrients confined in the soil or rhizosphere.

Regulation (EC) No. 1107/2009, point 34, Article 3; amended on 12/30/2025.

Some definitions

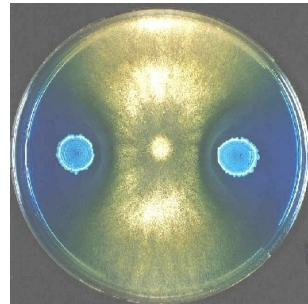
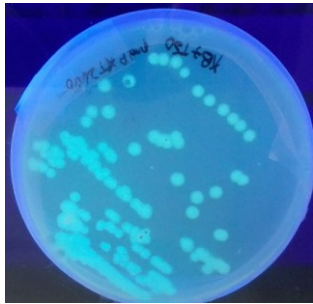
Biopesticides

Official proposal for a definition of biocontrol submitted to the European Commission as part of the Omnibus Food and Feed Safety package (filed on December 16, 2025)

"A definition for biocontrol substances should include **micro-organisms**, inorganic substances as occurring in nature, with the exception of heavy metals and their salts, or substances of biological origin or produced synthetically that are functionally identical and structurally similar to them such as **semiochemicals**, biological **macromolecules** or molecules comprised of components thereof, as well as substances, including of unknown and variable composition, originating from living organisms or derived by biological processes (e.g. extracts from plant products, metabolites produced by micro-organisms)."

Biopesticides (IBMA)

Invertebrate Biocontrol Agents (also called **Macrobia**ls) are natural enemies such as insect, mite and nematode species providing control of pest populations through predation or parasitism.



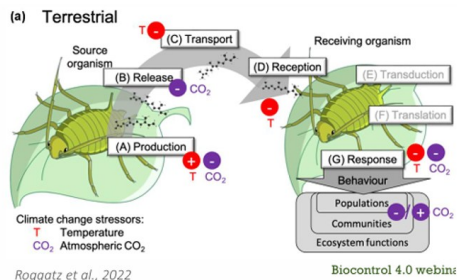
Microbials are based on microorganisms, including but not limited to bacteria, fungi, protozoans, viruses, viroids, peptides, mycoplasmas, and may include entire microorganisms, living and dead cells, any associated microbial metabolites, fermentation materials and cell-fragments.



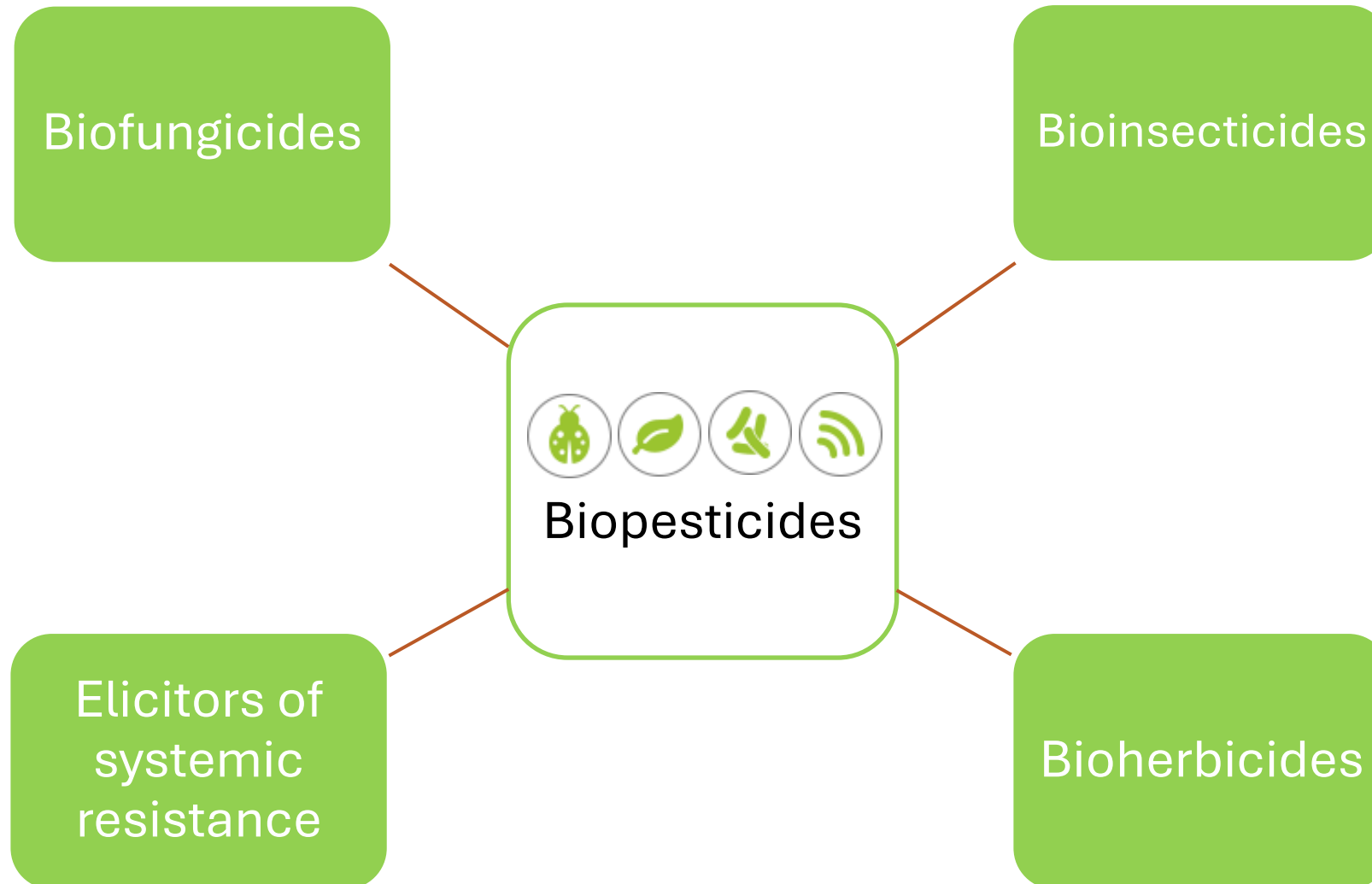
Natural substances consist of one or more components that originate from nature, including but not limited to: plants, algae/microalgae, animals, minerals, bacteria, fungi, protozoans, peptides, proteins (e.g. enzymes, antibodies), viruses, viroids, and mycoplasmas. They can either be sourced from nature or are nature identical if synthesized.



Semiochemicals are substances emitted by plants, animals and other organisms used for intra-species and/or inter-species communication and have a target-specific and non-toxic mode of action.

