



Practical Challenges to Inundative **and** **Inoculative** Biocontrol

Delemont, 17-01-2017

In order of appearance:

Tom Groot: production

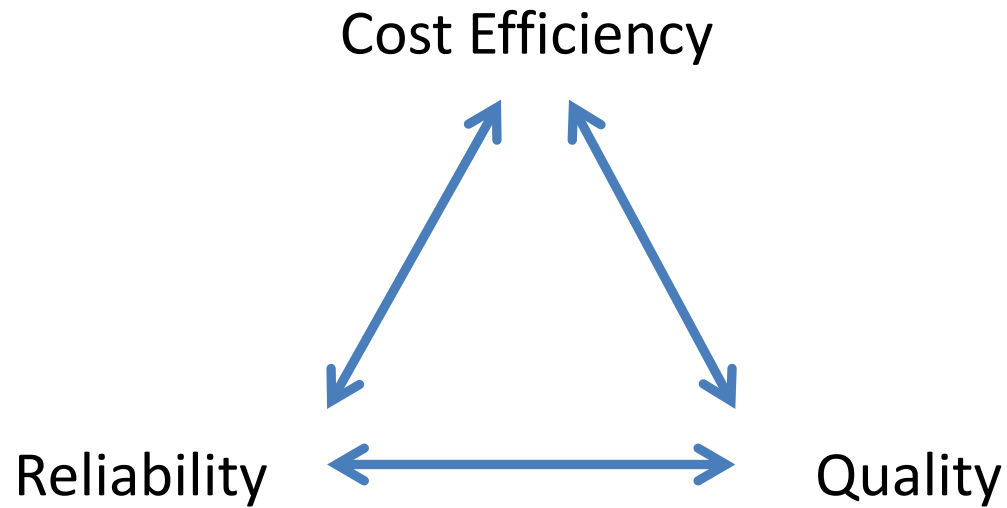
Markus Knapp: protected crops

Bernd Wührer: open fields





Practical Challenges in Production





Practical Challenges in Production

Cost efficiency

Why: biocontrol agents are considered expensive!

they are:

- competition = chemical
- now mostly in high value crops

they are not:

- good ROI
- other non-financial benefits

Cheaper is better, for producer and grower.

Practical Challenges in Production

Cost efficiency

Overall trend: changing systems

From classical tritrophic systems

To factitious hosts

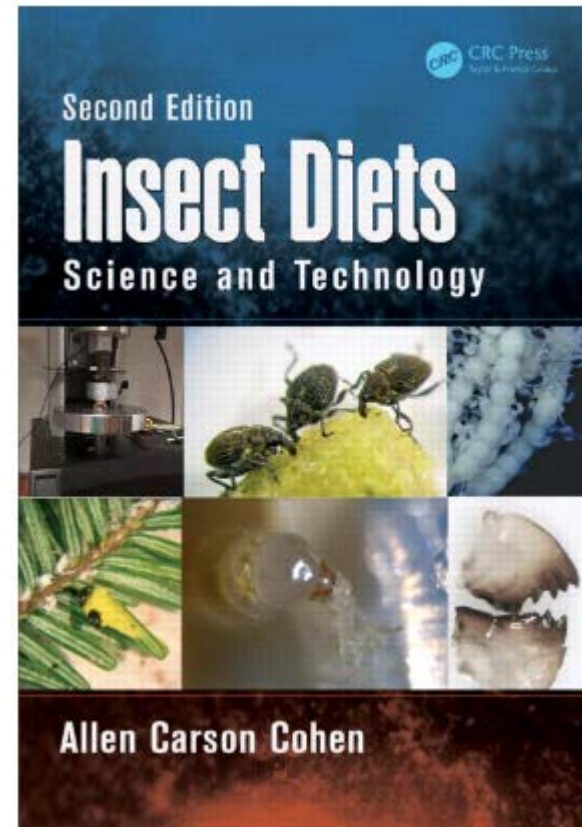


Practical Challenges in Production

Cost efficiency

Overall trend: changing systems

To artificial diets





Practical Challenges in Production

Reliability

Why: always be able to deliver required numbers

- late application misses the opportunity for balanced population
- chemical correction interferes with other biological systems
- no shelf life buffering
- long lead time

Practical Challenges in Production

Reliability

Overall trend: from greenhouse to climate chamber

- climate in the greenhouse is unpredictable
- climate chambers are less prone to contamination/ easier to disinfect

For the future:

Growing plants inside
with LED?



Brightbox



Practical Challenges in Production

Quality

Why: only good quality natural enemies deliver the right service!

Challenges:

- costs
- scaling
- raw materials: residue and GMO

Practical Challenges in Production

Quality

Challenges: logistics!

-how to control climate?

-if it is in out of your hands?

-different products
combined?

-speed is everything...



Practical Challenges in Production

Quality

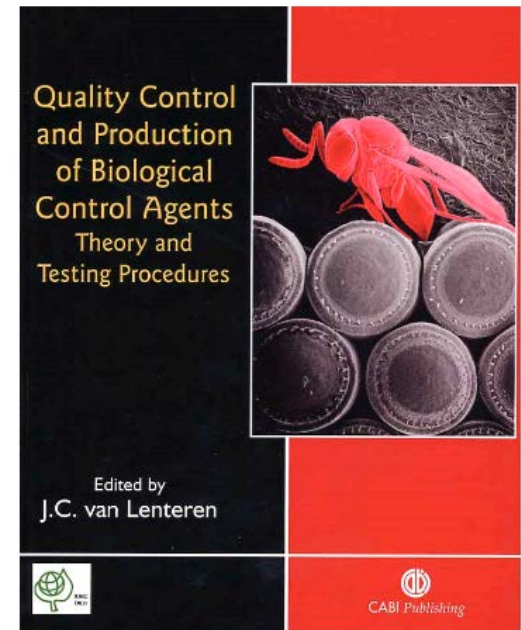
Quality checks

- QC leaving the factory
- Data loggers in transport
- Quick check at growers

IOBC Quality Control Guidelines

Van Lenteren et al 2003

<http://users.ugent.be/~padclerc/AMRQC/guidelines.htm>





Practical Challenges in Production

Not easy: lot of R&D

- protection: secrecy
- protection: patents. Not different from any other developing industry!

