PROGRAMME DE COOPÉRATION TRANSFRONTALIÈRE
GRENSOVERSCHRIJDEND SAMENWERKINGSPROGRAMMA

Interreg France-Wallonie-Vlaanderen
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SMARTBIOCONTROL
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SMARTBIOCONTROL
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LES ANTIFONGIQUES, C'EST PAS AUTOMATIQUE... DANS L'AGRICULTURE NON PLUS !

Biological crop protection products: an overview

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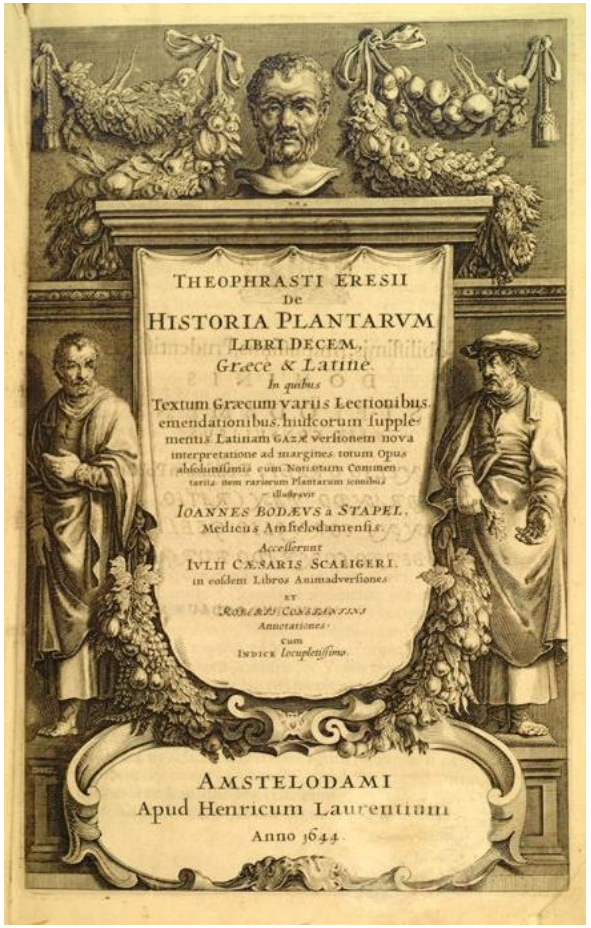
AVEC LE SOUTIEN DU FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL
MET STEUN VAN HET EUROPEES FONDS VOOR REGIONALE ONTWIKKELING

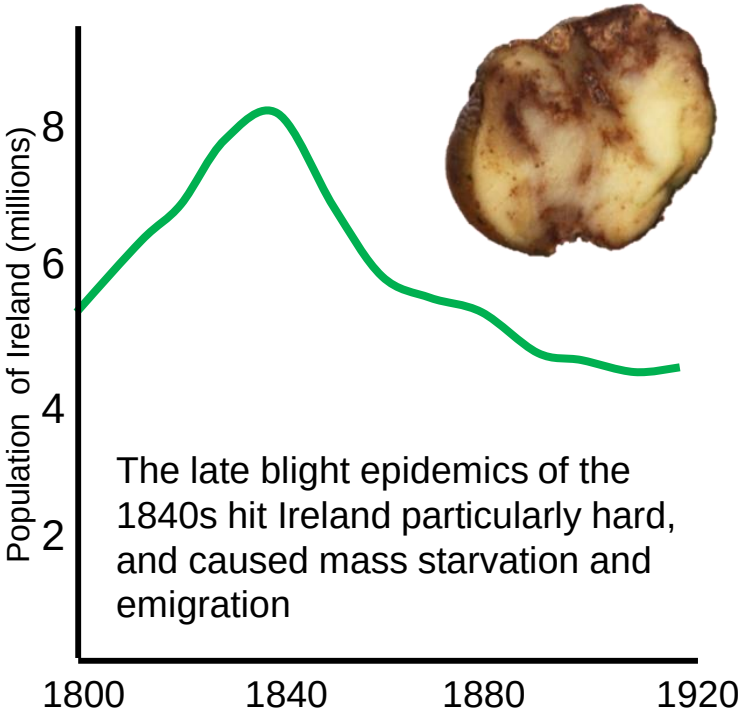
Since agriculture began, humans have struggled with plant pathogens

