
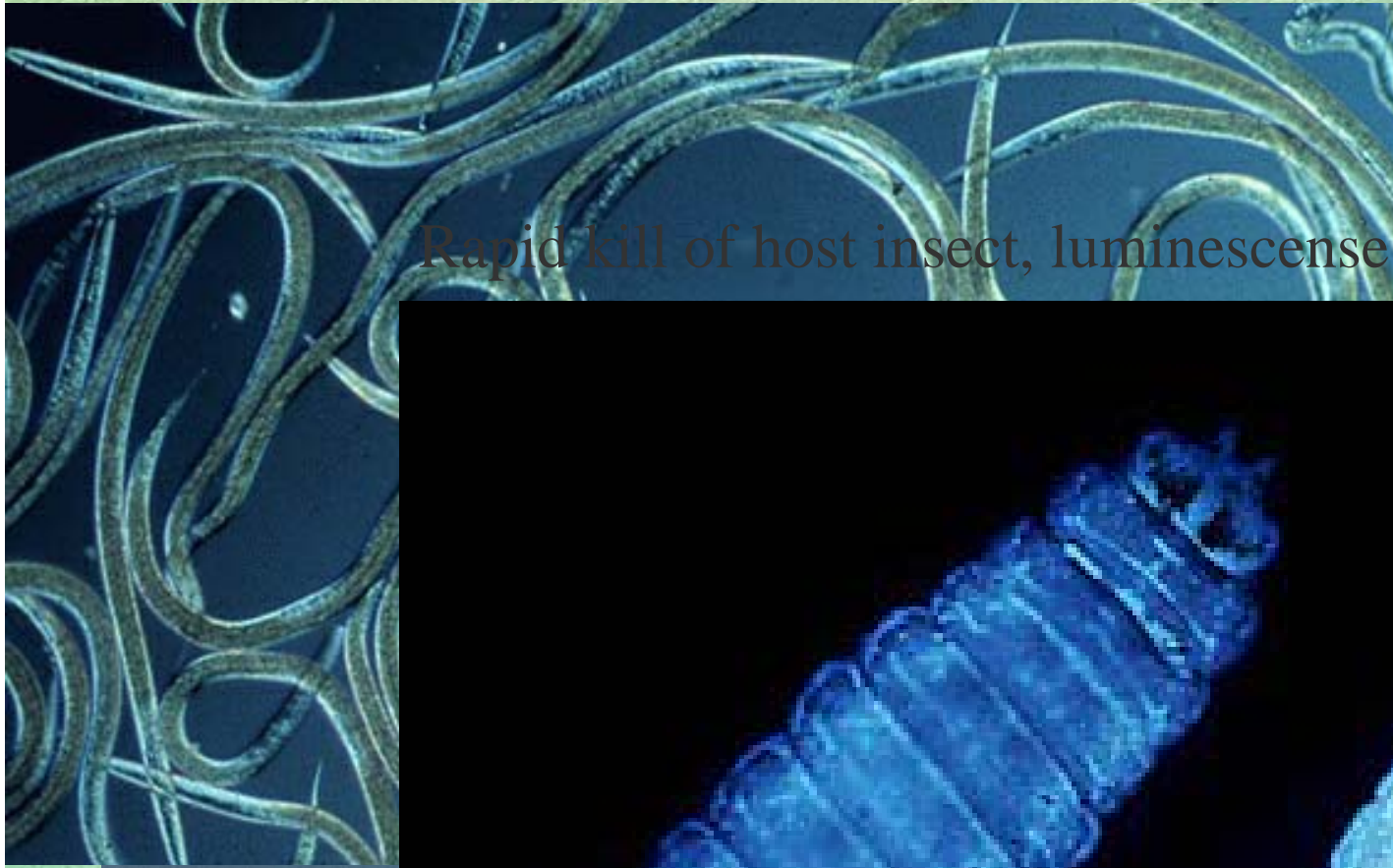


The position of entomopathogenic nematodes in the biocontrol market

A light blue arrow graphic pointing to the right, positioned below the title.