14th IOBC-MRQA Workshop

Mass Rearing High Quality Invertebrates for Multiple Purposes

Mérida, Mexico

November 14 - 17, 2017

<http://users.ugent.be/~padclerc/AMRQC/announcements.htm>

Practical Challenges in Protected Crops

Multiple pests

Multiple control strategies

Changing production methods



Multiple diseases

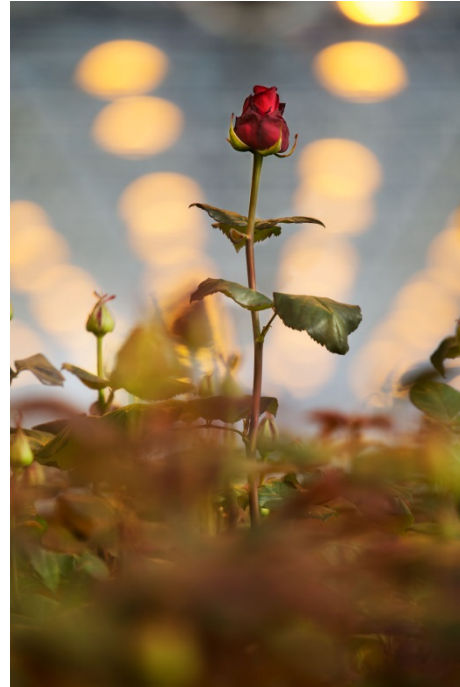
Cost efficiency

End user demands

Practical Challenges in Protected Crops

Roses

- Pests:
 - Thrips
 - Whiteflies
 - Spider mites
 - Aphids
 - Caterpillars
 - Mealybugs, scales



- Diseases:
 - Mildew
 - Botrytis

Practical Challenges in Protected Crops

Thrips control with predatory mites

- Tolerance is very low



- Mildew control: sulfur burners or frequent application of fungicides
- Use of insecticides and surfactants

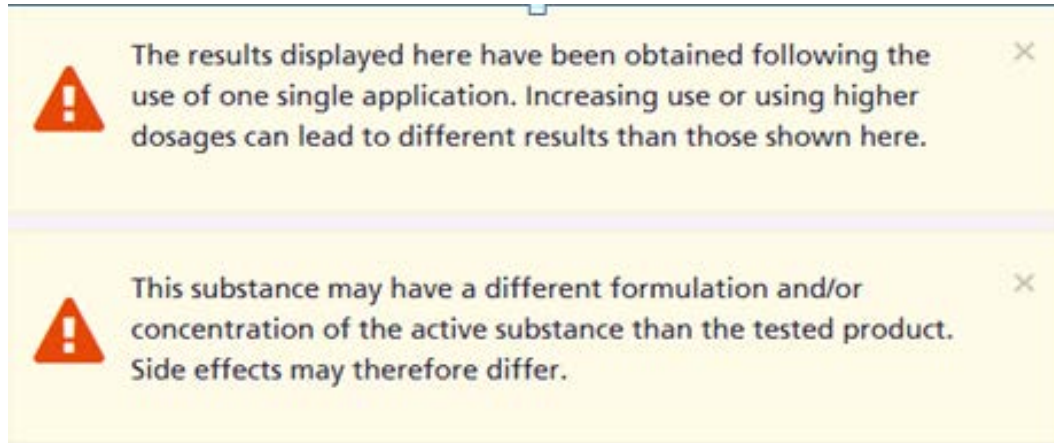
➤ **Difficult to establish a predator population**

Practical Challenges in Protected Crops

Side effects	ACTARA 25 WG ^x thiamethoxam		COLLIS ^x boscalid + krexoxim-methyl		CONSERVE SPINTOR ^x spinosad		MELTATOX ^x dodemorph	SILWET GOLD ^x heptamethyltrisiloxane
	SP	DR	SP	SP	DR			
<div style="background-color: #4CAF50; color: white; padding: 5px; display: inline-block;"> ^x Amblyseius swirskii SWIRSKI-MITE </div>	population		1					
	adult	2		1	4	1		
	egg			1	4			
	persistence	1 w	0 w	0 w		0 w		

Natural enemies	
1	= harmless or only slightly harmful < 25% reduction
2	= moderately harmful 25 - 50% reduction
3	= harmful 50 - 75% reduction
4	= very harmful > 75% reduction
	= effect/persistence unknown

Practical Challenges in Protected Crops



- Frequent applications?
- Interactions between compounds?
- Influence of spraying technology?
- Different growing conditions

Practical Challenges in Protected Crops

Strategies

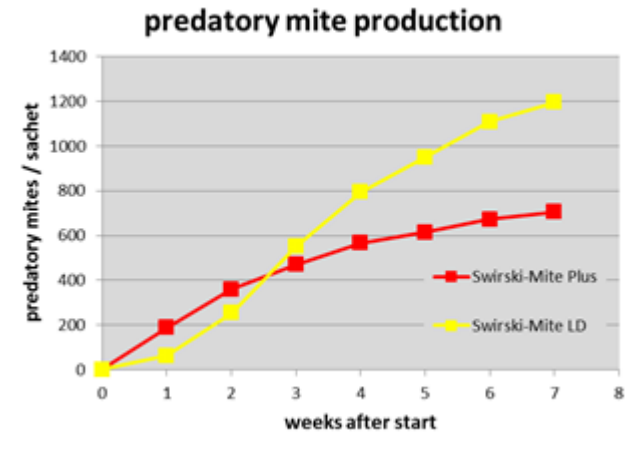
- Frequent releases of high numbers
- Slow release sachets



[?v=04Za8CQnVGA](#)



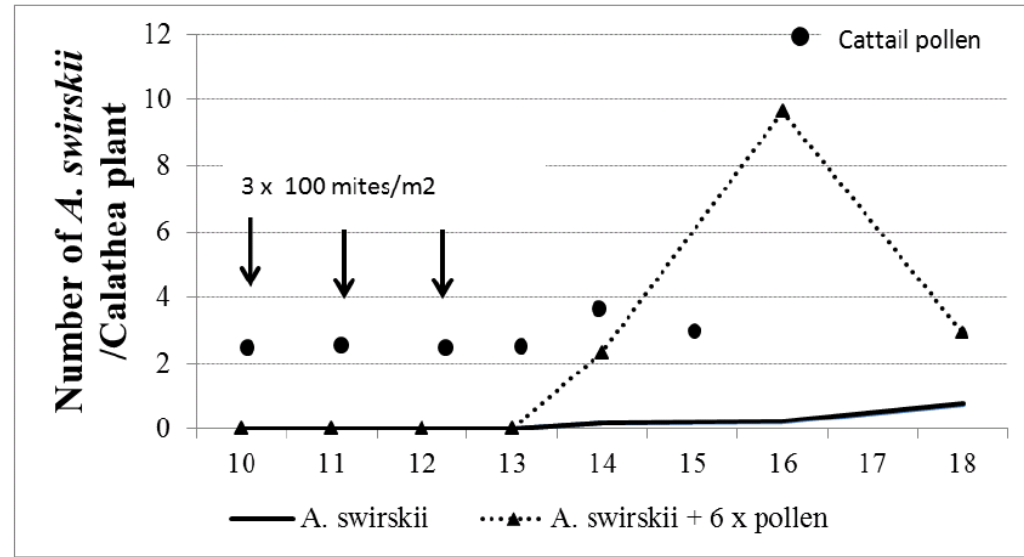
- Supplementary feeding
 - Pollen
 - Prey mites
 - On plants
 - In litter
 - Ephestia, Artemia...