- Texts describing best practices to avoid plant diseases date back thousands of years

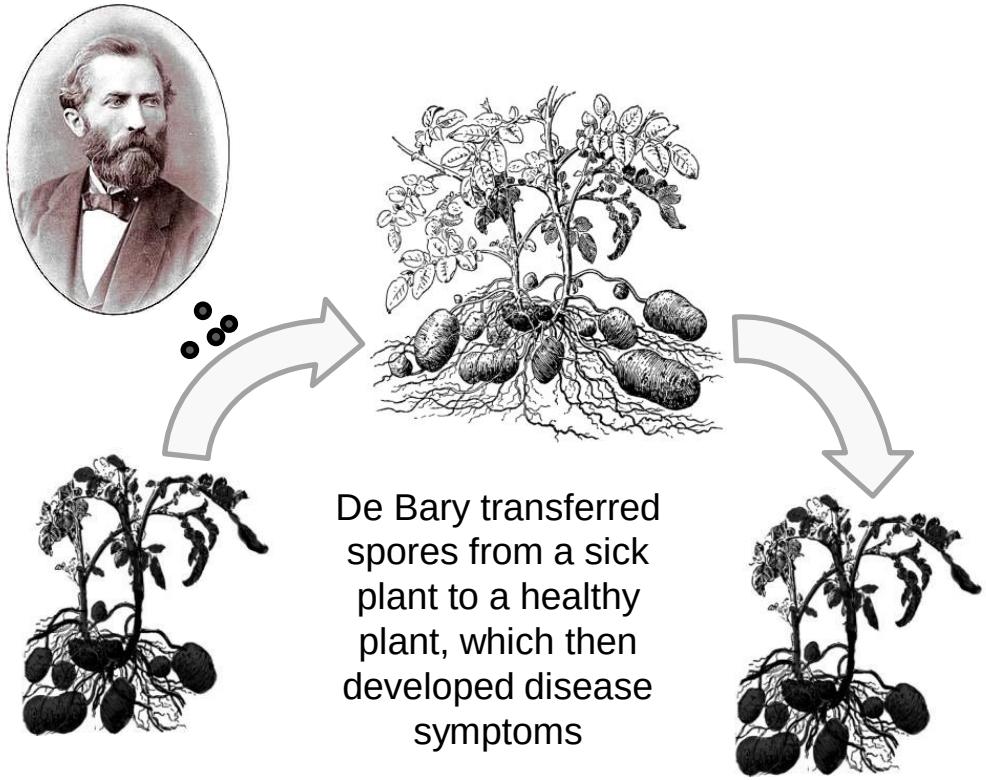


The 19th century - *Phytophthora infestans*, plant destroyer

- An outbreak of potato late blight, caused by *Phytophthora infestans*, led to the Great Famine in the 1840s



The late blight epidemics of the 1840s hit Ireland particularly hard, and caused mass starvation and emigration



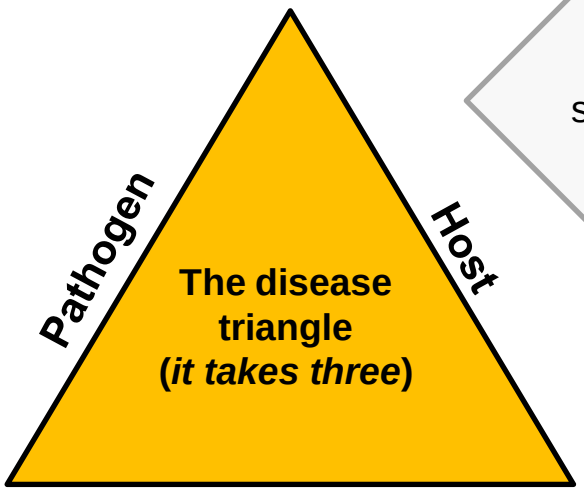
De Bary transferred spores from a sick plant to a healthy plant, which then developed disease symptoms

Plant defense: pathogen recognition

- Plants are exposed to countless microbes, but very, very few of these interactions lead to disease.