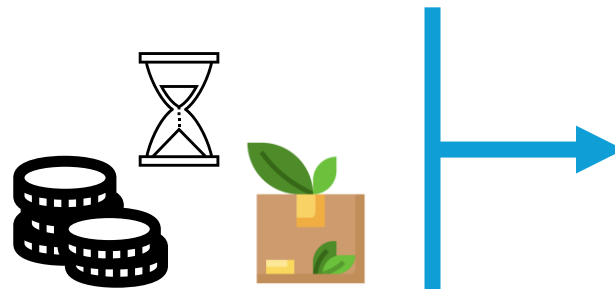
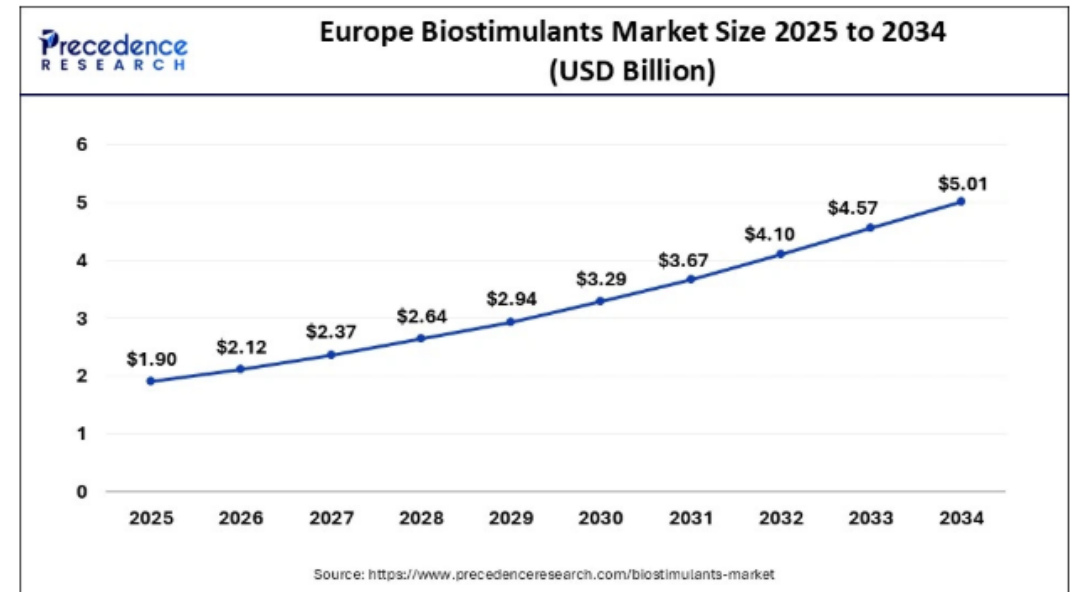
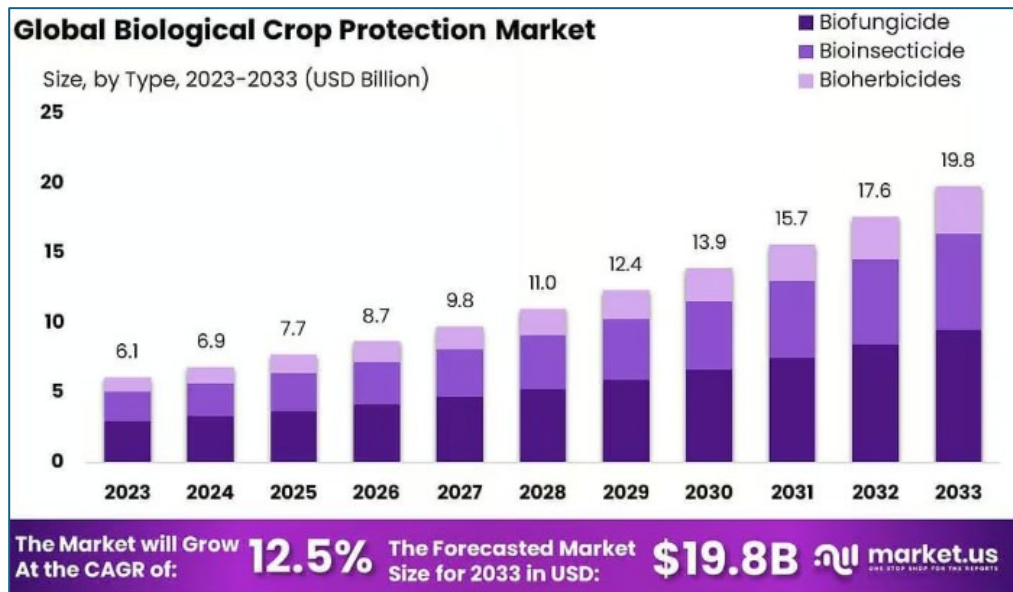


Biopesticides

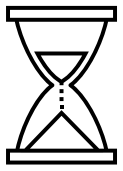


The biocontrol products market

- Global market value in 2023 : \$ 6.1 Billions
- Account for only 5.5% of the global pesticide market

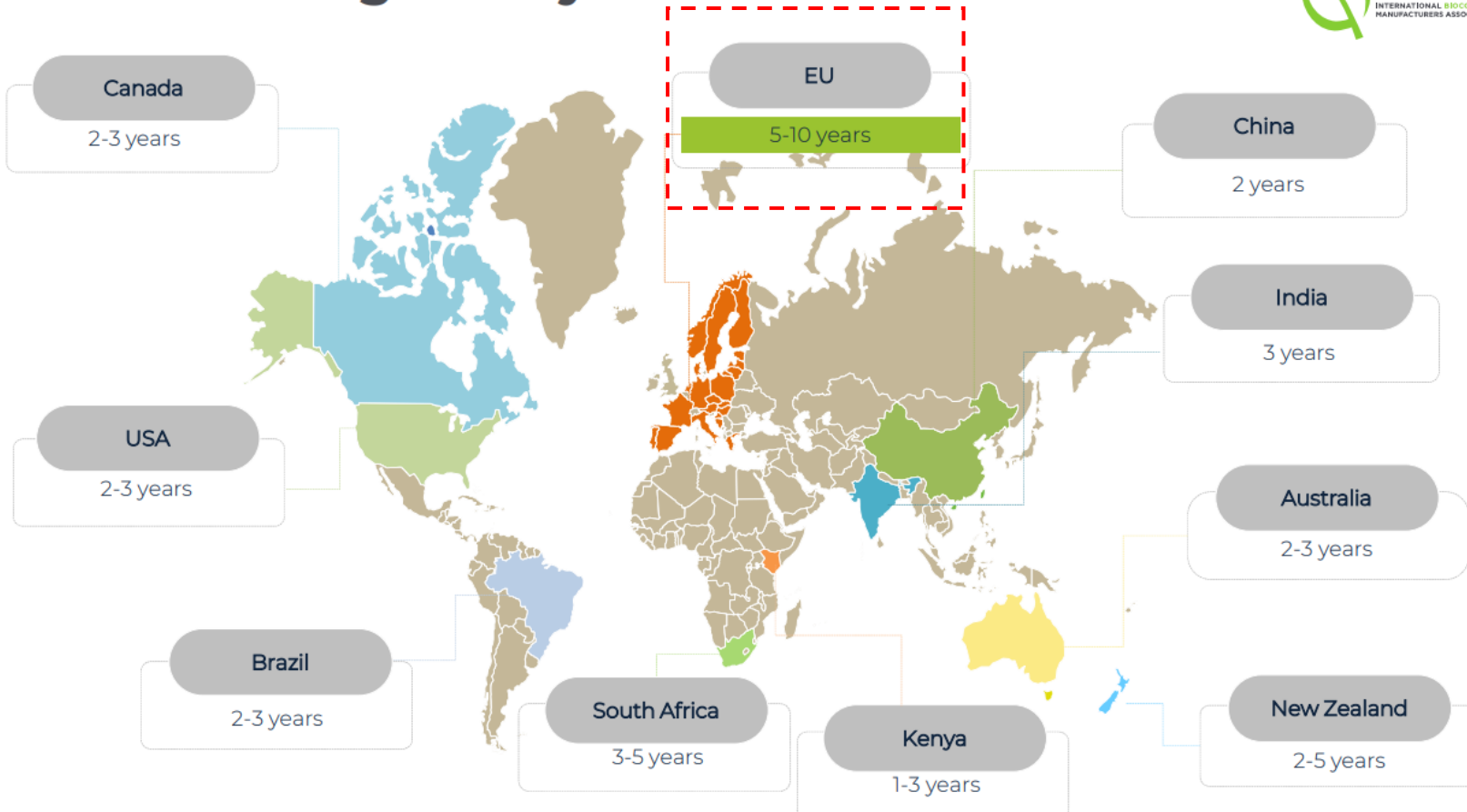


Constraints due to living or biodegradable products : reproducibility and cost.. But also regulatory constraints



