New microbial pesticides for managing insect pests and plant pathogens
Nemasys®
Beneficial Nematodes

- Nematodes that attack pests
- Five key species
- Favorable regulatory profile
  - Quick to market
- Meets Value Chain Demands
  - 0-MRLs, 0-PHI, 0-REI
  - Excellent IPM tool
- Flexibility for the farmer
  - Pest control until harvest
  - Compatibility with beneficials and pollinators
  - Persistent in the soil for long term control
What are Beneficial Nematodes?
Microscopic worms that target a wide-range of pests

- **Naturally-occurring macro-organisms**
- **Enter through openings of target pests**
- **Reproduce inside the host pest**
- **Powerful sustainable biological tool**
- **Used worldwide by growers and gardeners**
- **Safe for the environment**

Nemasys® Beneficial Nematodes
Nemasys mode of action

- Infective juvenile nematodes search actively for a prey. They enter the prey via natural openings. Inside the prey they release bacteria.

- The bacteria inside the nematode can kill the pest within 48 hrs. The insect body is food for the nematodes. New infective nematodes develop within the dead insect.
Biology
Nemasys – Mode of Action

Infective juveniles are produced when resources become limited.

Nematodes reproduce for 2-3 generations.

Nematodes become adults in dead larvae.

Nematode release symbiotic bacteria which kill larvae.

Infective juveniles enter larvae through natural openings.

Infective juveniles released in search of new hosts.
The Nemasys® range

- Ten products based on five species of nematode.
- Different products but with the same species based on market differentiation.
Where are Beneficial Nematodes used?

The Nemasys portfolio of products is sold into a versatile range of crop segments:

- Greenhouse
- Mushrooms
- Fruit
- Landscape & Nursery
- Vegetables
- Citrus
- Turf
- Forestry
- Home & Garden

Nemasys®
Beneficial Nematodes
<table>
<thead>
<tr>
<th>Nemasys Product</th>
<th>Nematode Species</th>
<th>Segment</th>
<th>Key Pest(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nemaslug</td>
<td><em>Phasmarhabditis hermaphrodita</em></td>
<td>Lawn &amp; Garden</td>
<td>Grey Slug, glasshouse slug, water snail</td>
</tr>
<tr>
<td>Nemasys G</td>
<td><em>Heterorhabditis bacteriophora</em></td>
<td>Turf &amp; Landscape</td>
<td>Chafer grub, White grub</td>
</tr>
<tr>
<td>Millenium</td>
<td><em>Steinernema carpocapsae</em></td>
<td>Lawn, Garden, Nursery</td>
<td>Chinch bugs, caterpillars, red palm &amp; pine weevil</td>
</tr>
<tr>
<td>Nemasys L</td>
<td><em>Steinernema kraussei</em></td>
<td>Garden</td>
<td>Black Vine Weevil, Strawberry Weevil</td>
</tr>
<tr>
<td>Nemasys</td>
<td><em>Steinernema feltiae</em></td>
<td>Indoor plants, interiorscape</td>
<td>Western Flower Thrips, fungus gnat</td>
</tr>
</tbody>
</table>
Nemasys®
Beneficial Nematodes

- Manufactured using liquid fermentation techniques in Littlehampton, UK.
- Formulated in an easy to use water dispersable gel.
Nemasys: shelf live

Product Storage

✓ Temperature Between 41- 45º F

✓ Nematodes Viable for 4 to 8 weeks
Nemasys beneficial nematodes: unique formulation

Stable, concentrated formulation easily dispersible in water
Nemasys beneficial nematodes: easy application

Ready for use
Nemasys – Application Methods
Beneficial Nematodes Portfolio

Applying Nemasys to Brussel sprout field

Nemasys for strawberries

Applying Nemasys on fruit trees

Nemasys in the greenhouse

Nemasys applied with spot applicator kit
Nemasys application check

- Before application – spraying solution
- During application – nematodes coming out the nozzles
Quality Assurance

Viable:
- Nematodes various shapes
- Nematodes moving

Non-viable:
- Nematodes straight
- Nematodes not moving
Spraying of Nemasys beneficial nematodes
Application conditions

- Use on moist soils / crops (Pre-irrigation is useful)
- Apply during overcast conditions
- Avoid direct sunlight / drying out, will kill nematodes
- Temperature between 5°C and 30°C (40 – 85 º F) (Depending on nematode species)
- Optimize conditions for contact between nematode and target pest
- Keep soil / crop wet after application
Main pest chrysanthemums: thrips!

