The use of biopesticides in IPM: lessons from AMBER benchmarking.

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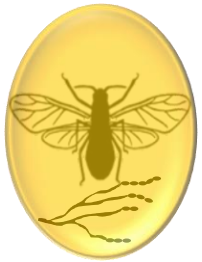


A global revolution in food

- From quantity to quality (healthy foods)

- **Sustainable intensification**:
  - Reduce yield gaps, fertilizer & water use efficiency, enhance biodiversity.
  - Make agriculture a net carbon sink.
  - Halve food losses and waste.

c. 30% global harvest is lost to crop pests

The 1960s Green Revolution: Unsustainable use of synthetic chemical pesticides

- Evolution of resistance
- Environmental damage
- Health concerns

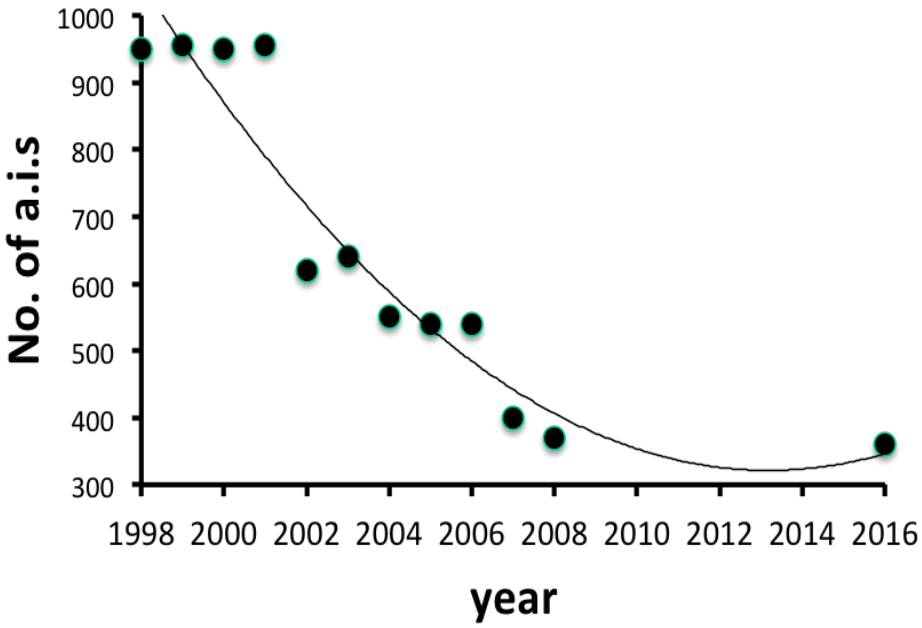
Reduction in availability:

- **Products stop working.**
- **Government restrictions.**
- **Retailer restrictions.**
- **Pesticides – precious resource.**

Pest: invertebrates, plant pathogens, weeds

Background: the number of synthetic chemical pesticides available is declining.

- Tougher safety rules.
- MRLs.
- Retailer pressure.
- Resistance evolution in target P&D.
- Expense of developing new actives.