The pathogen must be able to overcome plant defenses

Phytophthora colocasiae



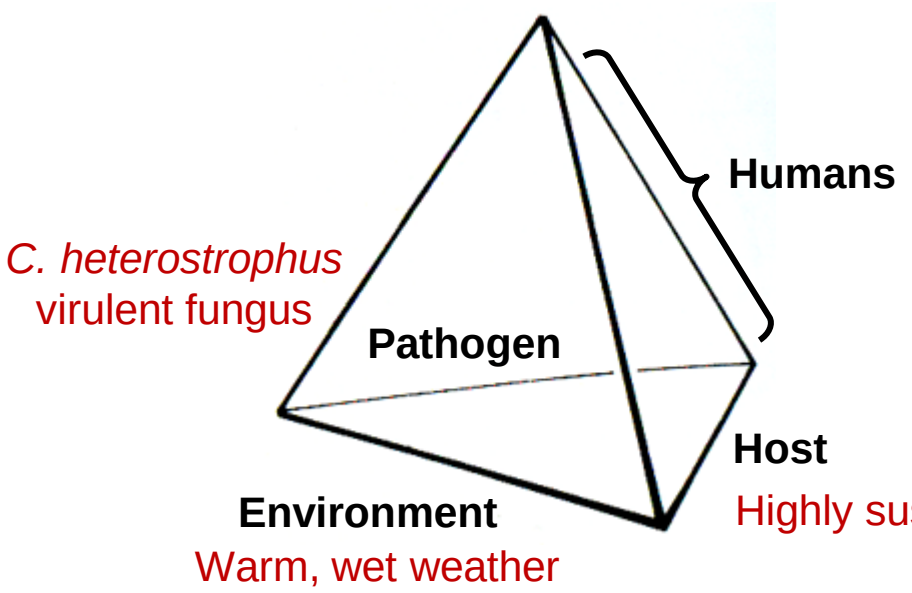
The host plant must be susceptible to the pathogen

Xanthomonas axonopodis

The environment must tip the balance in favor of the pathogen

Southern corn leaf blight epidemic - 1970

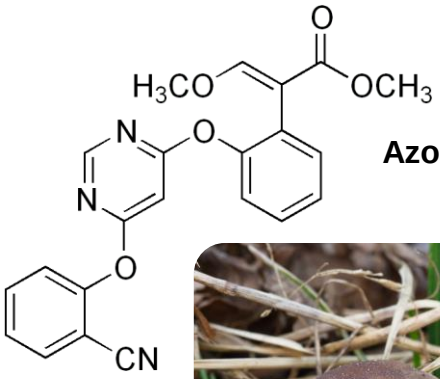
- Although not normally a major pathogen, in 1970 *Cochliobolus heterostrophus* was responsible for the worst epidemic in US agricultural history



Humans add another dimension (migration of people and plants, monoculture, growing practices, …)

Chemical controls critical for eradicating pathogens

- Compounds must be safe and effective, and application protocols must be followed to slow the development of resistance



Azoxystrobin

Strobilurus tenacellus

Because pathogens develop resistance, finding novel compounds to eradicate pathogens is an ongoing process

Integrated Pest Management (IPM)