Regulation for placing PPPs on the EU market

Biocontrol regulatory timelines

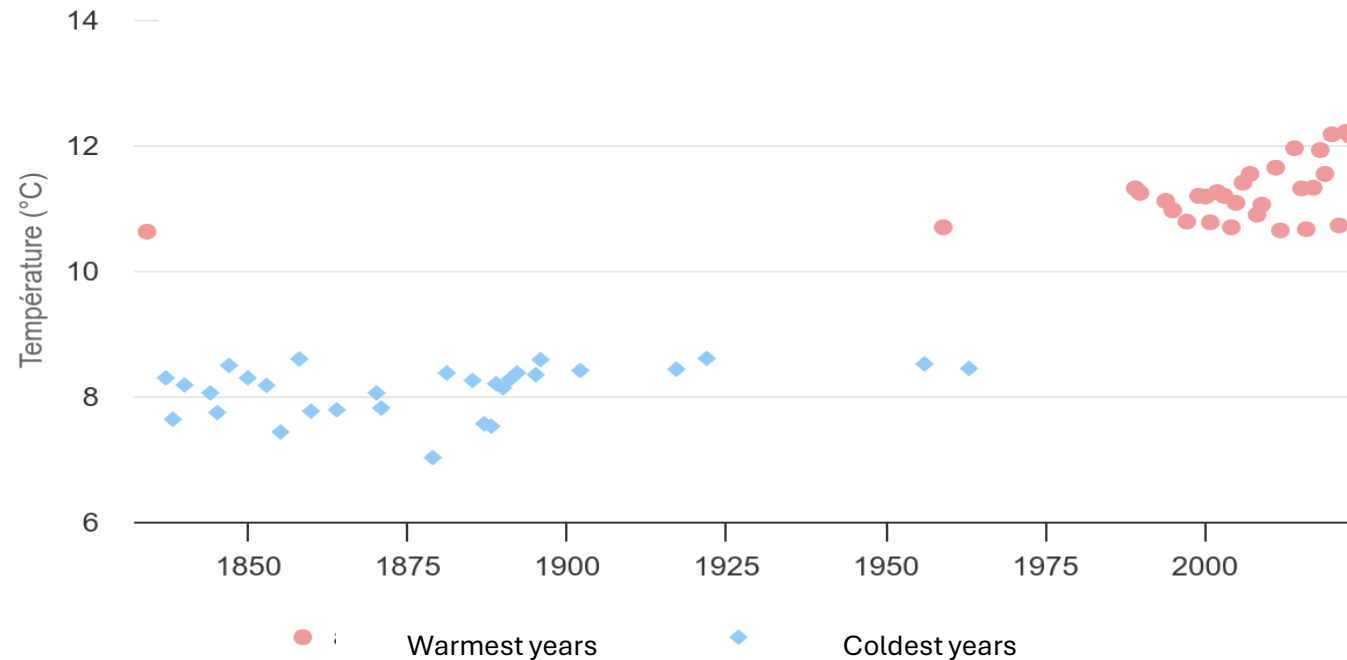


Climate change : another constraint

An increasingly evident climate disruption



The 30 warmest/coldest years in Uccle since 1833



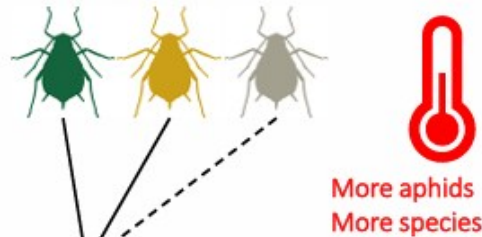
The current observed global warming is +1.1 °C, while it is +1.9 °C in Belgium

Climate change : another constraint

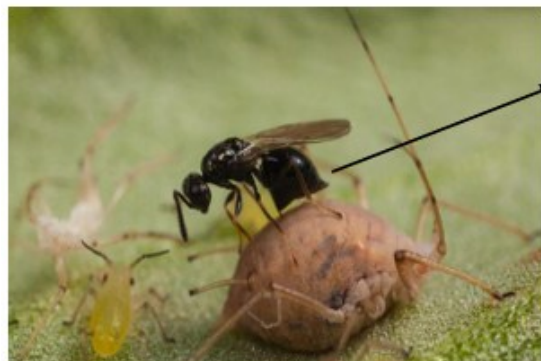
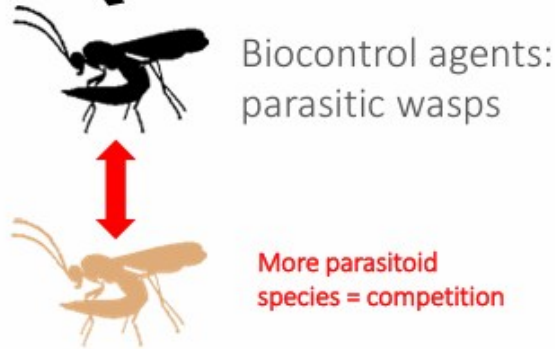
Example of species interaction modification



Aphid pests on cereals



Risks of asymmetrical changes among trophic levels



Biocontrol disturbance:

hyperparasitoids
new (super)predators

...
= decreased biological control efficiency on aphids!

Tougeron et al., 2018

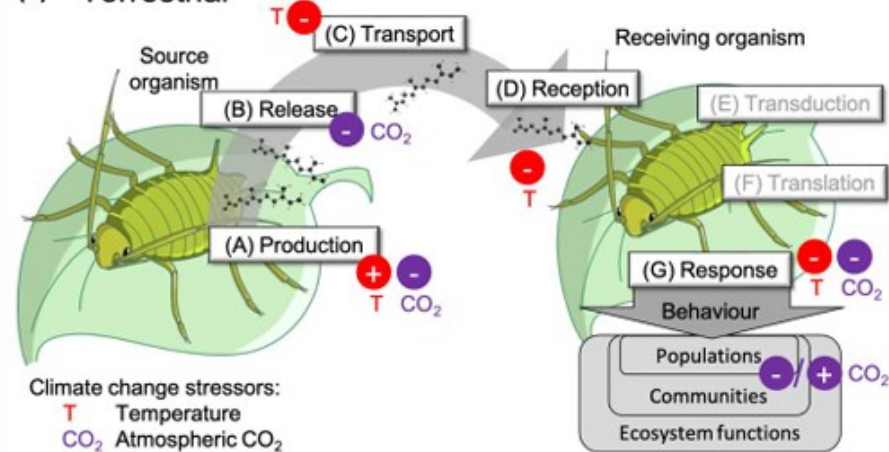


Use of pheromone-based lures to trap pest insects (e.g. thrips, click beetles, ...)