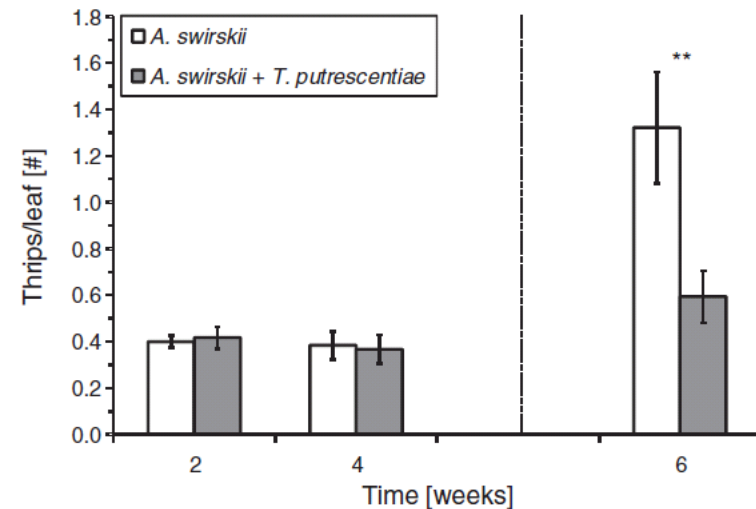
Practical Challenges in Protected Crops

Supplementary feeding

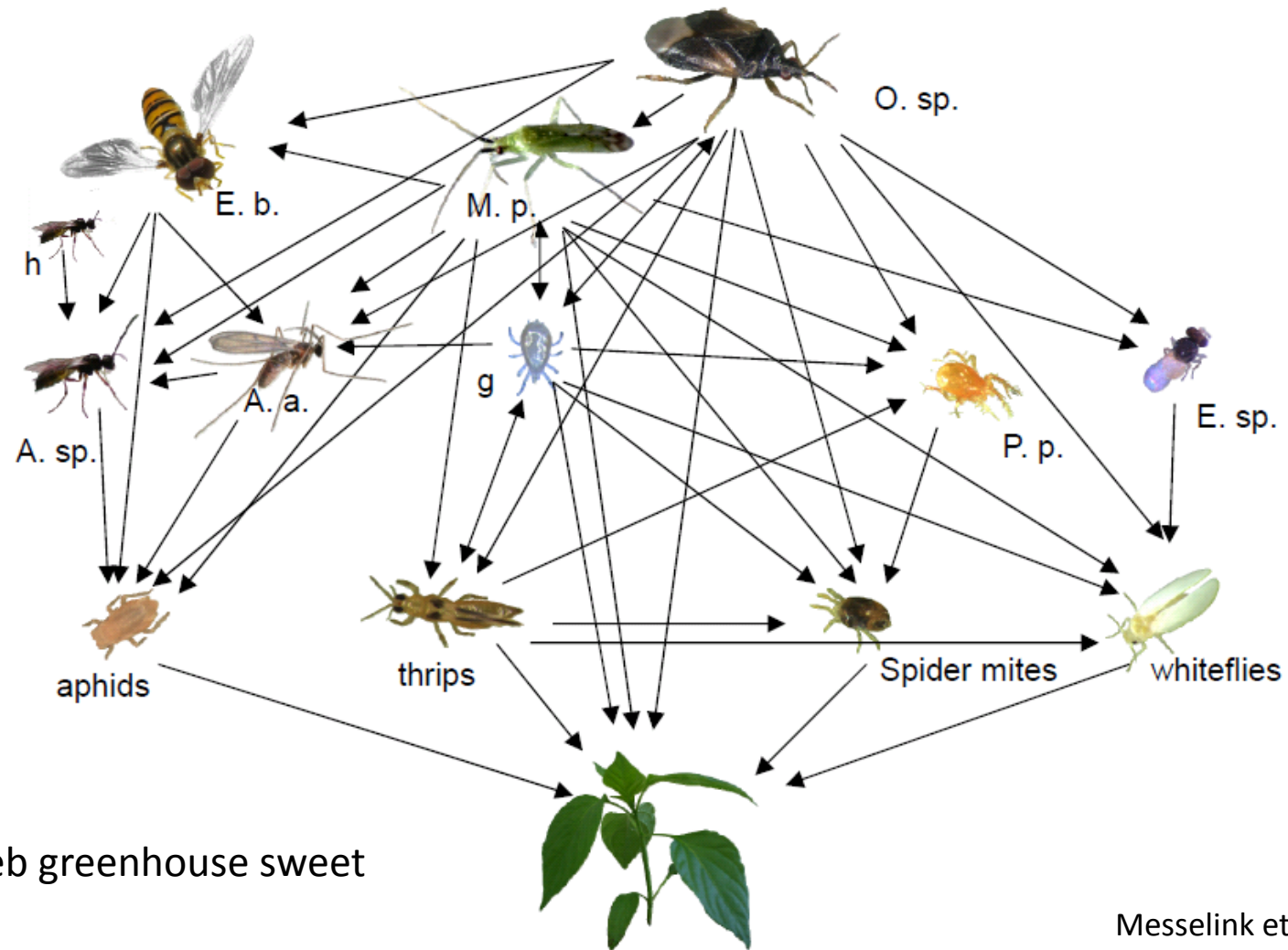
- On plants (Pijnakker et al. 2016)



- In litter (Munoz-Cardenas et al. 2017)



Practical Challenges in Protected Crops



Practical Challenges in Protected Crops

- Predation by generalist predatory mites on *A. aphidimyza* disrupts biological control of aphids (Messelink et al. 2012)