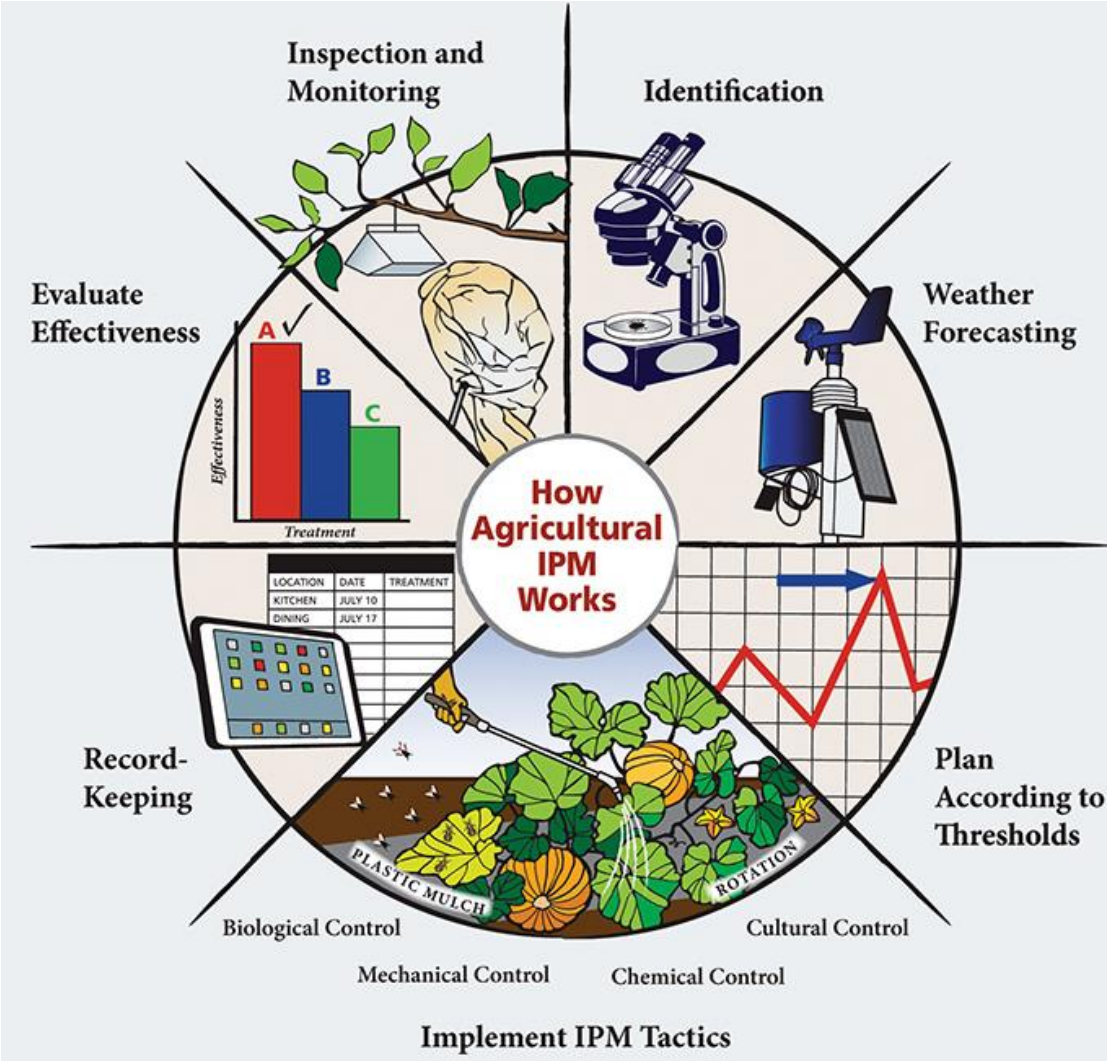
- EU directive 2009/128: all countries have to convert to IPM in agricultural practices, starting from 2014

- IPM “means careful consideration of **all available plant protection methods** and subsequent **integration** of appropriate measures that discourage the development of populations of harmful organisms and keep pesticides and other interventions to levels that are economically and ecologically justified and reduce or **minimise risks to human health and the environment**. IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and **encourages natural pest control mechanisms**.”

Key components of IPM

Prevention and/or suppression of harmful organisms by:

- crop rotation
- adequate cultivation techniques
- use where appropiate resistant/tolerant cultivars
- balanced fertilisation, irrigation/drainage practices
- hygiene measures
- protection and enhancement of beneficial organisms



Biological control

- Biopesticides
  - No official international definition

> Biopesticides are a sub-group within Plant Protection Products (PPP) for which the active substance is derived from a natural product

  - Products based on plant extracts or from animal origin
  - Products which contain a micro-organism
  - Chemical compounds secreted / produced by micro-organisms
  - Pheromones
  - Other biopesticides

  - *Natural enemies*
  - *Biostimulantia*
  - *Basic substances*

Biopesticides

- Advantages of biopesticides
  - No hazardous residues
  - Low chance of resistance development
  - Harmless to beneficial insects, pollinators
  - Ensure worker safety
  - Environmentally friendly
  - Reduce amount of conventional synthetic pesticides needed
  - Can be used in organic and conventional (IPM) agriculture

- Organic culture:
  - The plant protection products which are intended for organic farming form a sub-category of plant protection products to which we can add some products which are not of natural origin, but for which it is traditional to use them in this kind of cultivation (copper, sulphur, etc.).