Climate-change is a **threat** to the efficiency of such biopesticide solution for several reasons

(a) Terrestrial



Climate change stressors:
T Temperature
CO₂ Atmospheric CO₂

Roggatz et al., 2022

Biocontrol 4.0 webinar

Impact of climate change on pest and disease control



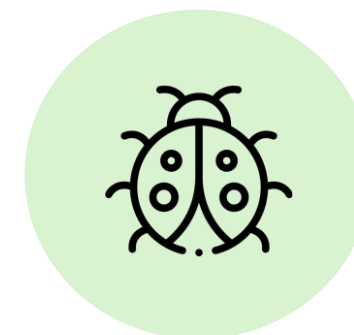
Plant phenology and physiology

- Increased growth rates
- Lower sensitivity thresholds
- Change in metabolic response
- Change in cultivation stages



Pest or phytopathogen phenology and physiology

- Increased pressure
- Faster population dynamics
- Higher dispersal rates
- higher consumption rates

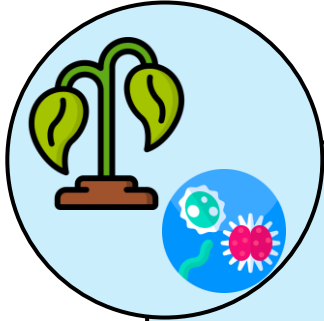


Biocontrol products behavior

- Increased attack rates
- Development rates
- Physiological thresholds reached
- Increased wash out and (bio)degradation

Change in the values of the biological control service
Change in the action capacity of biocontrol products

Digital solutions to address the main issues of biocontrol products



Resistance mechanism,
Efficiency problem
Reproducibility

The right dose

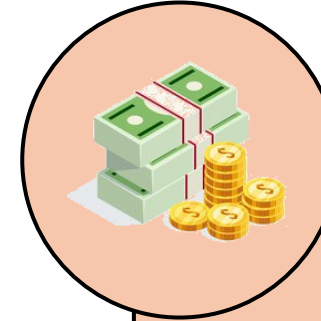
Limit the defense
inductions in plant
pathogens



Climate variability
Climate change

At the right time

Improve the
distribution in the field
and better target the
areas to be treated



Cost

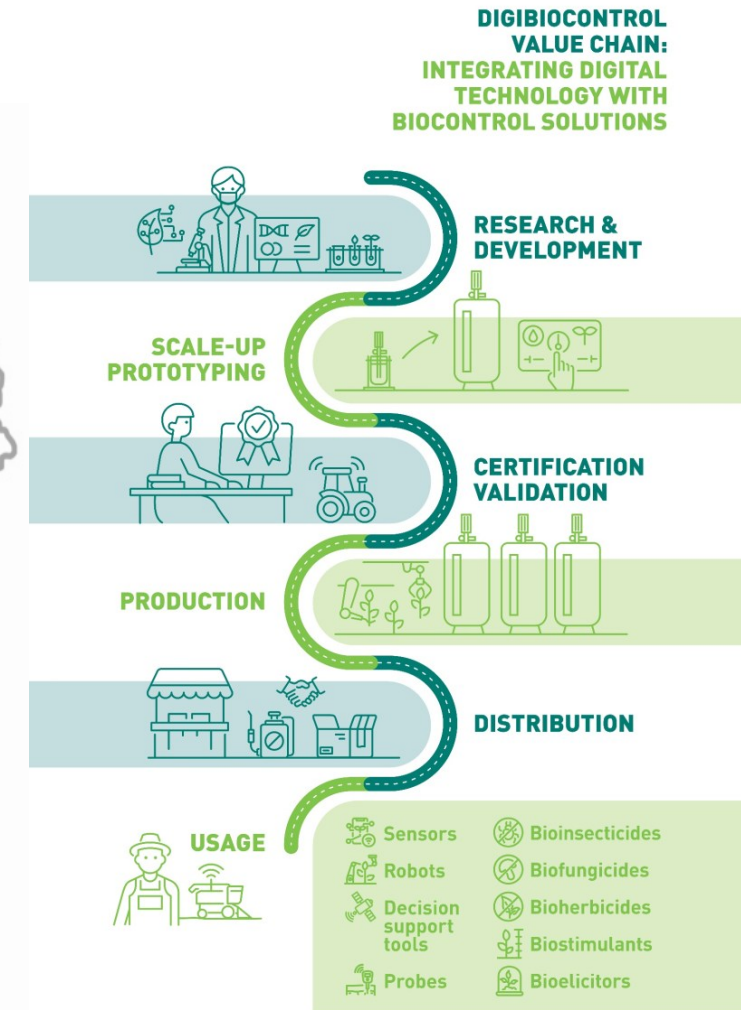
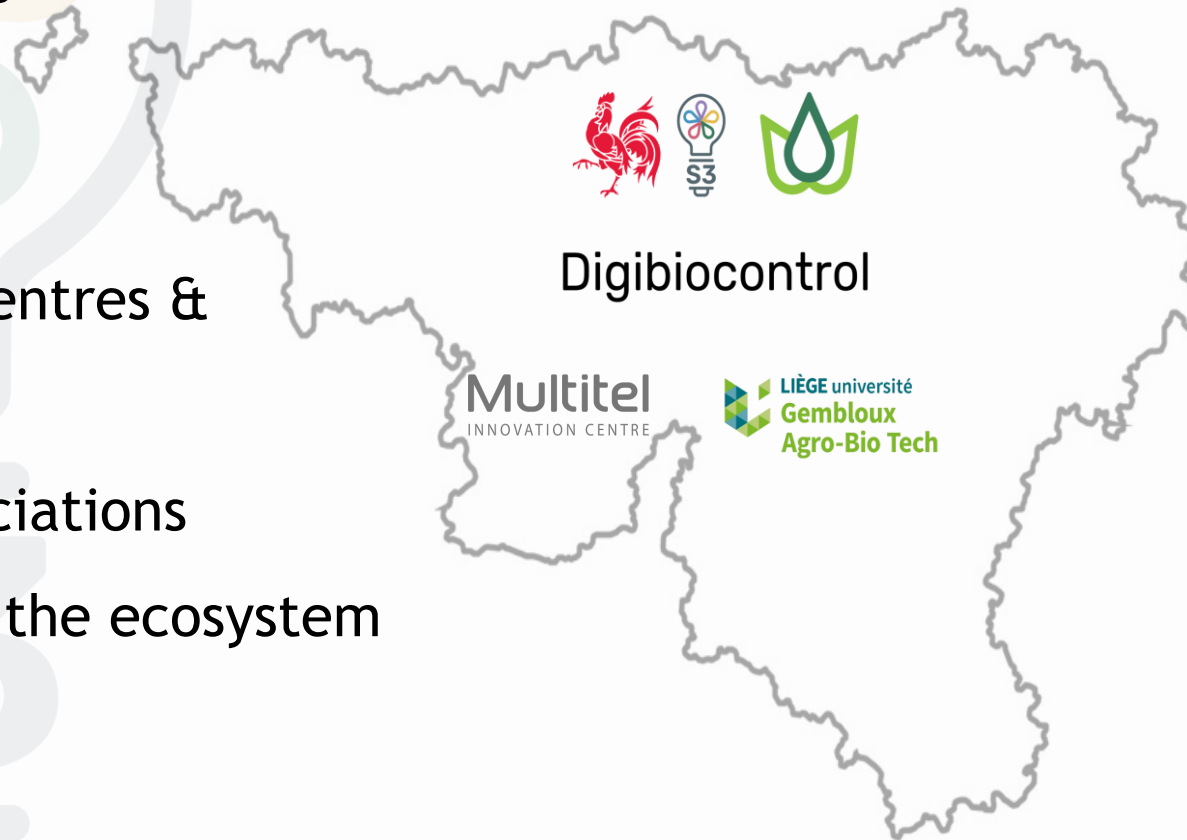
In the right place