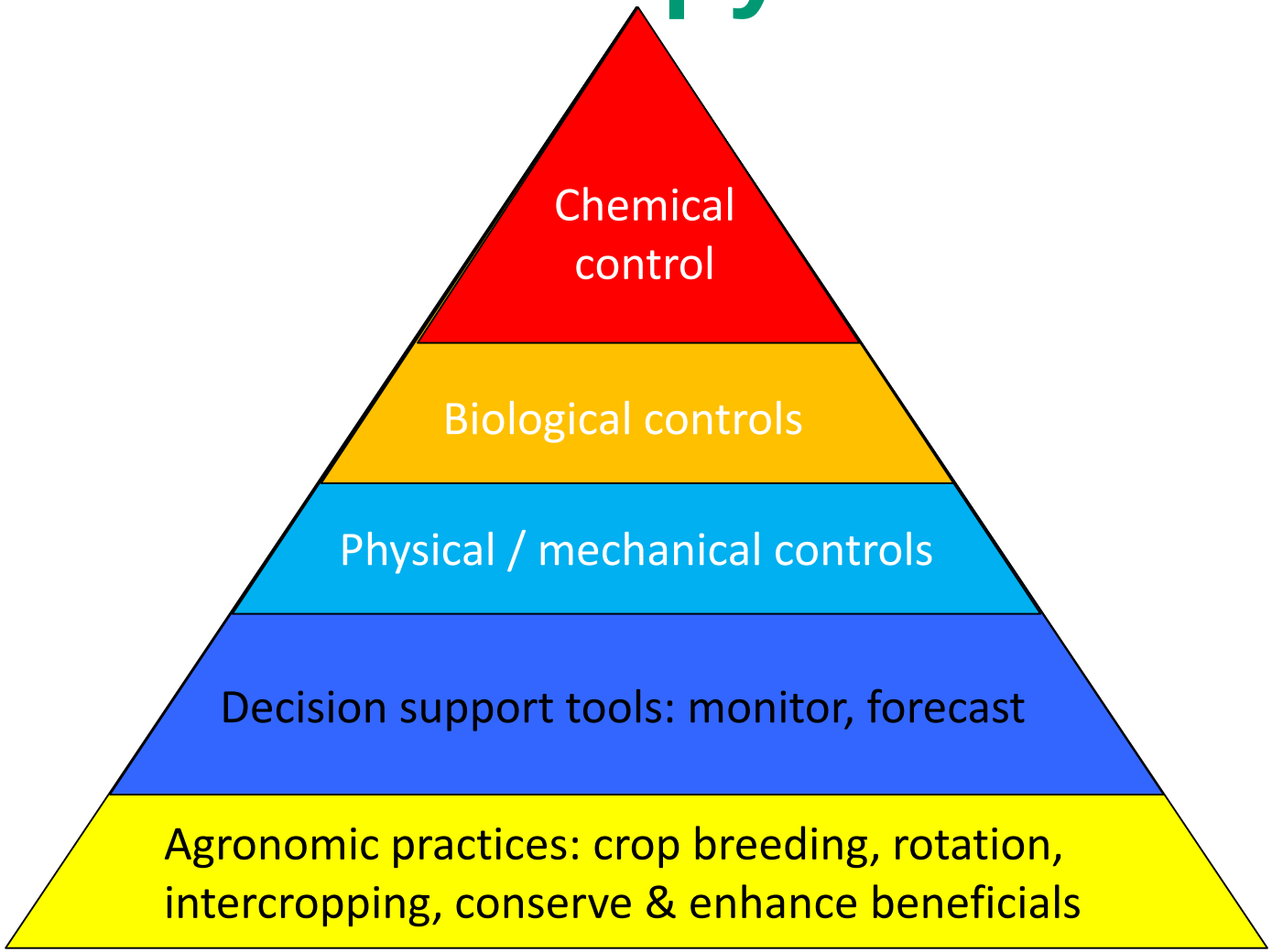
Conventional pesticides approved in EU

IPM is the way forward for all growers

- Integrated Pest Management.
- EU Sustainable Use Directive on pesticides:
  - IPM is mandatory.
  - "biological, physical and other non-chemical controls must be preferred to chemical methods if they provide satisfactory pest control."

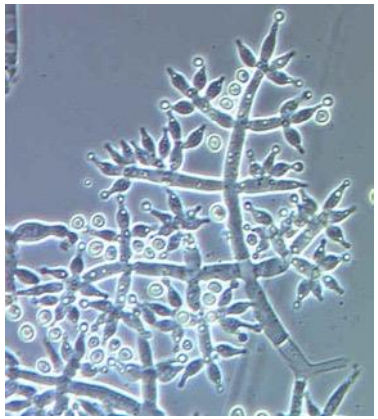
Increase in availability of biopesticides for IPM

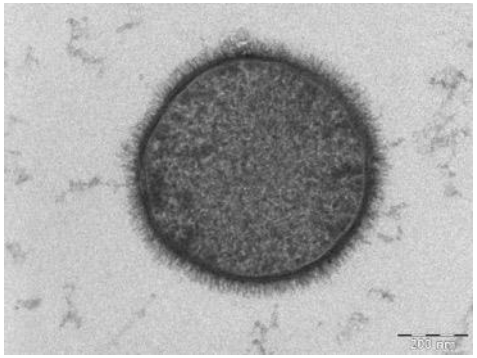
The IPM pyramid



What are biopesticides?

- Plant protection products based on:
  - Living microbes.
  - Natural products: e.g. plant extracts (botanicals), insect sex pheromones etc.
- Regulatory authorization.
- Formulated, packaged etc.
- Sprays, drenches, granules.