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Rapid kill of host insect, luminescence (Heterorhabditis)



Round worms, 0.5 to 1 mm long

Infective juveniles carry symbiotic bacteria

History

- First record *Steinernema kraussei* (1923)
- First use in 1930s
 - *Steinernema glaseri* against *Popillia japonica*
- Renaissance from approx. 1985
 - Biotech Australia (Australia)
 - Koppert (NL)
 - Biosys (USA)
 - AGC (UK) (now Becker Underwood)
 - Andermatt (CH)
 - A number of smaller enterprises



EPNs in comparison to other biologicals

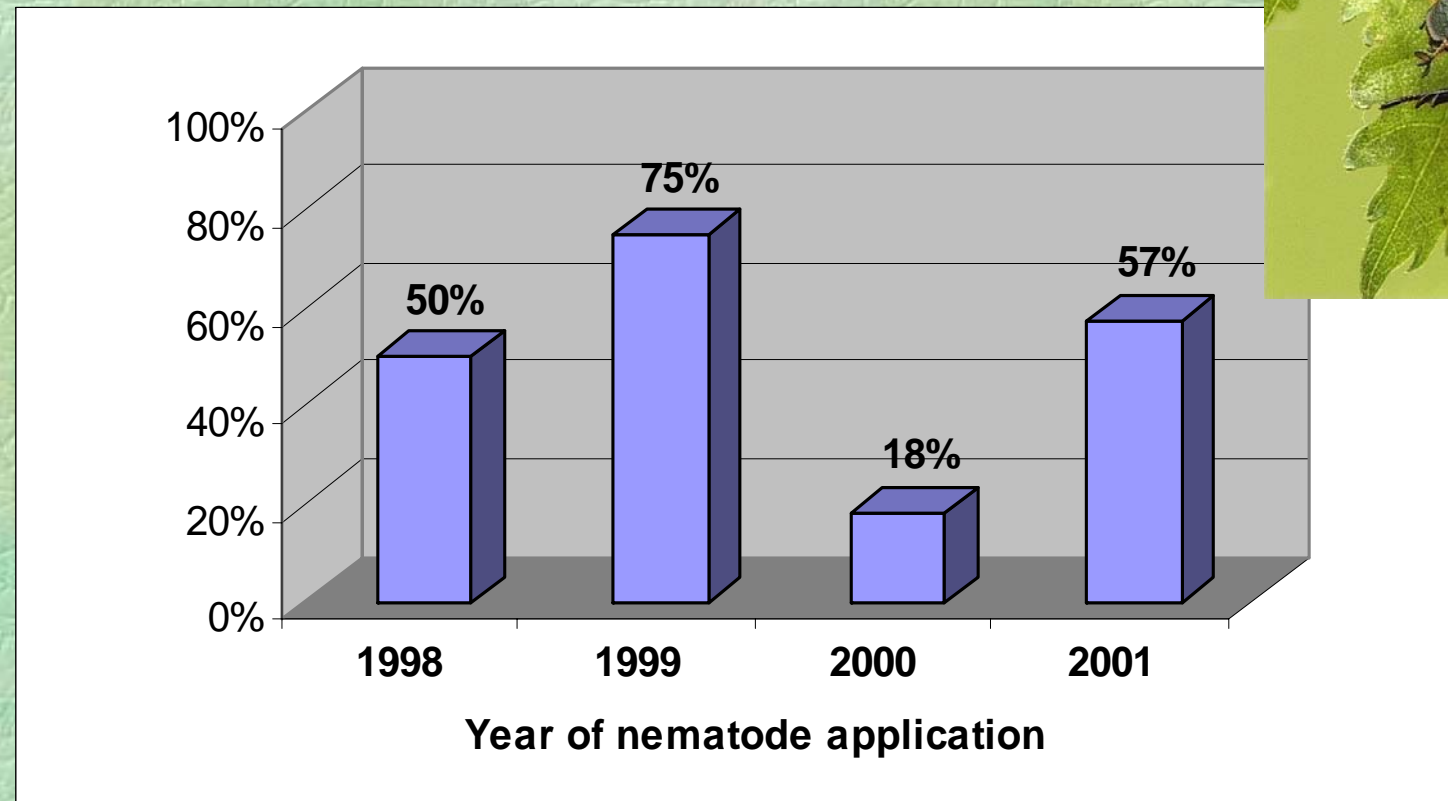
- Efficacy (Speed of kill)
 - Shelf life
 - Registration
 - Market expansion (Outdoor use)
 - Volume
 - Cost
- Compared to:
 - *B. thuringiensis*
 - Viruses
 - EP Fungi
 - Beneficial Arthropodes