Products based on plant extracts or from animal origin (1)

- <u>Azadirachtin</u>
  - **Insecticide**
  - Target pests on contact or by ingestion
  - Extracted from the neem tree (*Azadirachta indica*)
  - Oxidized tetranortriterpenoid effective against aphids, spider mites and other insects
  - Mode of action:

Repellency

Anti-feedant

Insect growth regulation

Ovicidal

Products based on plant extracts or from animal origin (2)

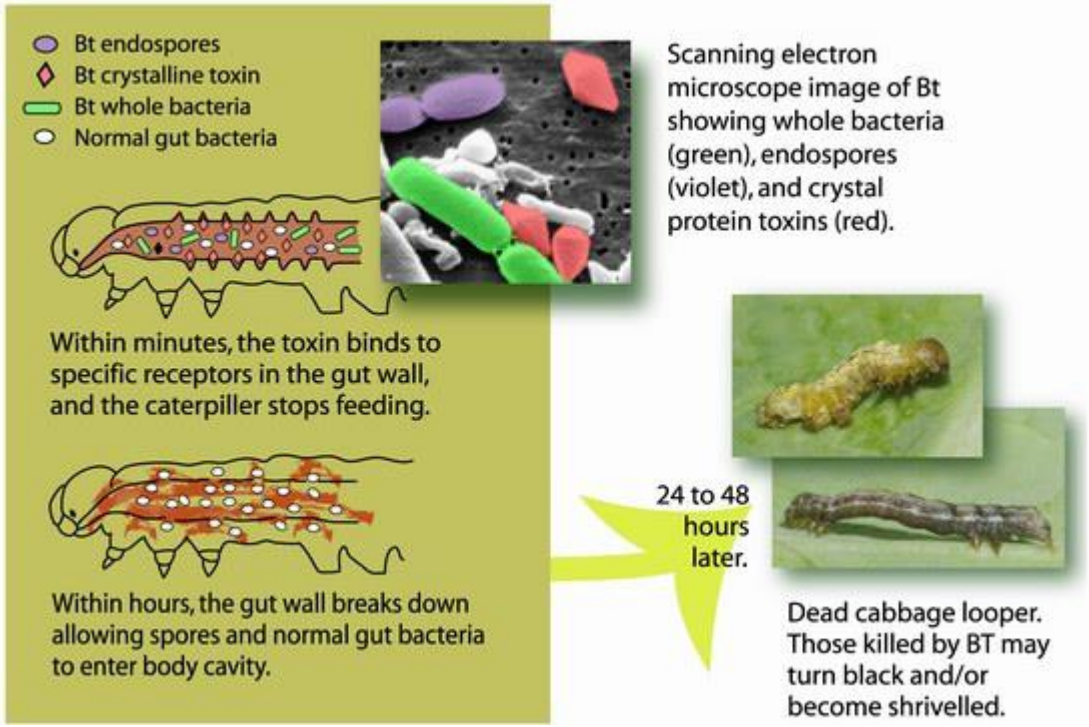
- Pyrethrin
  - **Insecticide**
  - Delay the closure of voltage-gated sodium ion channels the nerve cells of insects
  - Extracted from chrysanthemum flowers (*Chrysanthemum cinerariaefolium*)
  - Effective against a variety of insect pests
  - Often combined with piperonyl butoxide or other synthetic adjuvants
  - Considered to be low-toxicity pesticides from a human health standpoint, however, toxic for aquatic organisms
  - dissipation half-live of less than 24 hours

Products based on plant extracts or from animal origin (3)

- Vegetable oils
  - **Insecticide, acaricide, fungicide and/or inhibiting potato sprouting**
  - Fast knockdown and effective contact action
  - Not persistent in the environment
  - Mint oil (Biox-M)
  - Orange Oil (Prev-Am / Limocide)