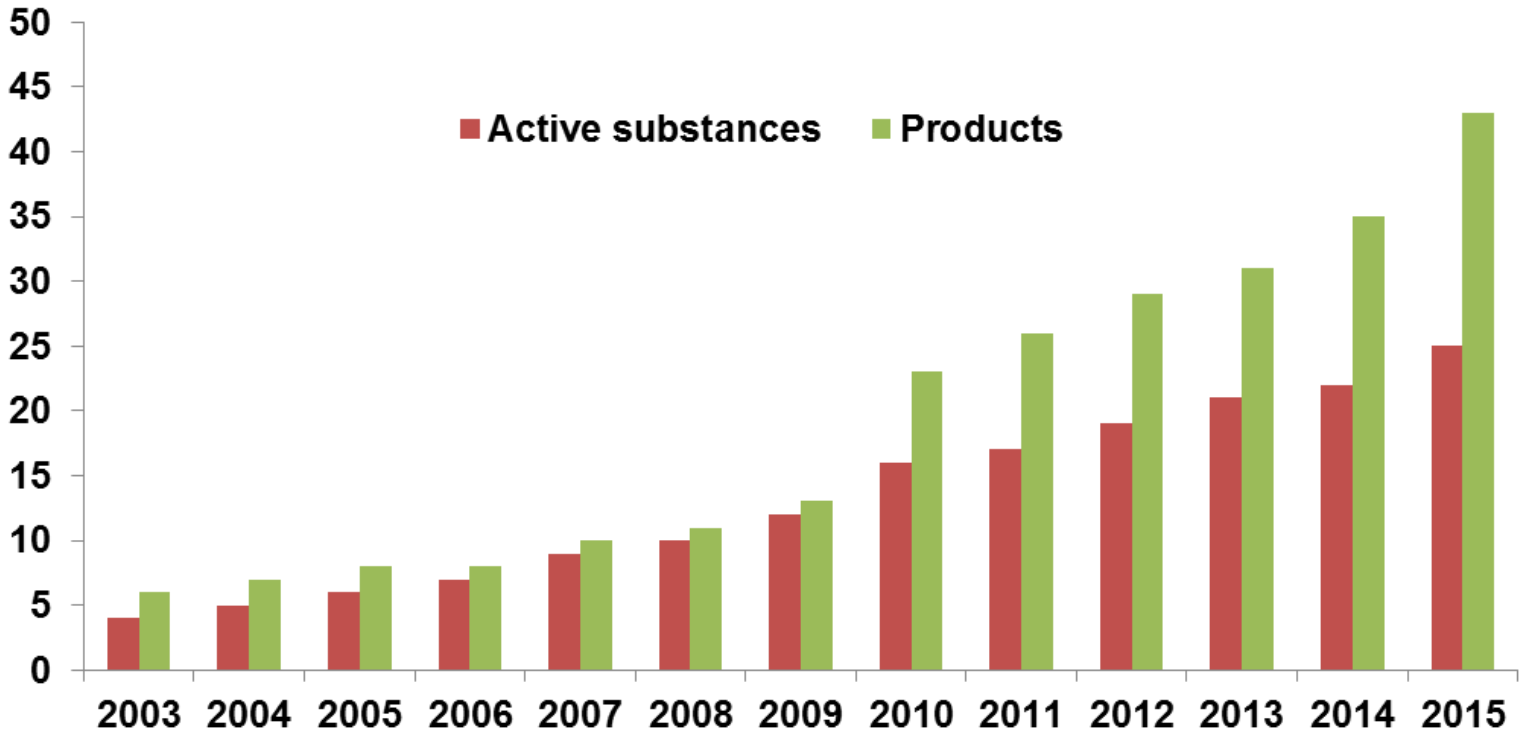




Protected edibles (salads, soft fruit)

- Microbial biofungicides
  - Preventative (e.g. PreStop, Serenade)
  - Curative (e.g. AQ10).
- Microbial bio-insecticides
  - Fungi (e.g. *Beauveria*, *Metarhizium*)
  - Bacteria (Bt).
  - (Nematodes).
- Plant extracts
  - Fatty acids (e.g. Flipper)
  - Volatile oils (in regulatory system).