Reduction of the
amount of product

Digibiocontrol : A projet under the Wallon Region's Smart Specialization Strategy aimed at strengthening interactions between the digital and biocontrol ecosystems

- ✦ 82 partners, including
 - ✦ 38 Companies
 - ✦ 5 Universities
 - ✦ 9 High Schools
 - ✦ 13 Research Centres & Associations
 - ✦ 4 Farmer Associations
 - ✦ 13 Partners of the ecosystem
- ✦ >200 Individuals

➔ Coverage of the entire value chain

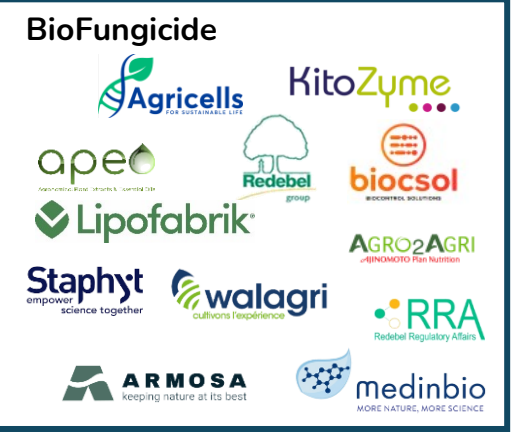


Current partners of the Digibiocontrol IIS

Academic and Research Institutions



BioFungicide



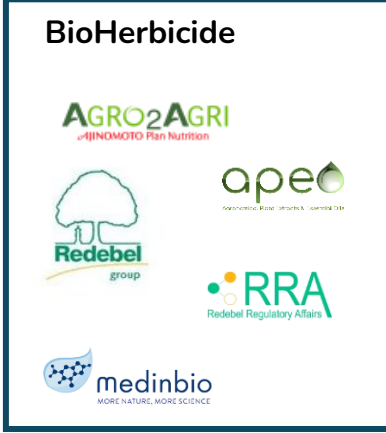
BioInsecticide



BioStimulant/Elicitor



BioHerbicide



Digital



Ecosystem partners



Others



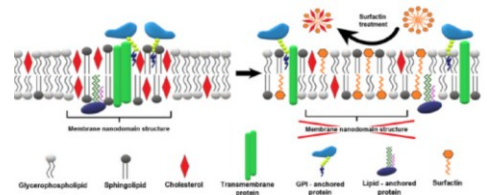
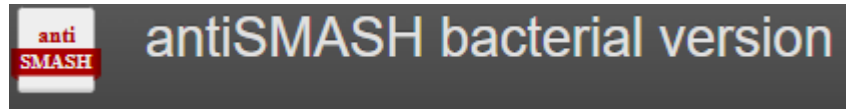
Digital tools in the value chain of biosolutions



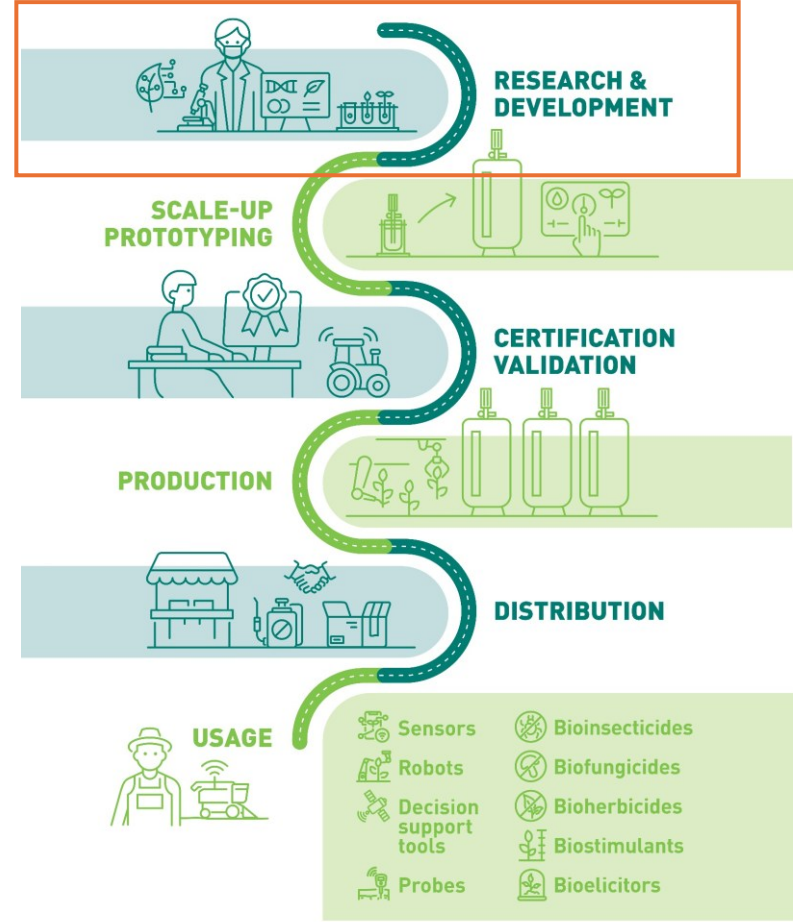
Research & Development

High throughput screening of new biosolutions *in silico*

- Use of digital tools to predict biological activities of potential biosolutions
 - Microorganisms :
Ex: antiSMASH
 - Biomolecules:
Docking
Interactions with plasma membrane

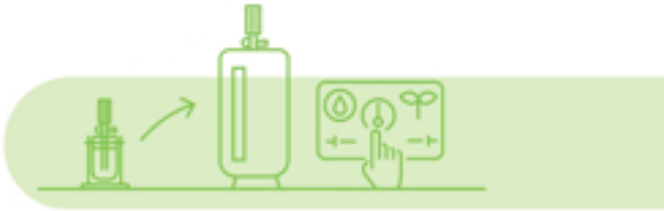


**DIGIBIOCONTROL VALUE CHAIN:
INTEGRATING DIGITAL
TECHNOLOGY WITH
BIOCONTROL SOLUTIONS**



Digital tools in the value chain of biosolutions

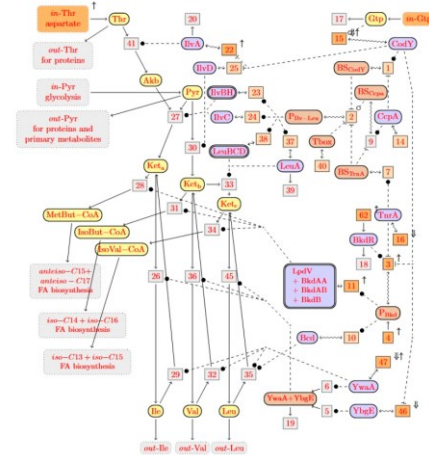
**DIGIBIOCONTROL
VALUE CHAIN:
INTEGRATING DIGITAL
TECHNOLOGY WITH
BIOCONTROL SOLUTIONS**



Scale-Up prototyping and production

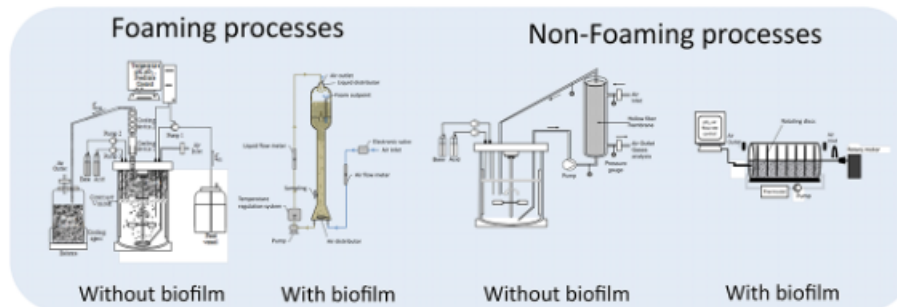
Bioprocess optimisation

- Use of digital tools to increase bioprocess productivity and reproducibility
- Metabolic engineering, system biology
- Bioprocess modelling and automation (precision fermentation)