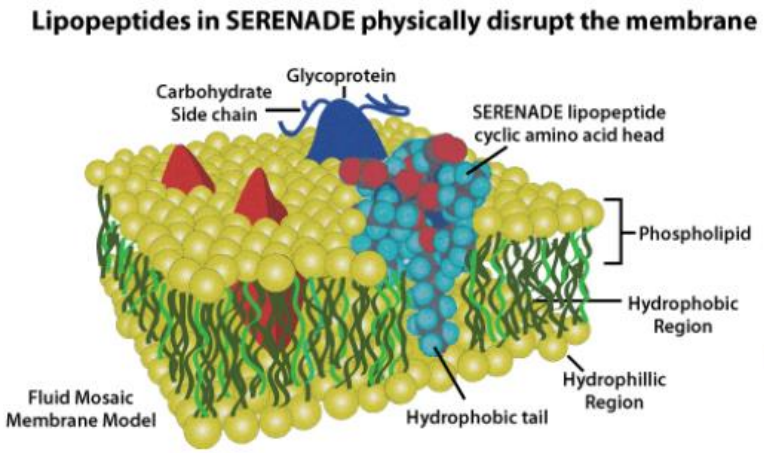
Products which contain a micro-organism (1)

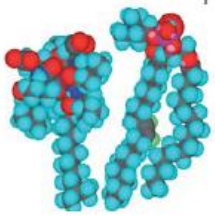
- Bacteria
  - **Insecticides** targeting leaf-eating caterpillars and *Tuta absoluta*
    - *Bacillus thuringiensis ssp. kurstaki* (Dipel DF)
    - *Bacillus thuringiensis ssp. kurstaki SA-11* (Delfin WG)
    - *Bacillus thuringiensis ssp. aizawai* (Xentari WG)



Products which contain a micro-organism (2)

- Bacteria
  - **Fungicides** targeting different pathogens (e.g. Botrytis, Fusarium, powdery mildew, …)
    - *Bacillus subtilis QST 713* (Serenade)
    - *Bacillus amyloliquefaciens ssp. plantarum D747* (Amylo-X WG)
    - *Streptomyces griseoviridis K61* (Mycostop)
    - *Pseudomonas chlororaphis – MA342* (Cerall)

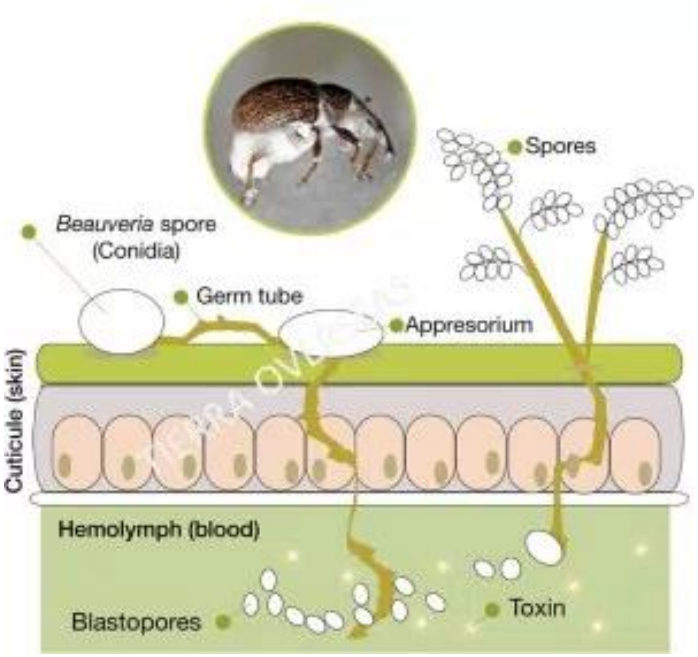




- Lipopeptides mimic cell membrane lipids
- Inserts deeply into membrane
- Conical shape disrupts packing of membrane lipids