- Thrips are a consistent problem
- Years of mono cultures in the same greenhouse
- Thrip populations (partial) resistant against chemicals
- Thrips quick multiplication
- Thrips hide in crop and soil

- Thrips control = a range of control measurements
- More and more growers are giving beneficial nematodes a fixed place in their IPM programs
Chrysanthemus: thrip damage

Thrip larvae
Thrip damage
Thrip control chrysanthemum predatory mites + beneficial nematodes

Good combination against thrips
Predatory mites + beneficial nematodes complementary

- P. mites - control of thrips larvae
- B. nematodes - control of thrips larvae, adults and pupae
- B. nematodes - thrips control in crop and soil
WFT in Strawberries

- **Target** – WFT larvae and adults

- **Opportunity**:
  - Current chemical options require stewardship (Spinosad/Spinetoram)
  - Nemasys (*S. feltiae*) shows high efficacy in other crops
  - Favorable conditions for Nemasys activity (cool application temps, high moisture soil)

- **Current activities**:
  - 2 Replicated trials in 2016 – high variability with foliar apps, moderate pressure
  - 2 large scale trials in 2017 – good control, but no UTC for comparison, foliar apps only.
  - 2018 – soil apps?
Cabbage Root Maggot in Brassicas

- **Target** – Cabbage Root Maggot (*Delia radicum*) larvae.

- **Opportunity:**
  - Opportunity to support current chemistry (Chlorpyrifos/Spinosad)
  - Nemasys (*S.feltiae*) shows high efficacy vs other dipterans
  - Favorable conditions for Nemasys activity (cool application temps, high moisture soil)

- **Current activities:**
  - 2018 – possible trial work
Serifel® Biofungicide
Serifel® Biofungicide

- A common, naturally occurring bacterium - *Bacillus subtilis*
  - *Bacillus amyloliquifaciens* – strain DMBI 600
- Foliar and in-furrow uses
- Formulation contains *Bacillus subtilis* spores
  - Robust under storage
  - Compatible with other products

Electron microscope cross-section of a spore of *Bacillus subtilis*. The spore is 1.2 microns across, about 100 times smaller than the width of a human hair. *(Credit: S. Pankratz)*
• When sprayed, Serifel spores are dormant
• On leaves or soil, spores grow and reproduce
• Fungi are inhibited in two ways:
  1. Spores give off metabolites
     • Metabolites inhibit the spores & mycelia of fungi
     • Lipopeptides disrupt fungi membranes allowing better penetration
       of tank mixed fungicides
  2. On the surface they compete with fungi for nutrients and space
     • When first on the bus, they take up available seats
Serifel® Biofungicide
Modes of Action

1. Metabolites inhibit fungal growth

2. Serifel takes up available seats on the bus
Serifel® Biofungicide – Modes of Action

Plant Protection from Outcompeting the Pathogens

- Serifel spores remain dormant until conditions are suitable to grow
- Serifel spores grow and reproduce on the surface of the plant
  - Competition for limited nutrients
  - Key factor is who gets there first
  - Early colonizer advantage
  - Niche exclusion
  - No seats left on the bus

Serifel® is Most Effective When Applied Before the Disease is Present
Field Research Results

Serifel® Biofungicide Foliar Applications in Grapes

Average Percent Severity of Powdery Mildew on Fruit

62/0 DAT/DALT
Serifel® Biofungicide
Formulation

- Wettable Powder
- Maintain constant agitation
- Large particle size requires 50 mesh screens
Serifel® Biofungicide

• Crops Labeled:

Berry and small fruit, citrus, cucurbit, fruiting veg, grape, pome, stone, strawberry.

Add crops and evaluate different application methods
BASF

We create chemistry

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