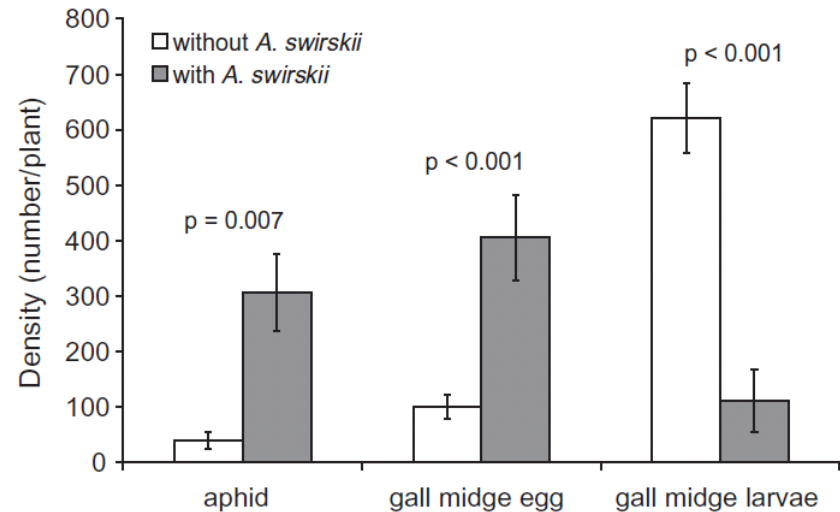
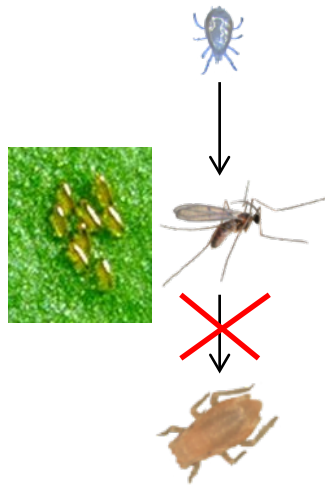


Fig. 5. Densities of aphids and eggs and larvae of the predatory midge *A. aphidimyza* on plants with or without the predatory mite *A. swirskii*. Shown are the average densities (\pm s.e.m.) 7 days after the first releases of midge adults. The *p*-values refer to the significance of differences between treatments per organism, based on Fisher's LSD test.



Without *Amblyseius swirskii*

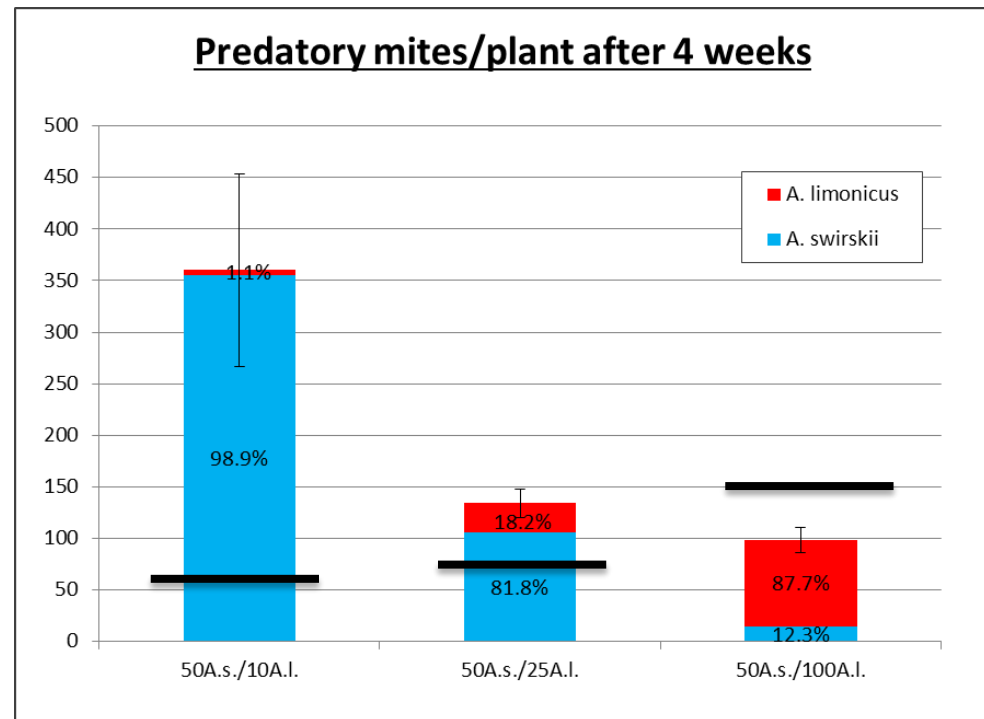


With *Amblyseius swirskii*

Practical Challenges in Protected Crops

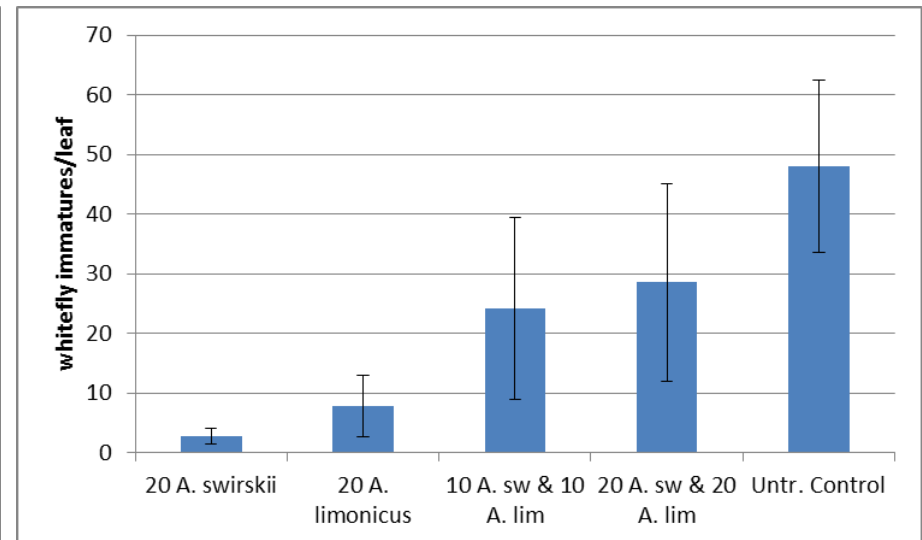
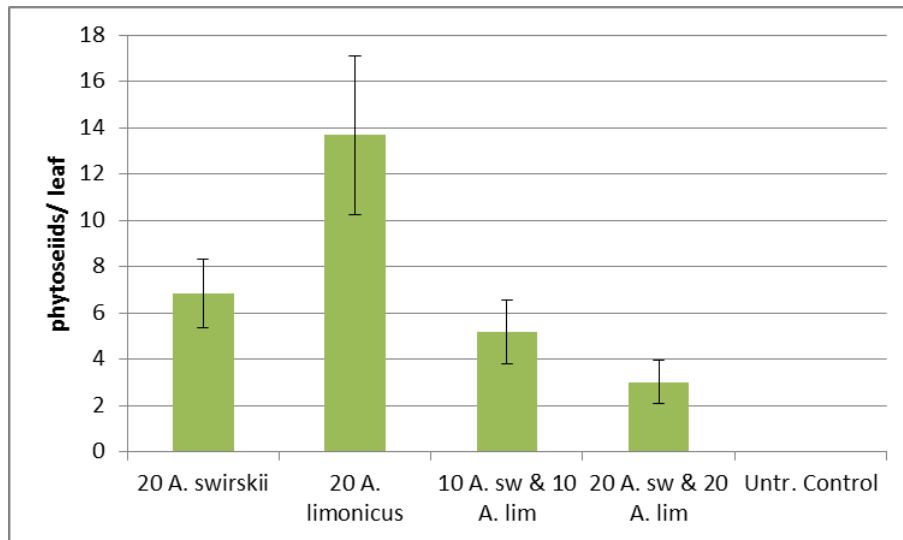
Price: *N. cucumeris* < *A. swirskii* < *A. limonicus*

