Integrated management of the invasive tomato leafminer *Tuta absoluta* in Flanders (Belgium)

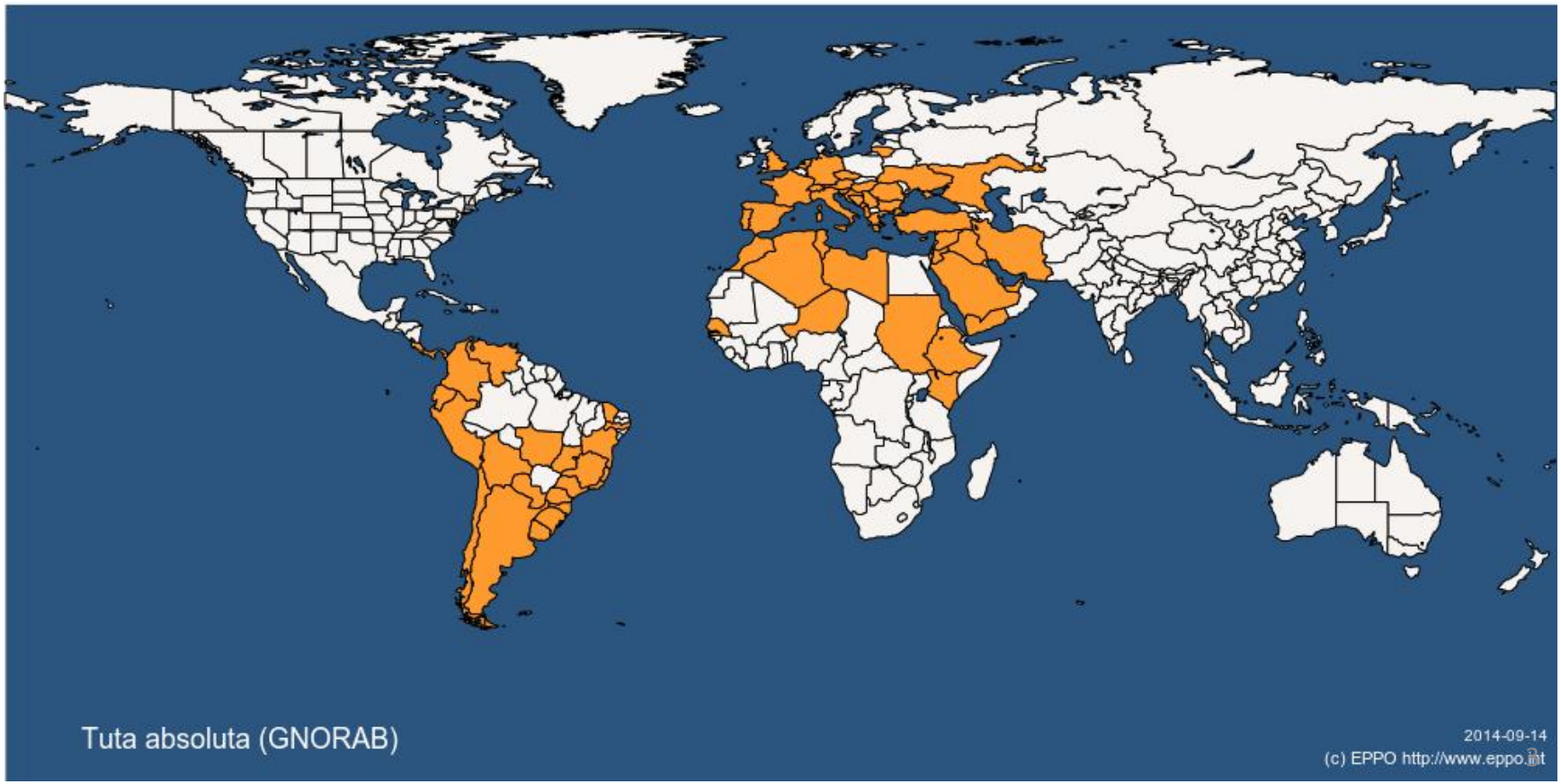
Veerle Van Damme, Rob Moerkens, Els Berckmoes, Lieve Wittemans, Nick Berkvens, Bert Beck, David Nuyttens, Raf De Vis, Hans Casteels, Luc Tirry, Patrick De Clercq

UNIVERSITEIT GENT
ILVO Institute for Agricultural and Fisheries Research
PROEFSTATION VOOR DE GROENTETEELT
PROEFCENTRUM HOOGSTRATEN

Introduction

- **Common name:** South American tomato leafminer or South American tomato pinworm
- Damage caused by the **larvae**, mainly leaves, stems and fruits as well
- Host plant: **mainly tomato**

Origin: South America
Detected in **Eastern Spain in 2006**
Detected in **Belgium** in **2009**
Introduction pathways: Infested tomato fruits and crates and packing boxes
In Belgium: mainly commercial greenhouses



