How can we help growers get the most out of bio-fungicides? The AHDB AMBER project.

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• Project aims.
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• 2 areas relevant to biofungicides: spray application & timing.
• What messages are we giving to growers?

Creating effective production systems

- **Precision Agriculture for Input and Water Use Optimization**
  - Reduce farmers’ costs by up to $100 billion
  - Increase production by up to 300 million tonnes
  - Reduce freshwater withdrawals by up to 180 billion cubic metres

- **Gene-Editing for Multi-Trait Seed Improvements**
  - Generate up to $100 billion in additional farmer income
  - Increase production by up to 400 million tonnes
  - Reduce the number of micronutrient deficient by up to $100 million

- **Biological-Based Crop Protection and Micronutrients for Soil Management**
  - Increase production by up to 50 million tonnes
  - Reduce GHG emissions by up to 5 megatonnes of CO$_2$ eq.

- **Off-Grid Renewable Energy Generation and Storage for Access to Electricity**
  - Generate up to $100 billion in additional farmer income
  - Increase production by up to 530 million tonnes
  - Reduce freshwater withdrawals by up to 250 billion cubic metres

- **Microbiome Technologies to Enhance Crop Resilience**
  - Generate up to $100 billion in additional farmer income
  - Increase production by up to 250 million tonnes
  - Reduce GHG emissions by up to 30 megatonnes of CO$_2$ eq.
Biologics / biopesticides in horticulture: UK grower experience

- Increasing products on market
- Growers want to use them
- Test them out
- Some products useful
- Others poor / inconsistent
- Reasons unknown
- Lack of knowledge on how best to use
The AMBER project: an overview

- Application & Management of Biopesticides for Efficacy & Reliability.
- PE, PO & HNS crops. Microbial biopesticides.
- Identify the reasons why biopesticides can be inconsistent.
- Develop generic management tools and practices to improve performance (all crops, all pests / diseases!) –
  - a very broad project.
Biopesticides in commercial practice: benchmarking trials

Observed growers using microbials on crop scale.

• Natural P&D outbreaks.
• Followed best practice guidelines.
• Compared to standard treatment if possible.

5 fungal BCA products

6 commercial growers

7 crops (pepper, cucumber, 5 ornamentals)

3 pests (aphids, thrips, whitefly)

3 diseases (mildew, botrytis, root rots)

Detailed quantitative & qualitative information on biopesticide / grower performance

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.
Observations of biofungicide performance in Amber

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

- Acceptable disease suppression on variety with intermediate resistance only.
- Concerns about tank residue effects on biofungicides?
- High volume application. Uneven distribution on crop.
Cyclamen: *Gliocladium* vs *Botrytis*; Ripa gun; Brinkman 200l tank sprayer


- *Gliocladium* gave more control than fungicide standard. Control could be better in both cases.

- Week 1 (plants with *Botrytis*): Standard = 60%; *Gliocladium* = 28%.

- 2 weeks after 3rd spray: Standard = 84%; *Gliocladium* = 56%.

- Estimated vol. 3000 l per ha.
Dianthus & Choisya: *Trichoderma* vs root rots; Drench with a hand lance.

- No difference in *Trichoderma* and fungicide standard.
- High volume application (10% pot volume).
- Better root growth with Previcur Energy.
Overall, across all biopesticides, what did we learn?

• Performance varied, from zero control, to better than conventional pesticides.

• All products had potential to give much better control.

• Application was poor (with 1 exception). Targeted, precision application needed, but the tools / knowledge are not yet available or in use (deliver effective dose, right time, right place).
What else did we find?

- Labels hard to follow.
- Lack of accessible ‘underpinning’ information (effective dose, persistence, environmental conditions etc.). *Companies addressing this now.*
- Growers need better knowledge (mode of action, storage, preparation, compatibility etc.).
- Spray equipment not fit for purpose (1 exception).
- Water volumes too high (run-off, inefficient).
AMBER: work areas

• Making *spray application* more efficient.