Ratio	<i>A. swirskii</i>		<i>A. limonicus</i>	
	#/plant	day	#/plant	day
5 : 1	50	0	10	2
5 : 2.5	50	0	25	2
5 : 10	50	0	100	2



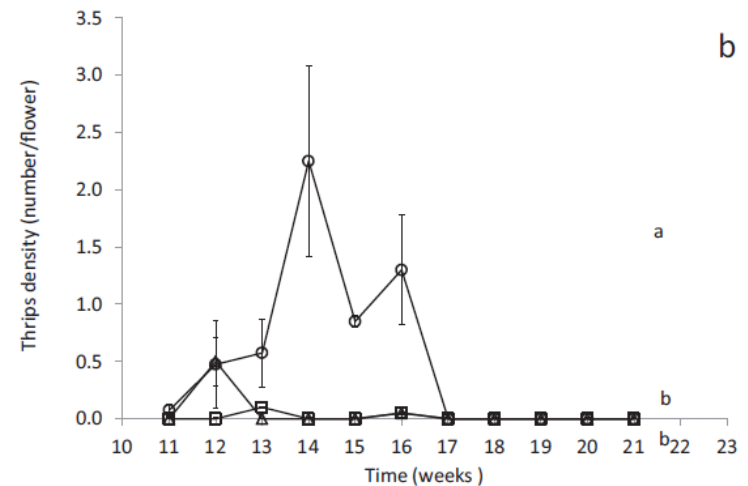
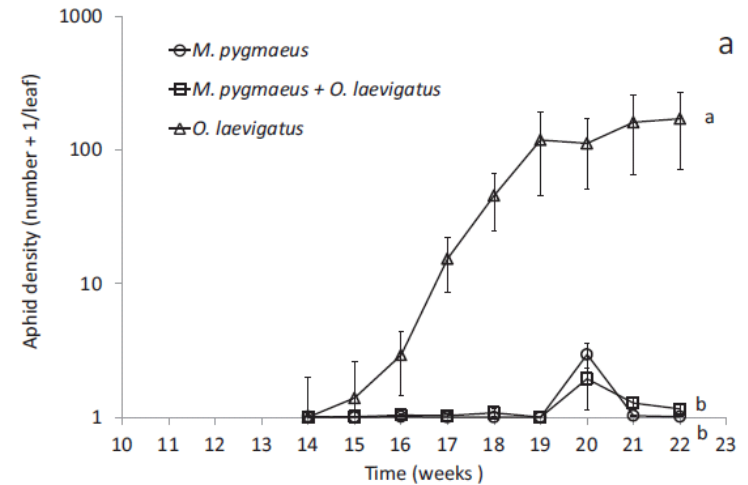
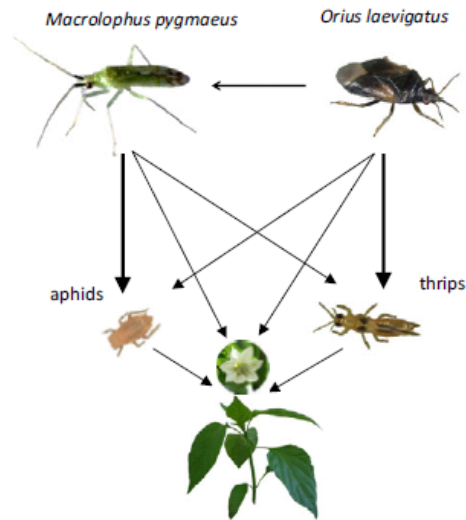
Practical Challenges in Protected Crops