Average development time

37 days at 19 °C

23 days at 25 °C (Cuthbertson *et al.*, 2013)

multivoltine species **= high reproductive potential**

4.6 x 1.3 mm (l x w)

pupae

adults

10.10 – 10.73 mm

L1 = 1.40–1.90 mm
L2 = 2.45–3.10 mm
L3 = 3.85–5.65 mm
L4 = 5.50–9.20 mm

(Vargas, 1970)

4 larval instars

eggs

0.4 x 0.2 mm (l x w)

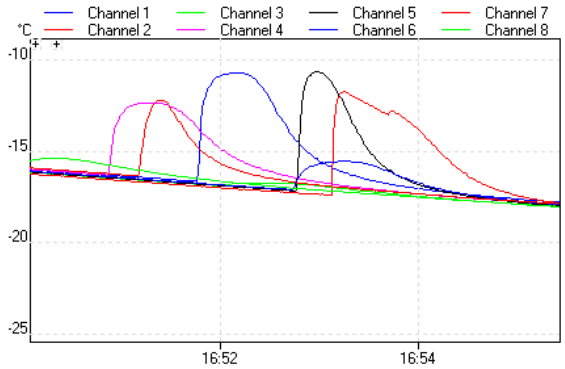
IPM *Tuta absoluta*

- Cold tolerance
  - Supercooling point
  - Lethal time
  - Reproductive diapause
  - Winterfield trial
- *Macrolophus pygmaeus*
  - Predation capacity
  - Time of release
  - Food Supplements
  - Other
- Entomopathogenic nematodes (EPN)
  - EPN species
  - Temp °C

1. Cold tolerance

- **Supercooling point (SCP)**

The SCP is the absolute lowest limit of cold tolerance, being the temperature at which the body fluids freeze (°C)



	n	Mean ± SE (°C)
Larvae	30	-18.2 ± 2.0 a
Adults	30	-17.2 ± 2.2 a
Pupae	35	-16.7 ± 1.1 a

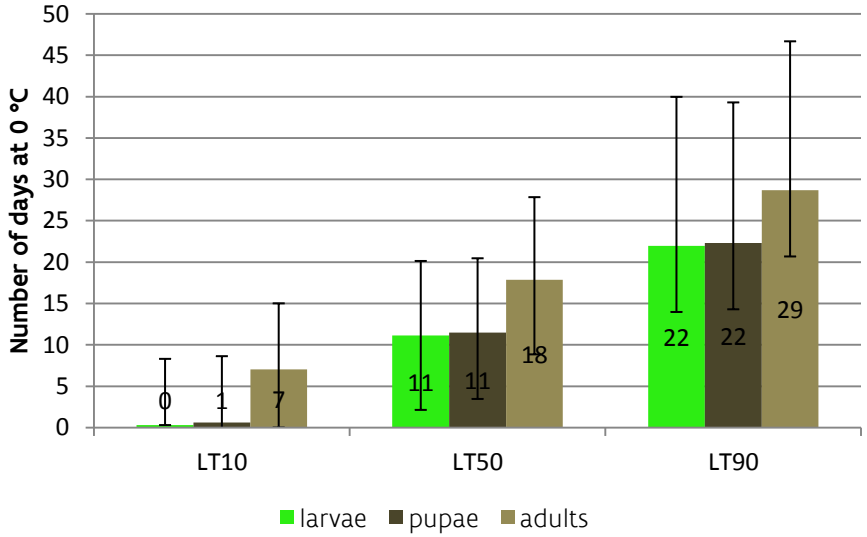
Very low temperatures

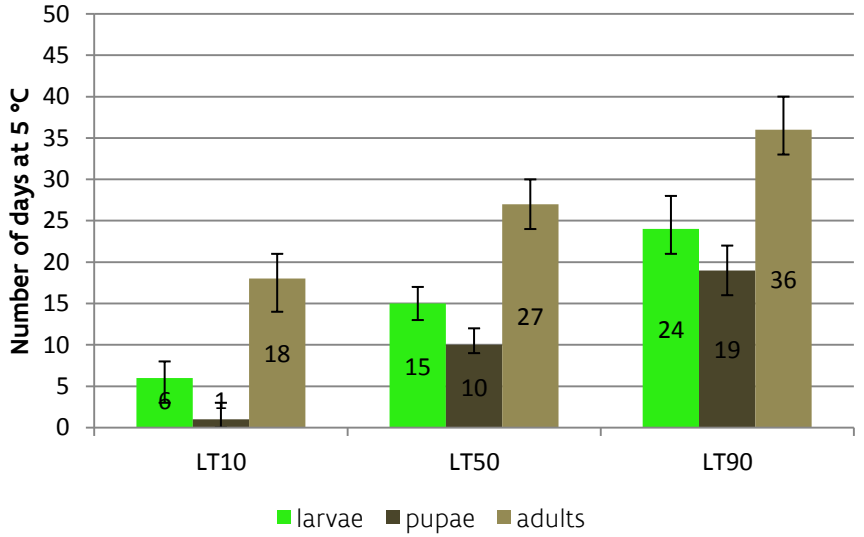
No differences between the different stages