The number of approved biopesticides is rising



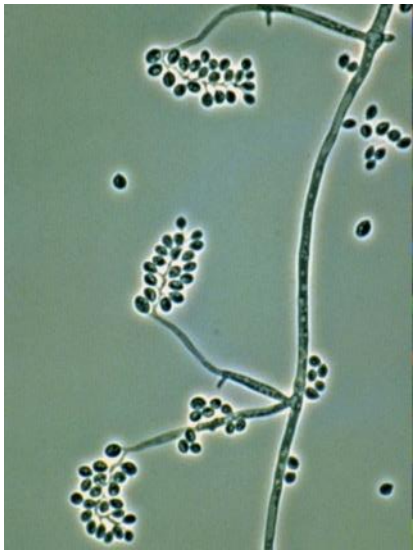
Cumulative no. biopesticides in UK (2003-2015) CRD

Biopesticides: pros and cons

- Safe to people and environment.
- MRL exempt.
- Low harvest interval.
- Spray, drench etc.
- Can work well in IPM – reduce dependency on conventionals.

- Slower acting.
- Many have contact action – so not systemic.
- Lower persistence.
- Lower efficacy.
- Environmental conditions.

Spider mites: Fungal pathogen combined with predators.



Biopesticides: UK experience

- Growers want to use biopesticides. Increasingly important tool.
- Some products reliable. Others give inconsistent results.
- More knowledge needed with these new products.
- How to use in IPM on many different crop types?

The AMBER challenge

- Capture the benefits of biopesticides and mitigate for their downsides.
- Do this by changing grower practice.
- Need **generic tools & practices**:
  - Different crop types.
  - Different P & D.
  - Different biopesticides.
  - Address gaps in knowledge (don’t reinvent the wheel).

The AMBER project

- **A**pplication & **M**anagement of **B**iopesticides for **E**fficacy and **R**eliability.
- PE, PO & HNS crops: but the results are also applicable to soft fruit (similar P&D issues, growing conditions).
- Identify the reasons why biopesticides can be inconsistent.
- Develop management practices to rectify this.

AMBER: how it works

Speak with growers, suppliers, manufacturers

Benchmark biopesticide performance

Identify areas where performance could be improved

Develop improved practices

Knowledge Exchange

Biopesticide ‘benchmarking’

- Observed how growers used biopesticides as part of IPM.
- Followed product guidelines.
- Identify practices that were likely to affect biopesticide performance (across different crop types).

Biopesticide benchmarking

- **Chrysanthemum** (*Beauveria* vs. thrips)
- **Peppers** (*Beauveria* vs. aphids)
- **Cyclamen** (*Gliocladium* vs. botrytis)
- **Choisya, dianthus** (*Trichoderma* vs. root rots)
- **Cucumber** (*Ampelomyces* vs. powdery mildew).

- Natural P&D infestation. Crop scale.
- Try to compare with a standard (pesticide or BCA).
- No untreated control.
- NOT an efficacy trial.

Biopesticide benchmarking

Data collected:

- *Product storage;*
- *sprayer performance, pressure, water volume, concentration;*
- *deposition on the crop;*
- *effect of spray on product viability;*
- *persistence;*
- *amount of P/D control;*
- *environmental conditions;*
- *non-target effects;*
- *phytotoxicity.*

Organic pepper; *Beauveria* & Majestik vs aphids; semi-automated vertical boom.

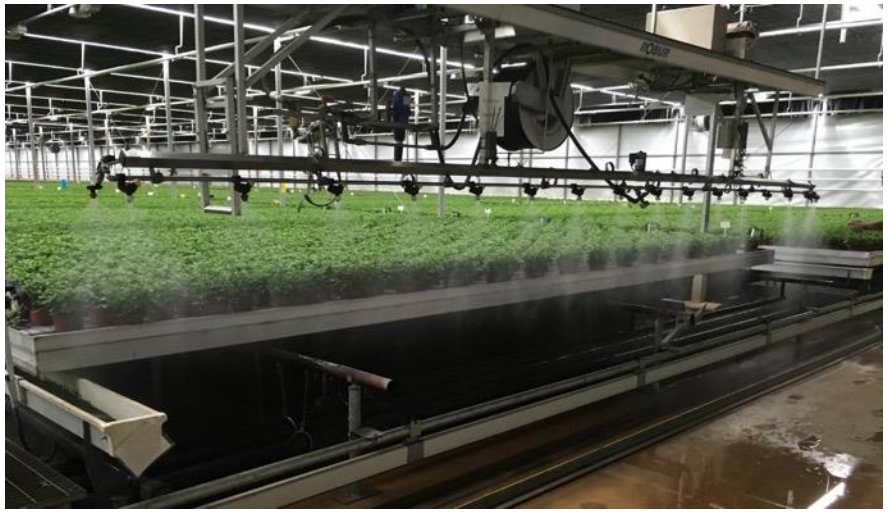
Aphid population v. high at start (fast growth rate).
No control. High volume.