Price: *N. cucumeris* < *A. swirskii* < *A. limonicus*



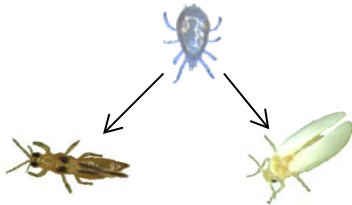
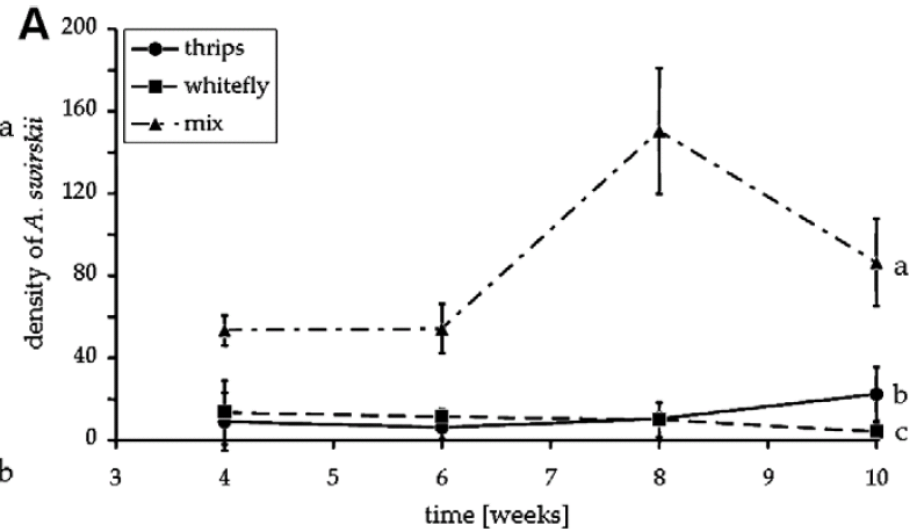
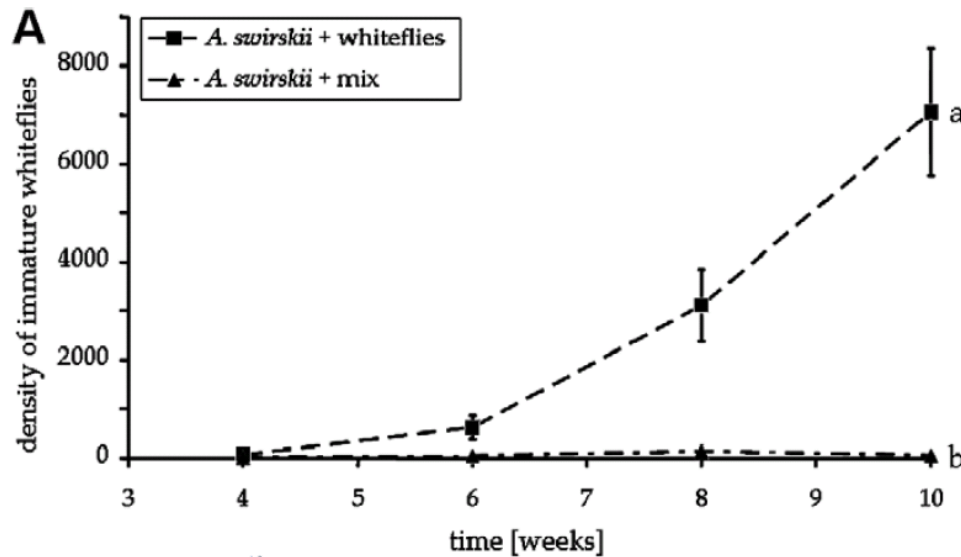
Practical Challenges in Protected Crops

- Combined releases of *M. pygmaeus* and *O. laevigatus* control thrips and aphids better than each of them separately (Messelink & Janssen 2014)



Practical Challenges in Protected Crops

- Whitefly control with *A. swirskii* better if also thrips present (Messelink et al. 2008)





Practical Challenges in Protected Crops

Knowledge intensive!

- Knowledgeable growers and advisors
- High R&D input

16th Meeting of the IOBC/WPRS working Group “Integrated Control in Protected crops
Temperate Climate”

Niagara Falls, Canada

June 4 - 8, 2017

<http://iobccanada2017.ca/>

Use of beneficials in the field

- Classical biological control (inoculative)

Use of beneficials in the field

- Classical biological control (inoculative)
- “Commercial” biological control (inundative / mass releases of beneficials)

Use of beneficials in the field

- Classical biological control (inoculative)
- “Commercial” biological control (inundative / mass releases of beneficials)
 - *Trichogramma sp.*
 - Nematodes

Use of beneficials in the field

- Classical biological control (inoculative)
- “Commercial” biological control (inundative / mass releases of beneficials)
 - *Trichogramma sp.*
 - Nematodes
 - others ?

Use of beneficials in the field

Why *Trichogramma* against corn borer?

Use of beneficials in the field

Why *Trichogramma* against corn borer?

- “new pest” that caused heavy damage in production of corn seeds in the early '70s



Use of beneficials in the field

Why *Trichogramma* against corn borer?

- “new pest” that caused heavy damage in production of corn seeds in the early '70s
- Synthetic pyrethroids were used to control this pest, but caused health problems of workers
- Efficacy of *Bacillus thuringiensis* was too low

Use of beneficials in the field

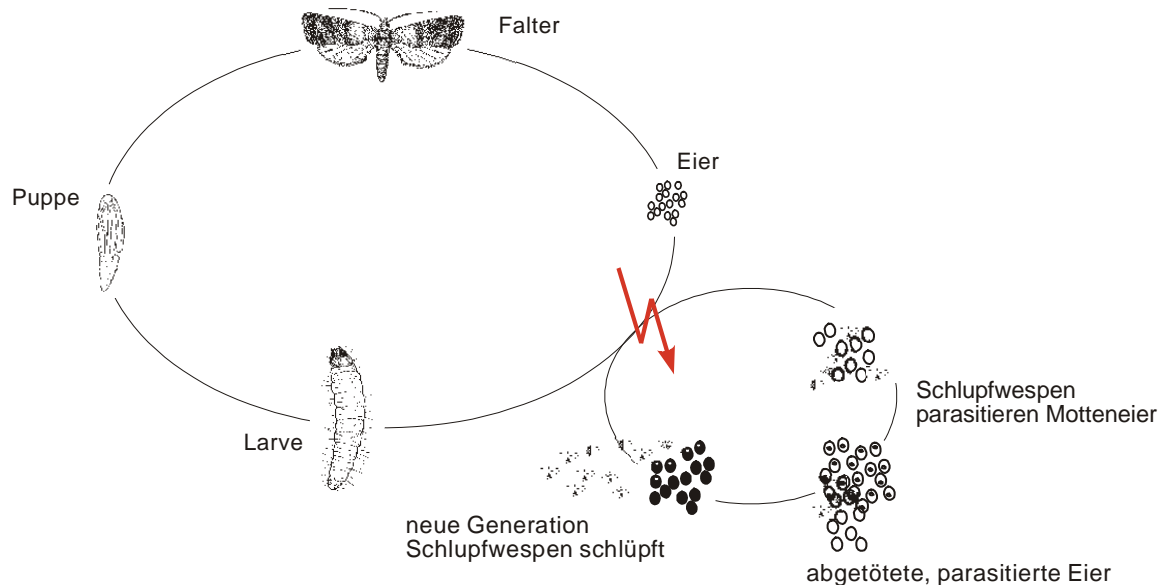
Why *Trichogramma* against corn borer?

- “new pest” that caused heavy damage in production of corn seeds in the early '70s
- Synthetic pyrethroids were used to control this pest, but caused health problems of workers
- Efficacy of *Bacillus thuringiensis* was too low
“only, cause there is no other solution ...”

Use of beneficials in the field

Why *Trichogramma*?

- *Trichogramma* was known to be effective to control pest insects (first trials 1900 in USA)



Use of beneficials in the field

Why *Trichogramma*?