1. Cold tolerance

- **Lethal time (LT)**

$LT_{10, 50, 90}$ is the time required to kill respectively 10, 50 and 90 % of the population at a certain temperature





Adults are more cold tolerant than larvae and pupae
Considerable proportion of larvae and pupae survive at 0 en 5°C

1. Cold tolerance

- **Reproductive diapause**

Reproduction is suspended but insect remains active

Assessment at **18 an 25 °C** combined with **16L/8D and 8L/16D** (4 combinations) of:

(1) pre-oviposition period

(2) oviposition period

(3) number of eggs laid after 10 days,

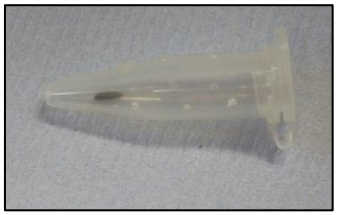
(4) percentage of egg hatching

No reproductive diapause was observed

Publication on cold tolerance experiments of *T. absoluta*

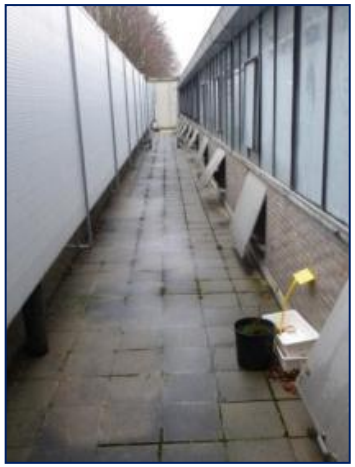
Van Damme et al. Overwintering potential of the invasive leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) as a pest in greenhouse tomato production in Western Europe. J Pest Sci DOI: 10.1007/s10340-014-0636-9

1. Cold tolerance



- **Winterfield trial (2012-13)**

1 pupa in perforated eppendorf
3 locations in and around frost-free greenhouse
35 replicates per location
registration of temperature and relative humidity
2 experiments of ± 3 weeks



1. Cold tolerance

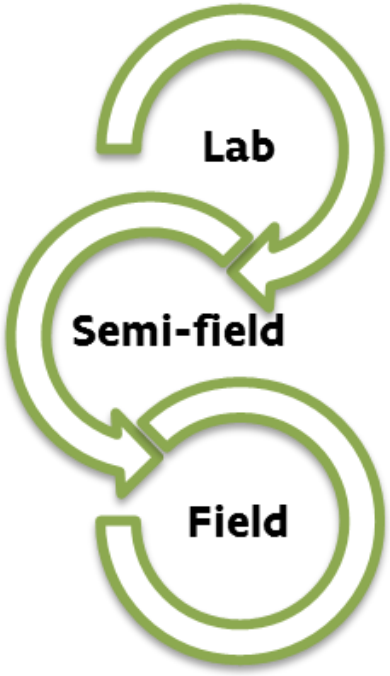
- **Winterfield trial (2012-13)**

	On/In soil of greenhouse		In corner of greenhouse		Between two greenhouses	
	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2
Tmin (°C)	8.3	4.2	4.4	-1.7	-1.9	-7.4
Tmax (°C)	17.4	14.5	16.2	20.2	12.1	12.2
Tmean (°C)	12.0	8.5	11.0	7.3	8.0	4.0
Emergence (%)	**69.0**	**17.6**	**74.0**	**11.4**	**63.0**	**2.9**