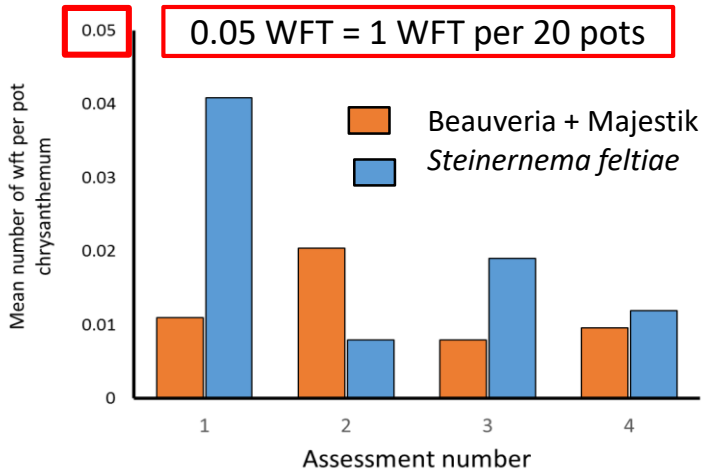
Cucumber: Ampelomyces vs powdery mildew; Vertical boom, manually operated.

- Acceptable disease suppression on variety with intermediate resistance.
- Concerns about tank residue effects on biofungicide.
- High volume application. Uneven distribution on crop.
- When to apply?

Chrysanthemum: Beauveria vs western flower thrips; automated horizontal boom.

WFT control same for Beauveria & nematodes. WFT v. low overall. Good application.





Cyclamen: Gliocladium vs Botrytis; Ripa gun.

- Gliocladium better than fungicide standard (Rovral & Amistar). But control could be better. Estimated vol. 3000 l per ha.
- Week 1 (plants with Botrytis): Standard =60%; Gliocladium = 28%.
- 2 weeks after 3rd spray: Standard = 84%; Gliocladium = 56%.

Dianthus & Choisya: Trichoderma vs root rots; Drench with a hand lance.

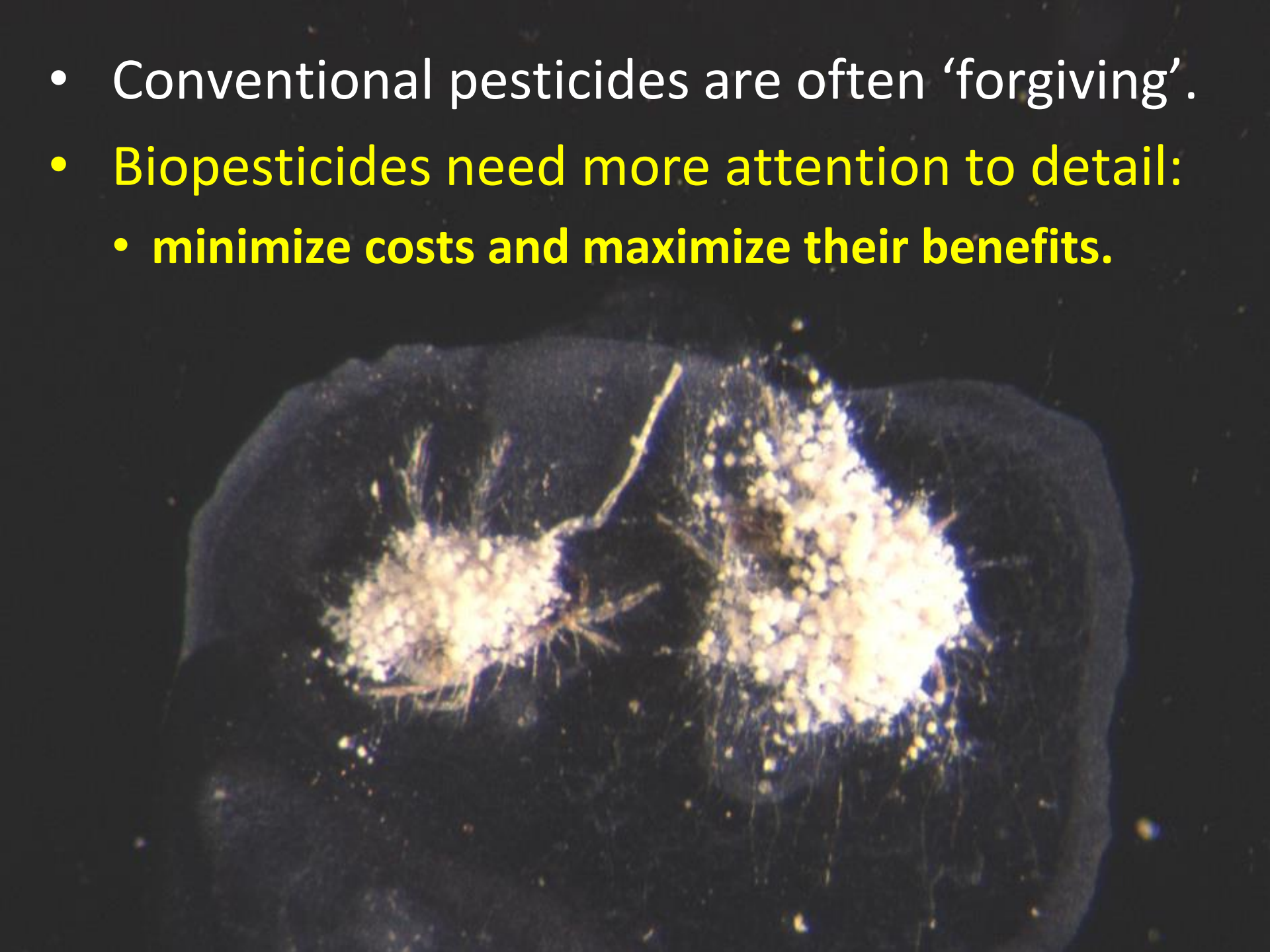
- No difference in Trichoderma and fungicide standard.
- High volume application (10% pot volume).