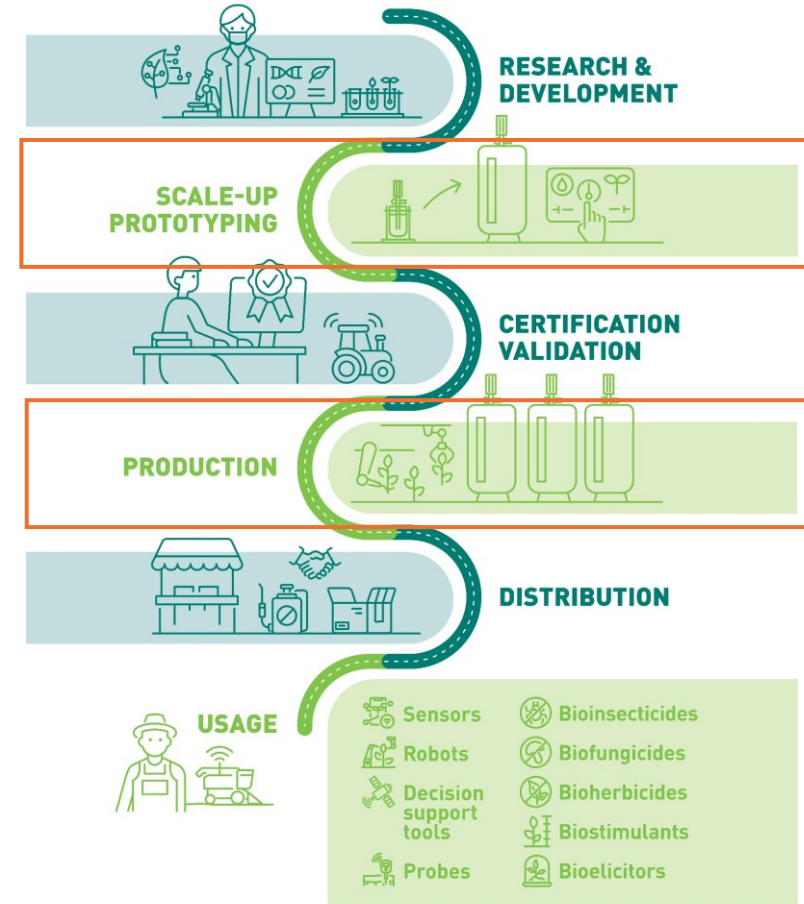


Guez *et al.* Metabolites 2022

Production and purification processes of lipopeptides



Coutte *et al.* Biotechnol. J. 2017



Digital tools in the value chain of biosolutions



Usage

Data collection and sharing

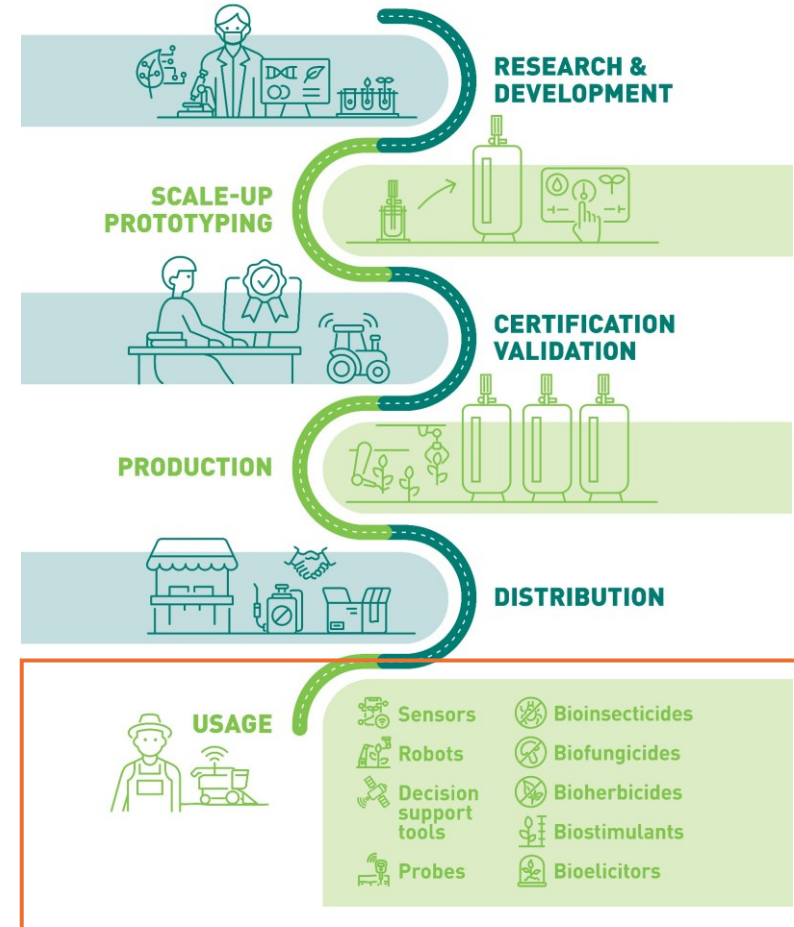
- Data collection from experimental trials in greenhouses and fields



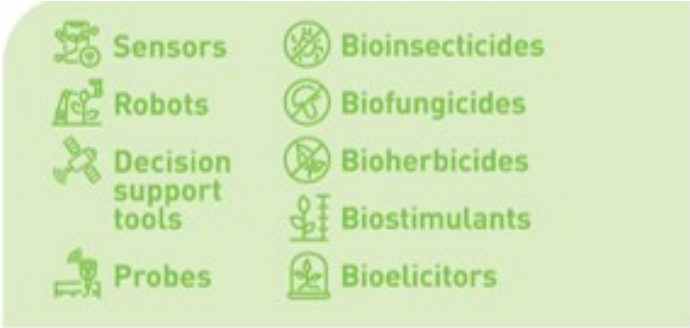
- Data collection from farmers



DIGIBIOCONTROL VALUE CHAIN: INTEGRATING DIGITAL TECHNOLOGY WITH BIOCONTROL SOLUTIONS



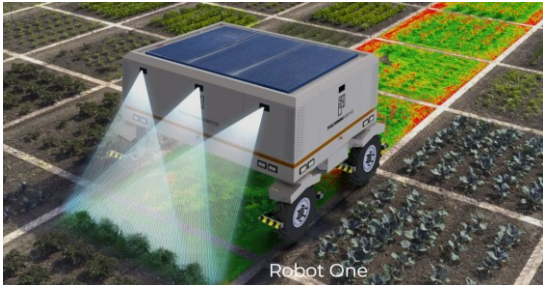
Digital tools in the value chain of biosolutions