- *Trichogramma* was known to be effective to control pest insects (first trials 1900 in USA)
- *Trichogramma* was available:
use of “strain Moldavia”;
declared as *T. evanescens*,
determined later as *T. brassicae*

Use of beneficials in the field

Why *Trichogramma*?

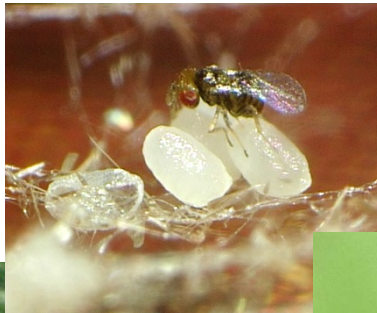
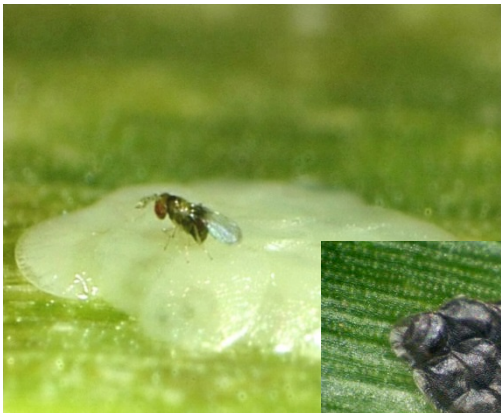
- *Trichogramma* was known to be effective to control pest insects (first trials 1900 in USA)
- *Trichogramma* was available:
use of “strain Moldavia”;
declared as *T. evanescens*,
determined later as *T. brassicae*

“problems, due to little knowledge”

Use of beneficials in the field

Why *Trichogramma*?

- Easy to multiply (egg parasitoid, polyphagous, short life cycle, nice and tiny ...)



Use of beneficials in the field

Why Trichogramma?

- Easy to multiply (egg parasitoid, polyphagous, short life cycle, nice and tiny ...)

but

- Big quantities needed in a short period of time
- Exact timing of releases - monitoring of ECB
close cooperation of producers, distributors, users with plant protection services)

Use of beneficials in the field

Monitoring



Use of beneficials in the field

Why Trichogramma?

- Easy to multiply (egg parasitoid, polyphagous, short life cycle, nice and tiny ...)

but

- Big quantities needed in a short period of time
- Exact timing of releases - monitoring of ECB
- Storage and shipment are difficult
- Releasing methods required

Use of beneficials in the field

- Releasing by hand



Foto: Fenaco UFA-Samen Nützlinge



Foto: fenaco UFA-Samen Nützlinge



Foto: fenaco UFA-Samen Nützlinge

Use of beneficials in the field

- Releasing by machines



Use of beneficials in the field

Releasing by machines



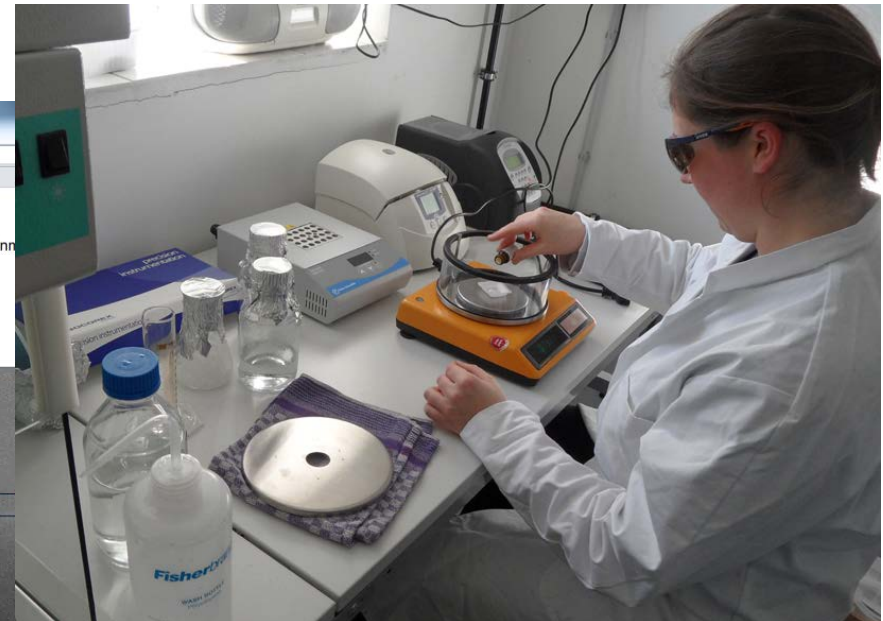
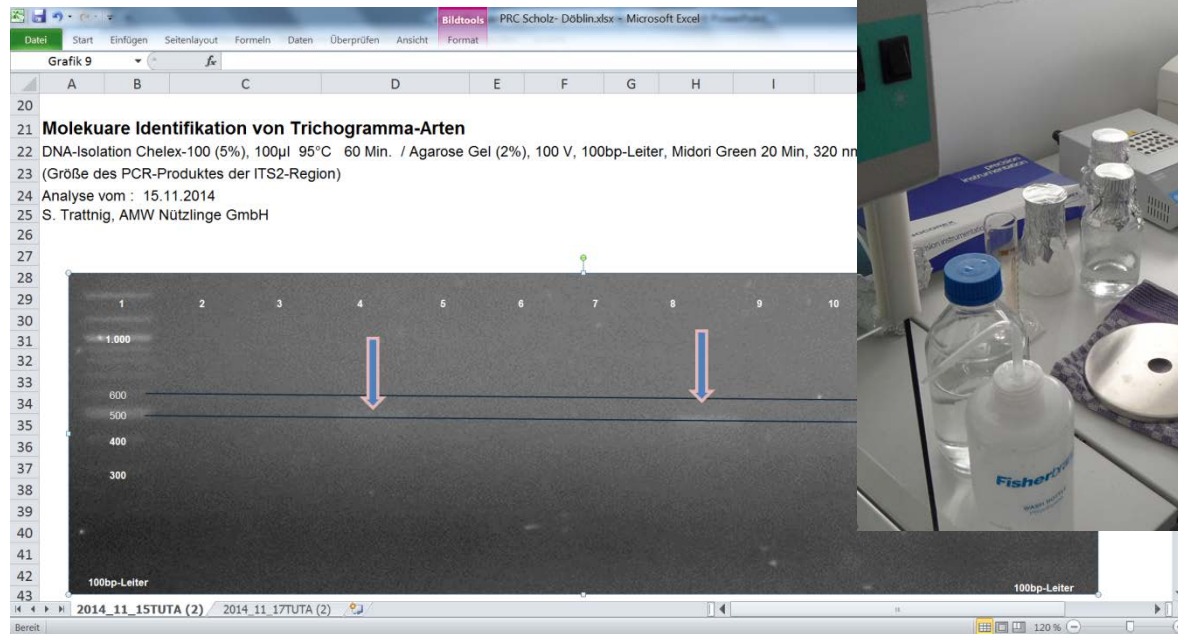
Use of beneficials in the field

“problems, due to little knowledge”

Use of beneficials in the field

“problems, due to little knowledge”

- Taxonomy – misidentification ...