What did we observe?

- Benchmarked products varied in performance.
- Labels hard to follow: suppliers provide extra guidance.
- Issues with application*:
  - High volume (run-off; takes long time).
  - Change nozzle. Tank cleaning. Calibrate sprayer. Better sprayers available.
- Effective dose – how much product do you want on the plant, where & when?*
  - Biofungicides – preventative or parasitic? Timing is critical.
  - Biopesticide efficacy links to pest population growth rate & size.

* New knowledge needed – AMBER is working on these.

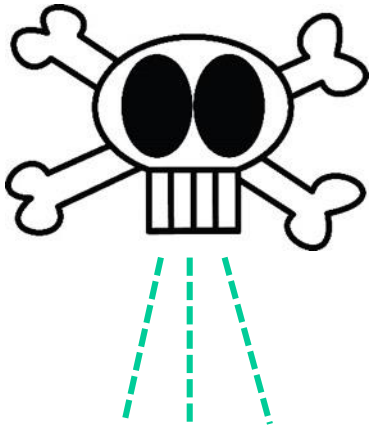
- Conventional pesticides are often ‘forgiving’.
- Biopesticides need more attention to detail:
  - **minimize costs and maximize their benefits.**



Effective application

(contact acting)

Right dose



Right place & time

Avoid waste

Biology of pest, disease & M.o.A. biopesticide

Environment; other IPM tools

Benchmarking: 2 key lessons

- They are connected.
- Both rely in new knowledge to help get the best out of biopesticides.
- Emphasis on attention to detail.

Lesson 1: They don't like it up 'em!

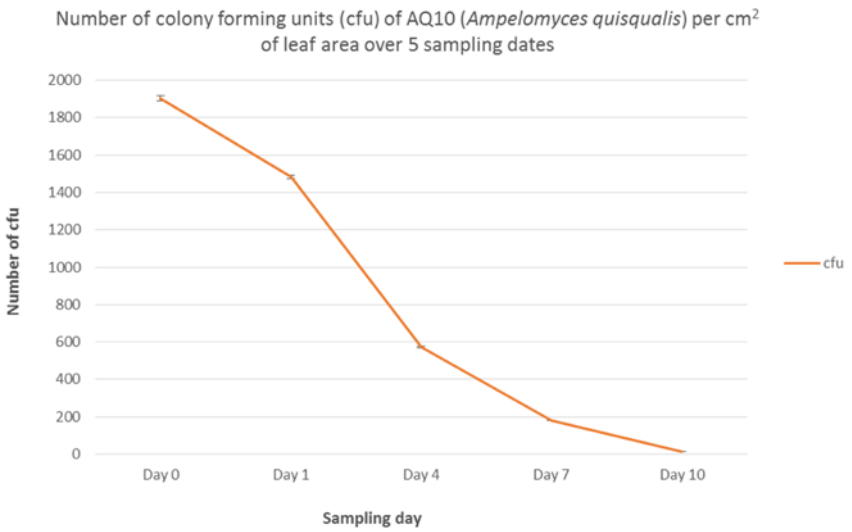
Efficiently deliver an effective dose to the target

Optimize water volume

Get the best from your sprayer

Lesson 2: timing is everything (a).