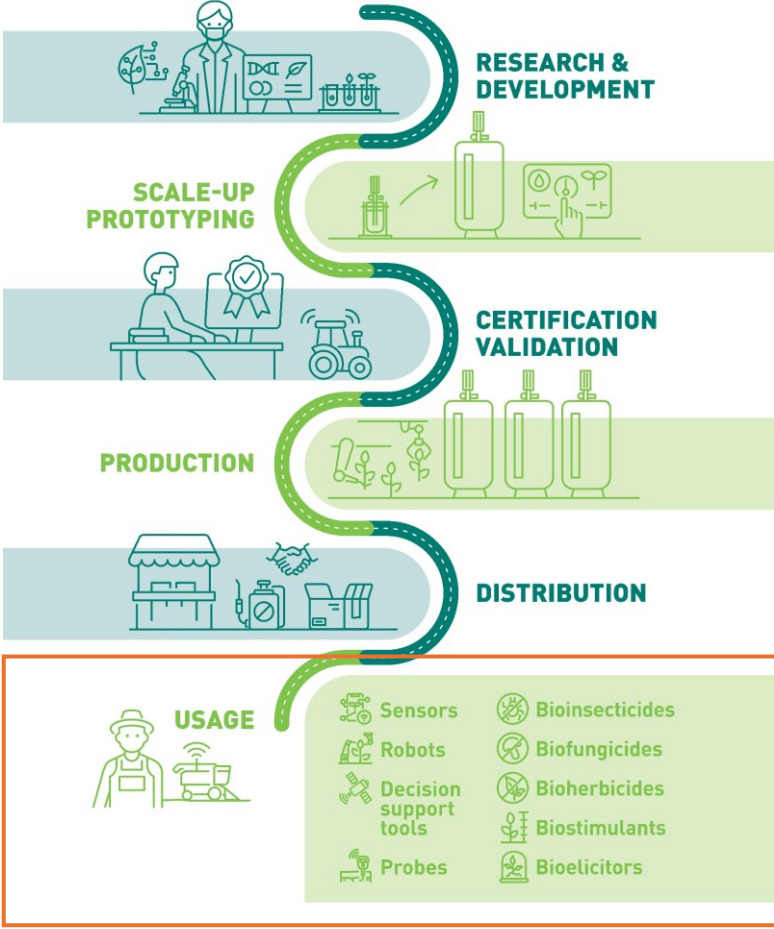
Usage

Numeric tools for biosolution application optimisation

- Sensors (spores, insects, weeds...)
- Robots
- Decision support systems



DIGIBIOCONTROL VALUE CHAIN: INTEGRATING DIGITAL TECHNOLOGY WITH BIOCONTROL SOLUTIONS





INTERNATIONAL SPRING SCHOOL



BIOSOLUTIONS FOR A SUSTAINABLE AGRICULTURE: INNOVATION IN ACTION



16-17 June
2026



Liège,
Belgium

Organised by



Supported by



Biocontrol 4.0: an innovative solution for sustainable agriculture

Biocontrol 4.0
Trans-Manage

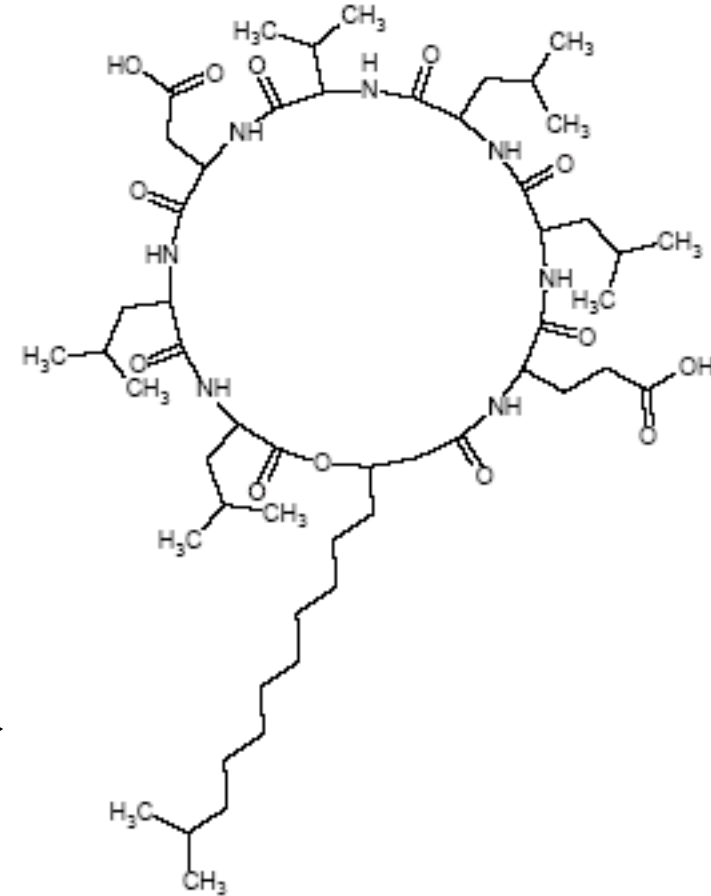


Lipopeptides

Peptide chain



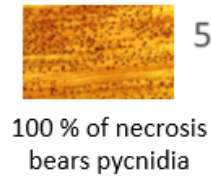
Fatty acid chain



Molecular properties of lipopeptides in relation with their roles in biocontrol of plant diseases



ZYMOSEPTORIA TRITICI – WHEAT

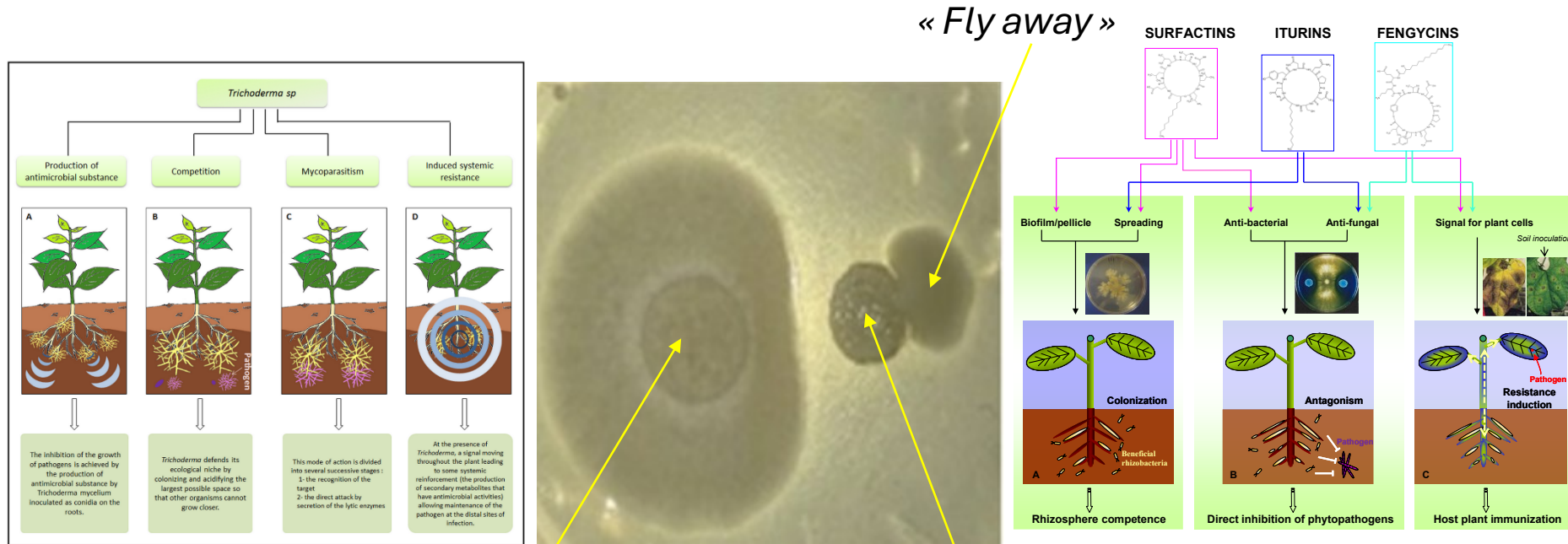


	%			
	Lipo	Myco	Surf	Feng
1	20	80		
2	40	60		
3	60	40		
4	80	20		
5	45	30	25	
6	30	20	50	
7	60		40	
8	33	33	33	



- Mycosubtilin was the most effective, and has a biocide action (germination and growth) in vitro and in planta

Are *Trichoderma* and *Bacillus velezensis* growths compatible ?