Use of beneficials in the field

“problems, due to little knowledge”

- Taxonomy – misidentification ...
- Elevation of natural occurring beneficials



Use of beneficials in the field

“problems, due to little knowledge”

- Taxonomy – misidentification ...
- Elevation of natural occurring beneficials
- Impact on natural environment (nature conservation, national permissions)

Use of beneficials in the field

Impact on natural environment

D. Babendreier et al. / *Biological Control* 26 (2003) 139–145

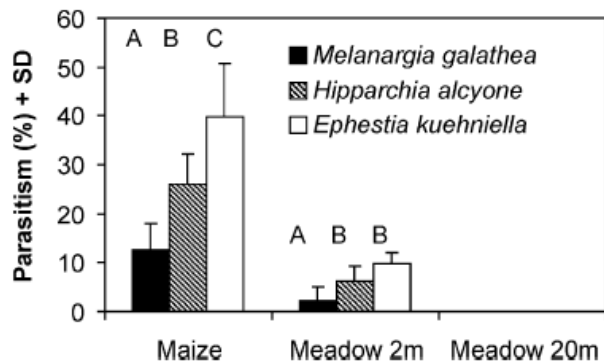


Fig. 2. Parasitism of *Ephestia kuehniella* and non-target eggs inside of maize and inside of a meadow at 2 and 20 m distance from the edge of a maize field where *Trichogramma brassicae* had been released. Number of eggs or egg masses recovered, ranged from 19 to 28 for each species and the $n = 4$ replicates, respectively.

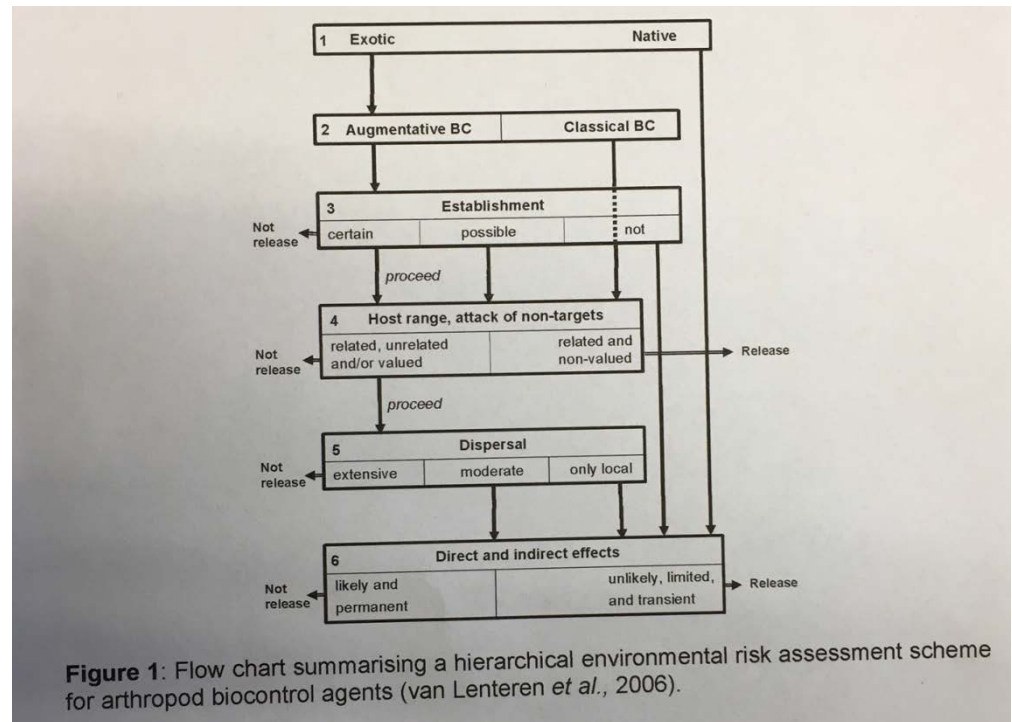


Figure 1: Flow chart summarising a hierarchical environmental risk assessment scheme for arthropod biocontrol agents (van Lenteren et al., 2006).

Use of beneficials in the field

“problems, due to little knowledge”

- Taxonomy – misidentification ...
- Elevation of natural occurring beneficials
- Impact on natural environment (nature conservation, national permissions)
- Acting in the framework of regulations (collection of species/strains, release of beneficials) which might change ...

Use of beneficials in the field

Regulation - Collection

- Access and Benefit Sharing (based on CBD)
- Nagoya Protocol
- EU Regulation 511/2014
- National Regulation

Regulation - Release

- Nature Conservation Act
- Plant Protection Act

Use of beneficials in the field

“problems, due to little knowledge”

- Taxonomy – misidentification ...
- Elevation of natural occurring beneficials
- Impact on natural environment (nature conservation, national permissions)
- Acting (collection of species/strains, release of beneficials) in the framework of regulations (which might change ...)

Use of beneficials in the field

“problems, due to little knowledge”

- Taxonomy – misidentification ...
- Elevation of natural occurring beneficials
- Impact on natural environment (nature conservation, national permissions)
- Acting (collection of species/strains, release of beneficials) in the framework of regulations (which might change ...)

“Now we know more, but still not enough ...”

Use of beneficials in the field

Finally:

- High efficacy is needed

for an acceptable price

Trichogramma is used to control the corn borer since more than 30 years in Europe – today on more than 200.000ha

Use of beneficials in the field

From the idea to the product:

- Identification of pest
- Search and identification of antagonists
- Selection of species/strains
- Development of rearing system
- Development of releasing units
- Creation of a product
- And allways keep the quality in mind!

Use of beneficials in the field

Summary and outlook:

- The potential market is very big
- But only very few beneficials are used
- Due to a lot of scientific work that is needed to develop a product
- **But we have BINGO!**

Thank you very much for your
attention!