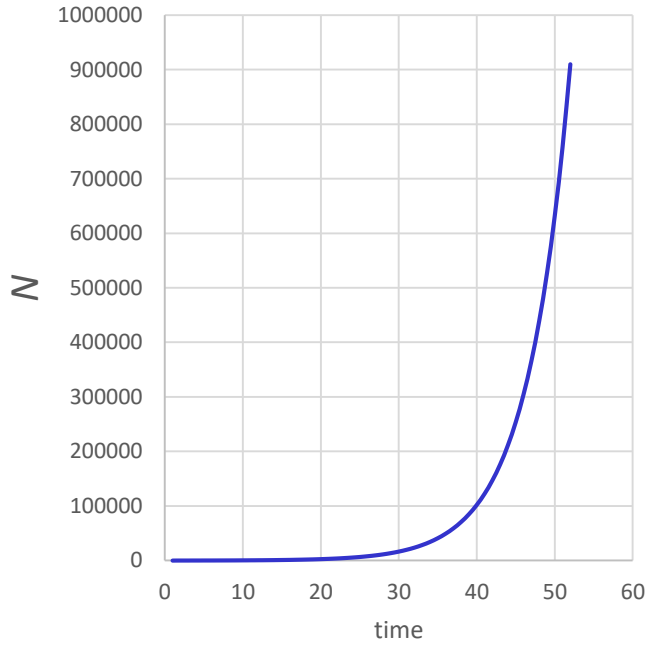
- Understand the mode of action of the biopesticide …
- …as it relates to the biology of the pest / disease.



- AQ10 is a parasite of powdery mildew.
- It does not persist long in the absence of its host.
- When is the best time to apply it? **The ‘Goldilocks’ zone**.

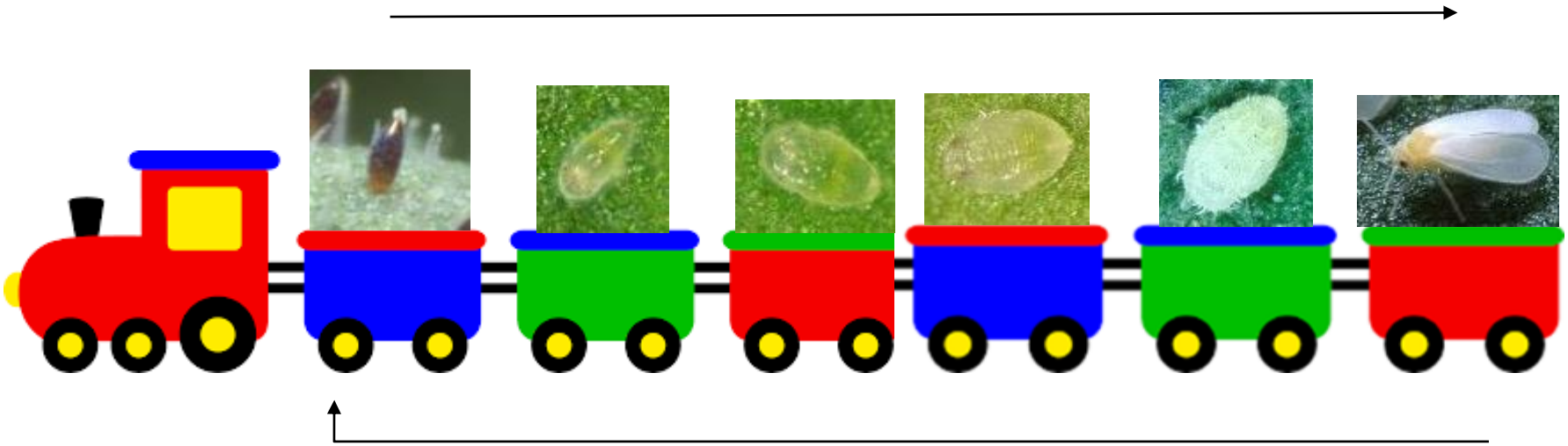
Lesson 2: timing is everything (b).

- Pests show exponential growth.
- BP efficacy affected by speed of kill, pest growth rate & population size.



- How does pest growth rate, speed of kill, crop type etc. determine the best application strategy?
- The Goldilocks zone again.