Efficacy & Persistence

- Fast action (days to few weeks)
 - Common with Bt
- Auto-catalytic (reproduction in host insects)
 - Common with arthropods, fungi and viruses
- Persistent
 - In bigger insects and undisturbed environment
 - But: Spatial distribution changes with recycling !
 - Common with fungi (and arthropods in protected crops)
- Ability to locate the host insect
 - Common with arthropods

Persistence of nematodes on turf

% Application sites with nematodes detected



Detection of *H. bacteriophora* in 2002 from soil samples of golf courses treated in previous years

Shelf-life

- From 4 weeks (*H. indica*) to 6 months (*S. carpocapsae*)
- Worse than *B. thuringiensis*, fungi, viruses
- Better than Arthropods
- No real breakthroughs during the last 20 years
 - Better shelf life with low nematode concentrations
 - Lowering application rate might allow for lower concentrated packages

Registration

- Exempt from registration in most countries
- ± reasonable registration procedures in other countries (Sweden, Austria, Hungary, Switzerland)
- Regarded as Macro-organisms

Potential for outdoor use

- Nematodes attack soil dwelling insects, which are very difficult to control with non-mobile BCAs
- No fading out by wind, rain etc. (like arthropods)
- Current outdoor markets developed:
 - Weevils (Citrus, strawberries, cranberries)
 - Stem borers (China: *Carposina nipponensis*)
 - Grubs and cutworms on turf
 - Codling moth (development ongoing)

Application methods outdoors



Sales volume

- Hectares treated worldwide highest for BT
- Development in the EU :
 - 1992:
 - 90% of sales in EU BT
 - 2000:
 - 26% Microorganisms (including BT)
 - 55% of sales by macrobials (nematodes and arthropods)
- Personal estimate for EPNs: < 10000 ha

Production cost

- Higher than for BT
- Higher than for fungi and viruses (currently)
- Comparable or lower than for arthropods
- Dependent on scale
 - Nematodes currently in 20 m³
 - Bt in 150 m³



EPNs in comparison to other biologicals

	Efficacy	Shelf-life	Registration	Outdoor use	Volume	Cost
B.t.	±	+	-	±	+	+
Fungi / Viruses	±	+	-	±	±	+
Nematodes		○			○	○
Arthropods	±	-	±	-	±	-

Areas for development

Within the past ten years

- Nematode customer price has dropped to less than one half (Europe)
- Sales volume has increased (2-fold, at least)
- New nematode species are offered:

1992
S. carpocapsae
S. feltiae
Heterorhabditis bacteriophora
H. megidis
Phasmarhabditis hermaphrodita

2006
Steinernema feltiae
S. carpocapsae
S. riobrave
S. glaseri
S. scapterisci
S. kraussei
Heterorhabditis bacteriophora
H. megidis
H. marelata
H. indica
Phasmarhabditis hermaphrodita

The past ten years and the future

New markets explored:

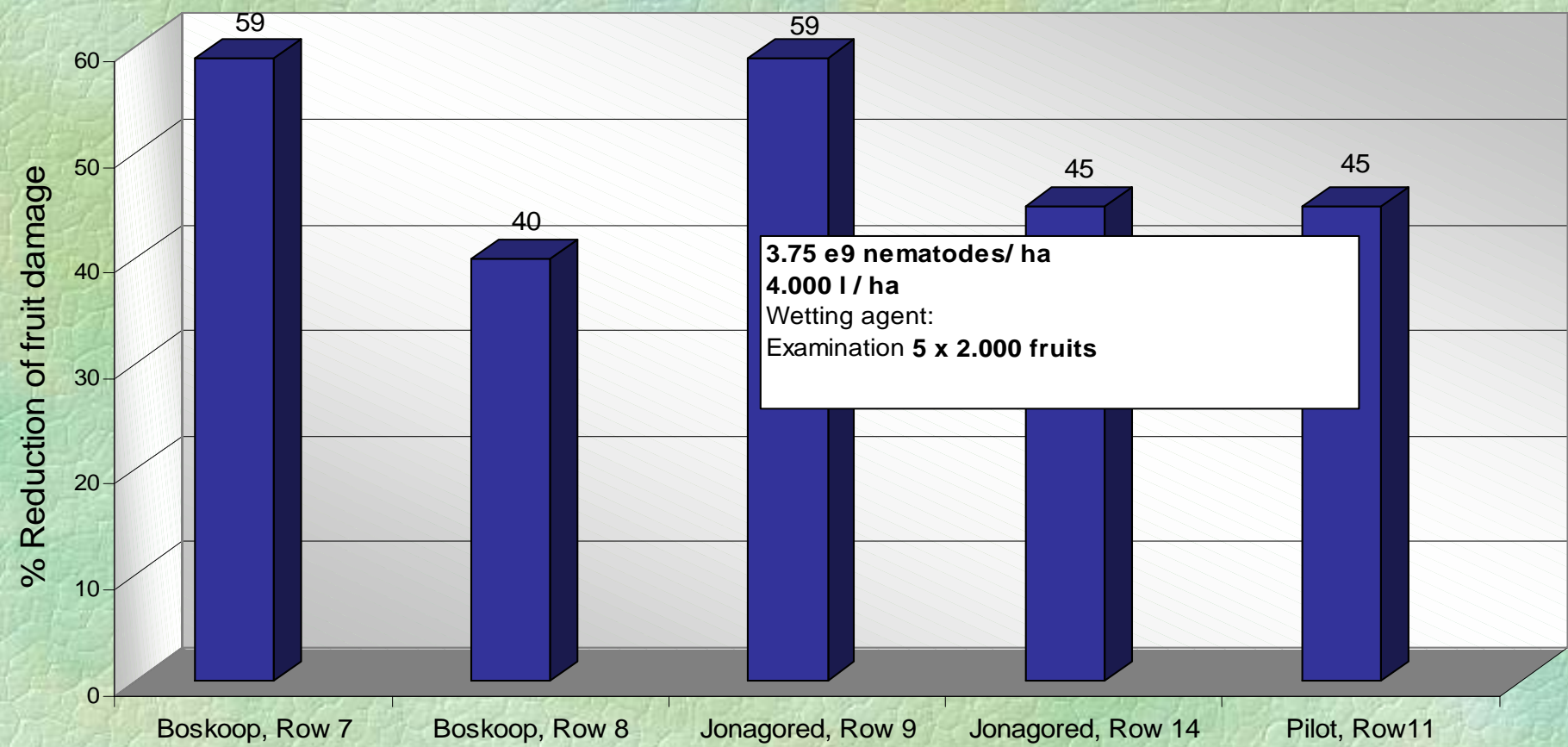
- Slugs
- Garden chafer on turf
- Thrips and leafminers in greenhouses
- Urban pests (cockroaches, woodlice)

Opportunities / activities:

- Codling moth (*Cydia pomonella*)
- Western corn rootworm (*Diabrotica v. virgifera*)
- Hazelnut borer (*Curculio nucum*)
-

Codling moth, Autumn treatment with *Steinernema feltiae*

Treatment: 21.10.2004, Examination: 12.07.2005



Conclusion

- Nematodes are mostly complementary, not competitive to other biocontrol products
- The production cost can be decreased further with increasing volume
- Little chance to improve shelf-life
- Great potential in decreasing dosage and in looking for alternative ways for application
- Nematodes would benefit from shift in paradigm to sustainable pest control
- Nematodes are a mediator for implementing such a shift:
 - They can provide both: rapid kill and sustainable effect

Thank you !

