Macro-organisms for biological control

... why biological control agents work – how and when?
Sustainable Use Directive – alternatives & IPM

- Monitoring
- Crop botany
- Agro-ecosystem

- IPM
  - Synthetic Chemical pesticides
  - EPN
  - Predatory mites
  - Insects
  - Fungi
  - Bacteria
  - Virus
  - Micro-organisms
  - Biorationales
  - Botanicals
  - Semiochemicals
Production of beneficial insects

- Cultured on plants on host under controlled conditions
- Grown on artificial diets – insectaries
- Distributed live, usually on-time delivery to order

Production of entomopathogenic nematodes

- Grown in vivo, solid or liquid fermentation
- Separated from host or media
- Reduced active water
- Formulated
- Cold stored
Macrobial use

Macrobials used in both glasshouses and field crops

~150 species regularly used in Europe

Globally >2000 natural enemy species introduced
  • into most countries
  • against >5,000 invasive insect pest species

Used in most crops
Macrobial commercial products

Value of natural pest control by insects in the USA = $4.5 billion per year

Economic potential of single products often does not exceed € 0,2 mio

High costs compared to market potential

Limited shelf life requires high demanding distribution logistics
Globally, top 10 of macrobials used in greenhouses (turnover)
Natural forces control populations

Without natural control, one cabbage aphid = 250 million tonnes of offspring in a year!

Factors that naturally limit populations:
- Density independent factors (e.g. climate).
- Density dependent factors:
  - Competition for limited resources between individuals of the same species.
  - Competition / antagonism with other species.
  - Being eaten/parasitised/infected by other species.

Information and photo: courtesy of D. Chandler, Warwick Crop Centre and eplantswholesale.com.au respectively.
Strategies to use macrobials

- Compared to nature, cropping systems are less stable.
- Often populations of the naturally occurring macrobials are too small or develop too late to prevent plant damage.
- Management intervention needed

Macrobials can be harnessed in agriculture by:

- Introduction
- Conservation
- Augmentation
Strategies to use macrobials - Introductions

- The intentional introduction of an exotic biological control agent for permanent establishment and long term pest control
- Based on the ‘natural enemy release hypothesis’
- Also called classical control

1868: Cottony cushion scale, *Icerya purchasi*, accidentally introduced to California citrus orchards.

1886: Nearly destroys citrus farming.

The scale came from Australia. 2 natural enemies imported:

- A parasitoid *Cryptochaetum* (12,000 released),
- A true predator, the vedalia beetle *Rodolia cardinalis* (500 released).

Beetle spread rapidly, controlled the scale by 1890. Still working now.

Parasitoid took longer to establish. Effective on the coast.
Strategies to use macrobials - Conservation

Actions that preserve or protect natural enemies that are already present.
  – Habitat manipulation to attract and retain natural enemies.
Strategies to use macrobials - Conservation

Adding floral resources to vineyards in New Zealand

- Growing flowering plants between vines attracts & retains parasitoids of leafroller caterpillars.
- Now used by 80 wine growers in New Zealand.
- Wine marketed as ‘environmentally friendly’.
- www.waiparawine.co.nz

Strategies to use macrobials - Augmentation

- Intentional release of a species of macroorganism that occurs already within the area, region or country of use.
- The idea is that the resident natural enemy population is too low to control the pest, so it has to be ‘augmented’.
- The introduced population expected to reduce to the carrying capacity of the agro-ecosystem.
- Inundative or Inoculation

*Encarsia formosa*  *Phytoseiulus persimilis*  *Trichogramma* spp.
Strategies to use macrobials - Augmentation

Population

Time

Biopesticide 1

Biopesticide 2

Damage threshold

0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00
Strategies to use macrobials – Augmentation products
Strategies to use macrobials – nematodes
Strategies to use macrobials - Future

- Can we get augmentation biocontrol to work better and be adopted more in outdoor crops?
- Make best use of ecological features of macrobials
- Better integration within IPM
- Better understanding and use of conservation control

- Knowledge transfer to advisors, farmers, consumers
  - New technology - education
  - New way to grow plants - agronomy
  - Description of benefits – new way of crop protection
Regulation of macrobials

Ratifications: (# 194) Almost all EU countries, S-AM, (USA)

1 Conservation of Biological diversity
“prevent the introduction of all alien species and, when prevention fails, to control as far as possible species that threaten indigenous ecosystems, habitats or species”

2 Sustainable use of biological components

3 ABS (Access and Benefit Sharing)
Regulation of macrobials - EU status

Implemented (16)  In preparation (3)  No regulation
Regulation of macrobials

Identify risks of introducing exotic natural enemy
- Establishment and/or dispersal in non-target habitat
- Non-target host range
- (In)direct effects on non-target organisms

Determine likelihood and magnitude of each of the risks

Quantify risk and apply cost-benefit analysis

(Van Lenteren, 2006)
Regulation of macrobials

1. Exotic Native

2. Augmentative BC Classical BC

3. Establishment
   - Certain
   - Possible
   - Not

4. Host range, attack of non-targets
   - Related, unrelated
   - And/or valued
   - Related and non-valued

5. Dispersal
   - Extensive
   - Moderate
   - Only local

6. Direct and indirect effects
   - Likely and permanent
   - Unlikely, limited, and transient

On request

YES

NO
EPPO list of species used in biological control for inundative releases includes:
• 14 Coleoptera species
• 4 diptera species
• 8 Hemiptera/homoptera species
• 49 Hymenoptera species
• 1 Neuoptera species
• 4 Thysanoptera species
• 16 Acarina
• 7 Nematoda

EPPO list of species used in successful classical control includes:
• 8 Coleoptera species
• 1 Diptera species
• 33 Hymenoptera species
Macrobials – ERA implications

How will macrobials fit with ecosystems services?
Thank you for your attention