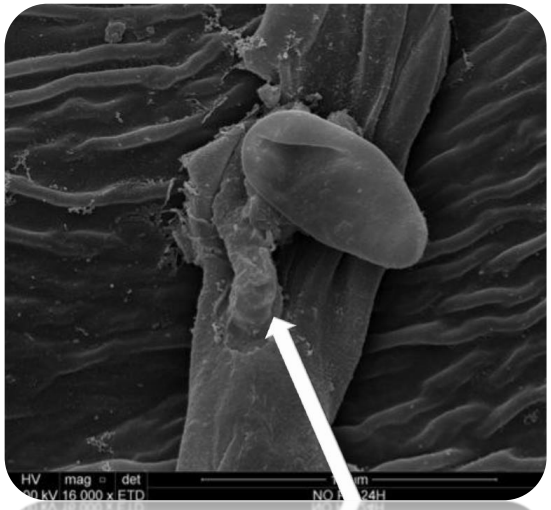
Products which contain a micro-organism (3)

- Fungi
  - **Insecticides** targeting aphids, thrips, whiteflies and more
    - *Beauveria bassiana* ATCC 74040 (Naturalis-L)
    - *Beauveria bassiana* stam GHA (Botanigard 22WP)
    - *Paecilomyces fumosoroseus* FE9901 (Futureco Nofly)
    - *Paecilomyces fumosoroseus* var. *apopka* (Preferal WG)

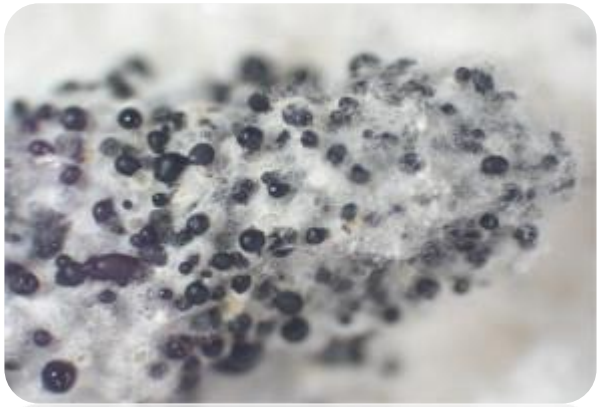


Products which contain a micro-organism (4)

- Fungi
  - **Fungicides** for the control of different fungal diseases
    - *Ampelomyces quisqualis* AQ10 (AQ 10)
    - *Coniothrium minitans* (Contans WG)
    - *Gliocladium catenulatum* J1446 (Prestop)
    - *Trichoderma harzianum Rifai* T-22 & ITEM-908 (Trianum-P en GR)
    - *Trichoderma asperellum strain T34* (Asperello T34 Biocontrol)



AQ 10 penetrates the mycelium of powdery mildew



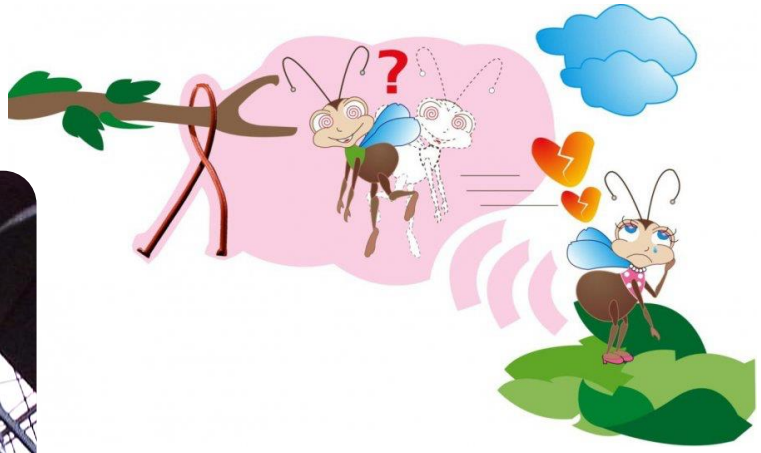
Colonization of *Sclerotinia sclerotiorum* sclerotia by *Coniothyrium minitans* (Contans)

Products which contain a micro-organism (5)

- Viruses
  - Granulose virus (Carpovirusine)
  - **Insecticide** for control of codling moth larvae in apple and pear