Biopesticides & pest population growth

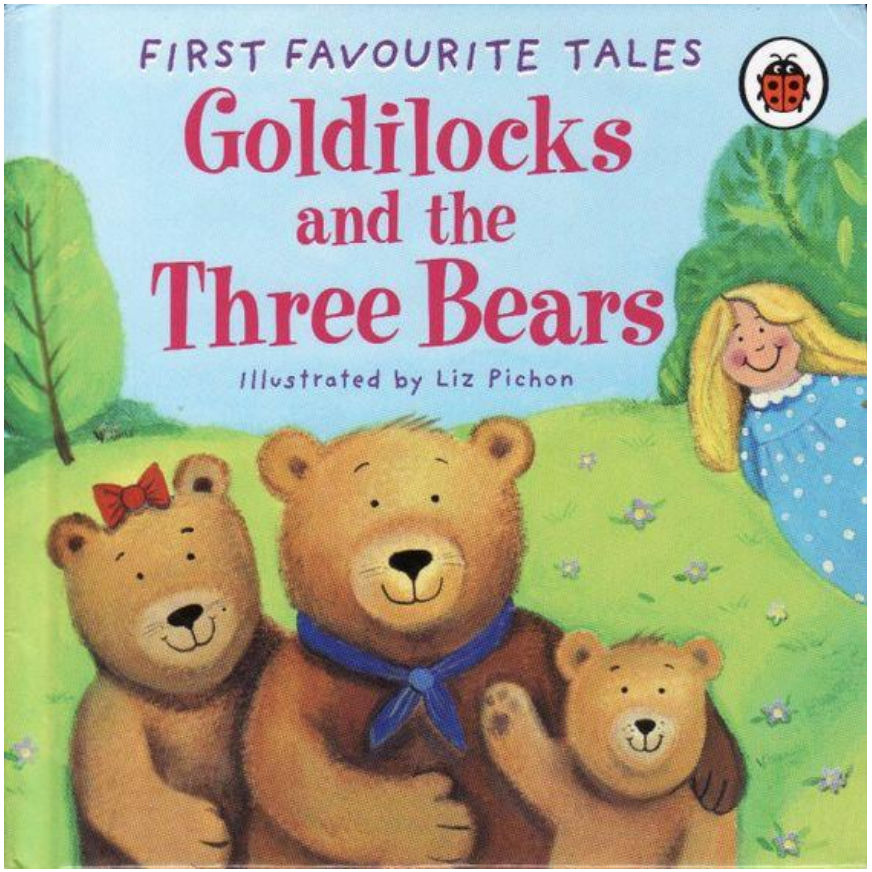


- Biopesticide - pest ‘race’: kill pest before it reproduces.
- Use models to inform best biopesticide strategy for particular pests & crops (when to apply, what product type.)

What have we learned to date?

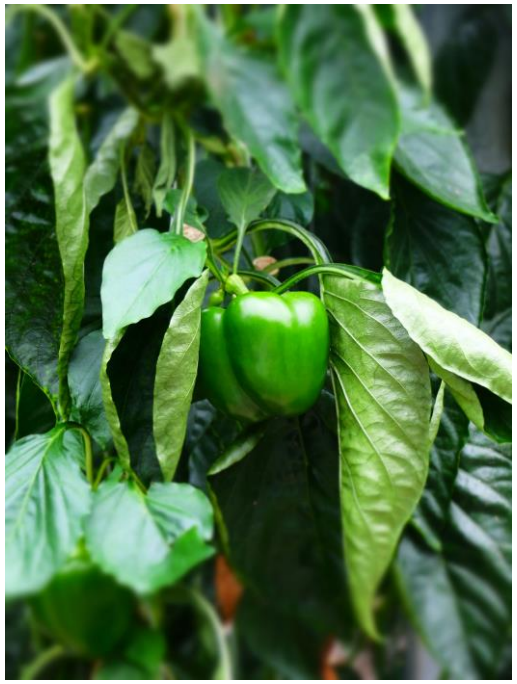
- Biopesticide use requires knowledge on the biology of P&D, the mode of action of the biopesticide, the delivery mechanism.
- Applies to all biopesticides, all crops, all IPM systems.
- Deliver this underpinning knowledge through AMBER.

Which translates to …



Getting it right

- Right Kit.
- Right Amount.
- Right Place.
- Right Understanding.
- Right Time.
- This applies across crop types, (PE, leafy salads & soft fruit).



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AMBER

Thanks for your attention

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