• Measuring biofungicide *persistence* to improve timing of application.

• A Boxcar *model of insect pest growth to* inform bioinsecticide use strategy.

• *Thermal time model* to predict bioinsecticide efficacy at fluctuating temperatures.

• Improved *data recording template* for biopesticide trials.

• Forward look – how decision support & precision application will impact on biopesticide management.
Knowledge exchange

• Grower articles.
• Talks and workshops for 9 crop sectors.
• Application workshops (> 100 growers / agronomists).
• Website, YouTube
Biopesticide spray application workshops

• Correct storage, mixing, tank washing.
• Principles of good spray application (water volumes).
• Peer to peer discussions led by grower ‘pioneers’.
Spray application is a critical factor

- Biopesticides are not ‘forgiving’. If spray application is poor, they are likely to fail.

- Water volumes are usually too high: inefficient to apply, with loss of product through run off.

- For best results, control the water volume to achieve the highest concentration of biofungicide on the leaf surface.

- Many people still believe high water volume is best. The truth is more complex.
Silsoe Spray Applications Unit: spray water volumes (tracer dye, track sprayer, constant dose) – short crop

- Dye is more dilute at higher volumes.
- Deposit = mean amount per g leaf tissue.
- V low volumes, not all leaves are sprayed.
- Higher volumes, leaves are saturated & run off occurs.
Tracer dye studies: On short crops, horizontal boom

• Amount of active substance deposited on the plant is sensitive to volume.

• Product applied at a constant dose: maximum active substance = lowest water volume (but do not exceed max label concentration).

• Product applied at a constant concentration: the max volume = 1000 L/ha, but for smaller plants it is better to go 500 L/ha.
Tracer dye: On tall crops, vertical boom

• Amount of active substance deposited on the plant is relatively insensitive to volume.

• Product applied at a constant dose: choose low water volume to make application time efficient.

• Product applied at a constant concentration: the max volume = 1000 - 1500 L/ha.

• Silsoe calculator: converts volume needed for vertical crop into volume applied per floor area. Ensures label recommendations aren’t exceeded.
Biofungicide persistence determines application strategy

- CFUs of *G. catenulatum* on foliage of tomato plants.
- Sampled for up to 14 days after application of Prestop WP to leaves with no host disease present.
Poor survival of *Ampelomyces* in absence of host

- Used to inform a smart decision support system

Some grower users thought *Ampelomyces* was a true preventative

Narrow use window
Integration with conventional fungicides

• Not stand-alone products. Use them to reduce conventional fungicide applications.

• Knowledge gaps about fungicide compatibility.
  • Safer to have separate tanks.

• But there are reports from scientific literature of co-application with compatible fungicides, giving superior control:
  • Trichoderma.
  • Bacillus and azoxystrobin
  • These are experiments. We need to check them out.

• Use biofungicide in a programme to reduce the number of conventional fungicide applications.
Biopesticides have a critical role in future crop protection – but we must use them better

- Assess performance under real world conditions. Why do they work / not work?
- We still think of them as like-for-like replacements of conventional pesticides.
- Precision spray application. New equipment. Deliver effective dose, right place, right time.
- Smart decision support (predictive modelling, IoT sensors, cloud computing, dashboards).
- Identify synergies within IPM (e.g. with durable plant resistance, plant vaccination, natural enemies).
Advice for growers & agronomists

- Use biofungicides in a programme to reduce total number of conventional fungicide applications.

- Measurable, incremental improvements in management practice rather than a ‘giant leap’.

- Combine with other IDM tools (cultural control, environment management). Smart decision support.

- Biofungicides work differently to conventional fungicides. They are less forgiving and require much more attention to detail.

- Take into account the modes of action. Consider compatibility with other products.

- Good spray application is critical. Efficacy is dose dependent; deliver highest dose of product per unit area of foliage. Lower water volume is best. Label reform needed.
Don’t forget why we are doing this...

- Helping growers achieve sustainable production of quality food & ornamentals.
Thankyou

Google ‘amber biopesticides’