Pheromones

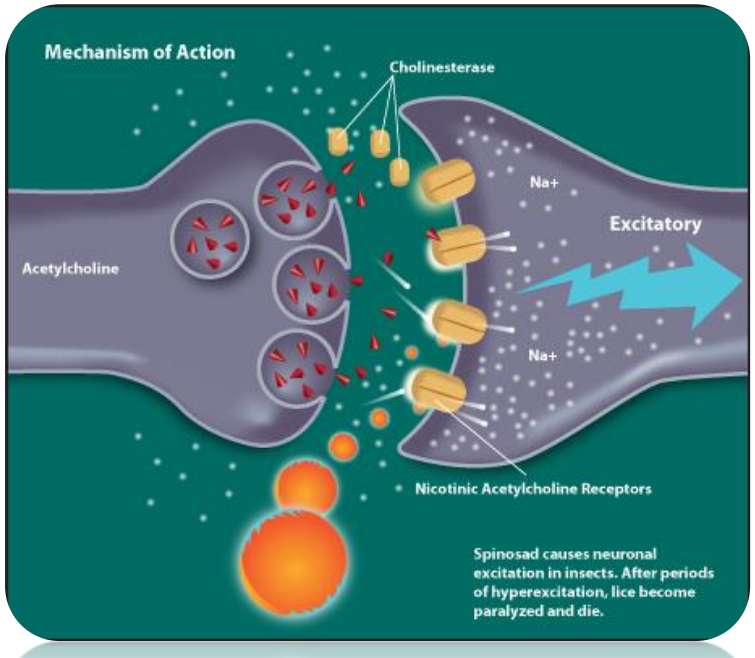
- chemical substances excreted by plants and animals which alter the behaviour of other individuals within the same species.
  - **mating disruption**: the male animal cannot find the female
  - **mass trapping**: trapping technique
  - **attract & kill**: trapping technique of a pheromone in combination with an insecticide
  - **monitoring**



Chemical compounds secreted / produced by micro-organisms

- Spinosad
  - **Insecticide** used to control thrips, leafminers, spider mites, mosquitoes, ants, fruit flies and others.
  - Target pests by both contact and ingestion
  - Obtained by fermentation of *Saccharopolyspora spinosa* (soil-born pathogen)

  - mode of action: to alter the function of nicotinic and GABA-gated ion channels, causing rapid excitation of the insect nervous system, leading to involuntary muscle contractions, tremors, paralysis, and death
  - Spinosad is low in toxicity to people and other mammals



Other biopesticides (1)

- <u>Iron phosphate</u>
  - **Molluscide** used in controlling snails and slugs on food crops and ornamentals at outdoor and indoor sites
  - When the pellets are eaten, the iron phosphate interferes with calcium metabolism in the gut, causing the snails and slugs to stop eating

- <u>Copper</u>
  - **Fungicide**, available in different formulations
  - Traditionnaly used in organic culture
  - Risks of its permanent use
    - accumulation and pollution of soils;
    - high residues in fruits and vegetables
  - controlled use!

Other biopesticides (2)

- Sulphur
  - **Fungicide and acaricide**, available in different formulations
  - Traditionally used in organic culture
  - Regular use can affect beneficial insects

- Potassium salts of plant fatty acids
  - **Insecticide** for the control of aphids, whiteflies
  - works only on direct contact with the pests

- Paraffin oil
  - **Insecticide, acaricide and/or fungicide**
  - the oil film covers and smothers the insect eggs and larvae. It also forms a barrier that can prevent the transmission of certain diseases or the arrival of spores

Other biopesticides (3)

- Potassium hydrogen carbonate
  - **Fungicide, insecticide**
  - Multiple modes of action (Repellent, insecticidal, drying spores)

- Maltodextrine
  - Physically acting **insecticide** with a broad spectrum
  - Plant derived starch combined with vegetable oils
  - Mode of action:
    - coats and dries on the target
    - blocks the spiracles

- COS-OGA
  - **Fungicide**, ellicitor of plant immunity
  - Oligosaccharide: combination of cationic chitosan oligomers (COS) and anionic pectin oligomers (OGA)

Natural enemies

parasitic wasp

gall-midge

predatory bug

lacewing

predatory mite

Entomopathogenic nematodes

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