Zaki et al., 2020,
Biol. control

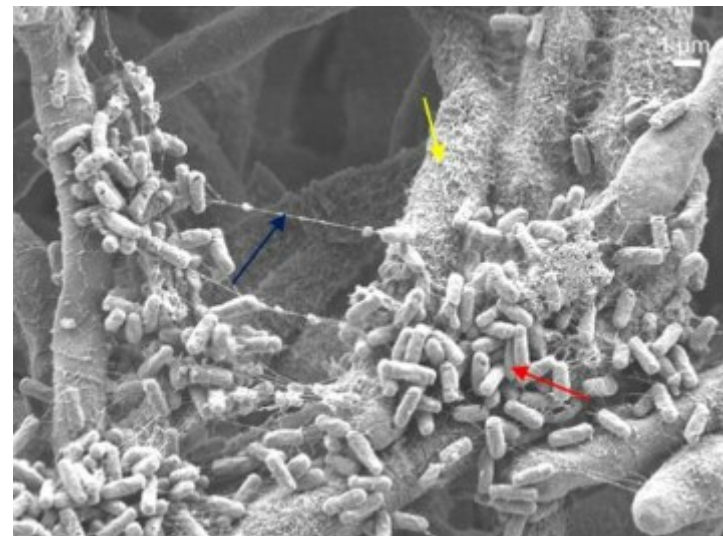
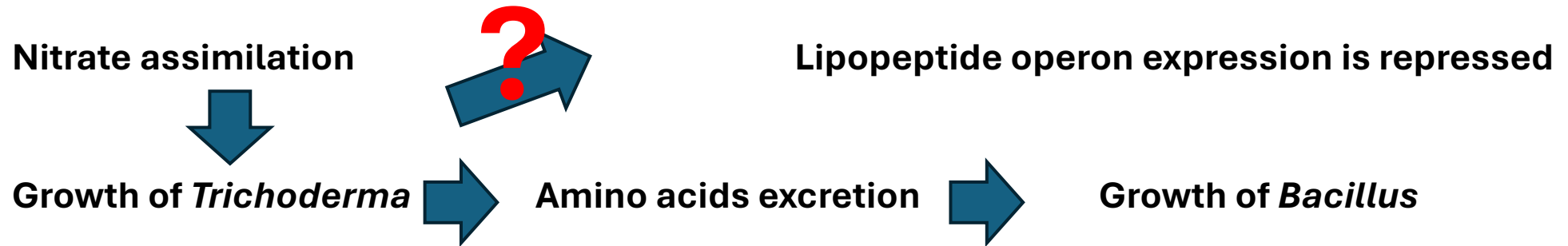
Trichoderma

Fifani et al., 2022,
Microorganisms

Bacillus

Ongena and Jacques, 2008,
Trends microbiol,

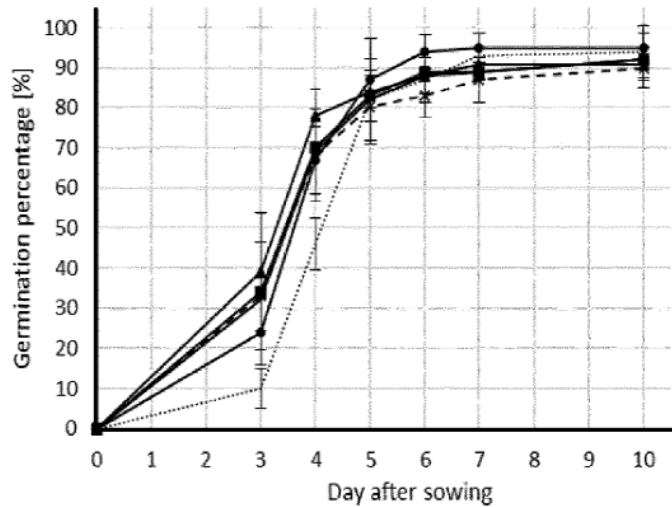
In coculture with nitrate, lipopeptide production by *Bacillus* is down regulated



Trichoderma-Bacillus-nitrate formulation favours tomato seeds germination in hydric stress conditions

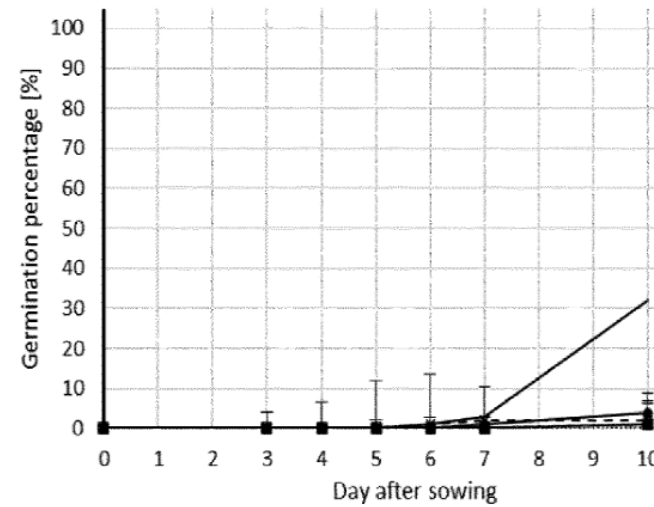
Patent WO2022/207940 A1

Tomato germination kinetics without osmotic stress (0 MPa)



- * - Control
- Sodium nitrate
- B. velezensis FZB42
- ▲— T. harzianum MUCL29707
- B. velezensis FZB42 + T. harzianum MUCL29707
- — B. velezensis FZB42 + T. harzianum MUCL29707 + sodium nitrate

Tomato germination kinetics under high osmotic stress (-0,3 MPa)



- * - Control
- Sodium nitrate
- B. velezensis FZB42
- ▲— T. harzianum MUCL29707
- B. velezensis FZB42 + T. harzianum MUCL29707
- — B. velezensis FZB42 + T. harzianum MUCL29707 + sodium nitrate



Digibiocontrol

Thank you for your attention

Contact details

Coordinator

Digibiocontrol:

Lore Detienne

MiPI, Gembloux Agro-Bio Tech,
University of Liege

Email : digibiocontrol@uliege.be



<https://www.digibiocontrol.org>

Contact général :

Philippe Jacques, Professor,

Chair of Teaching and Research Centre

MiPI, Gembloux Agro-Bio Tech,
University of Liege

Tél. 081/62 24 79

Email: philippe.jacques@uliege.be



Interreg



Cofinancé par
l'Union Européenne
Medegefinancierd door
de Europese Unie

France - Wallonie - Vlaanderen



Biocontrol 4.0

Coordinator

Biocontrol 4.0:

Sigrid Görgen, *PhD*

MiPI, Gembloux Agro-Bio Tech,
University of Liège

Email : biocontrol4.0@uliege.be



<https://www.biocontrol4-0.eu>