Pupae survive easily inside greenhouse when kept frost free

2. *Macrolophus pygmaeus*

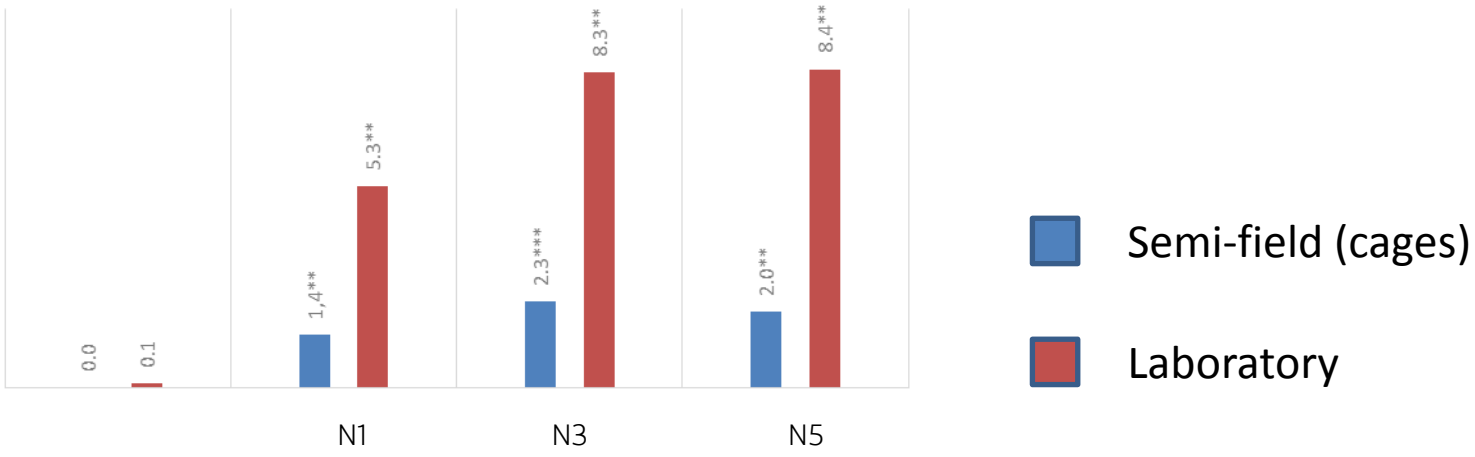
- **Predation capacity**



Predation capacity in **semi-field and field conditions, assessment of**
(1) search efficiency of *M. pygmaeus*
(2) treshold (how many *M. pygmaeus* needed to control *T. absoluta*)

2. *Macrolophus pygmaeus*

- **Comparison predation capacity laboratory and semi-field**

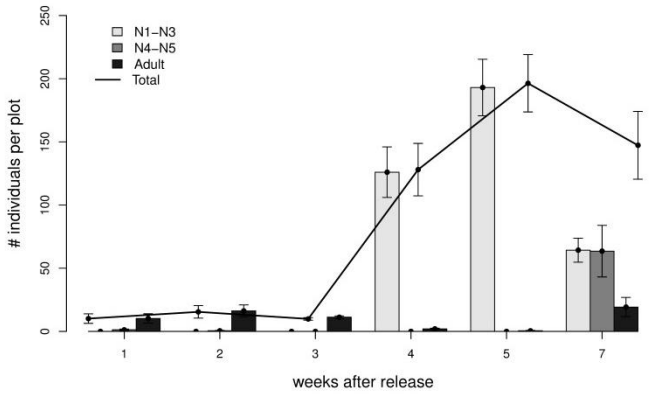


Predation in cages is already much lower than in petri dish

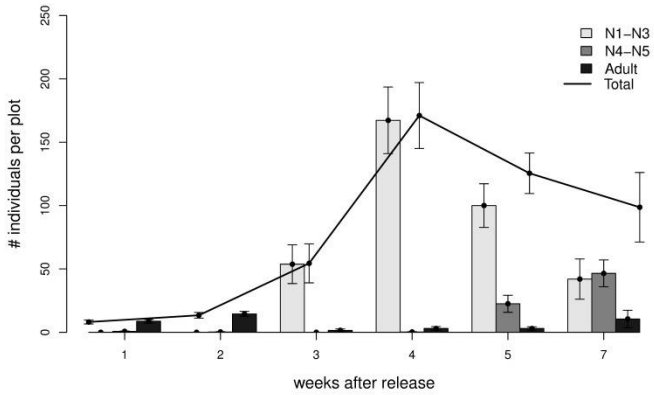
2. *Macrolophus pygmaeus*

- **Time of release**

A. Early release



B. Late release



Population dynamics of the 1st generation of *M. pygmaeus* after an early (A) and late (B) release under semi-commercial conditions

Planting: January 4th, 2012 (no application of abamectine)

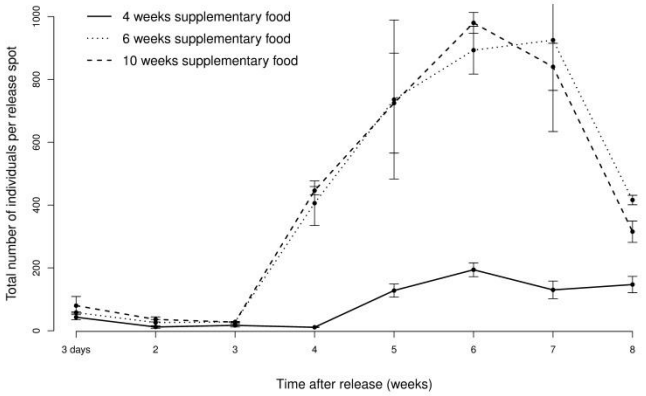
Early release: Jan 10th, 2012
Late release: Jan 30th, 2012

Development rate slower at late release but no difference in population dynamics

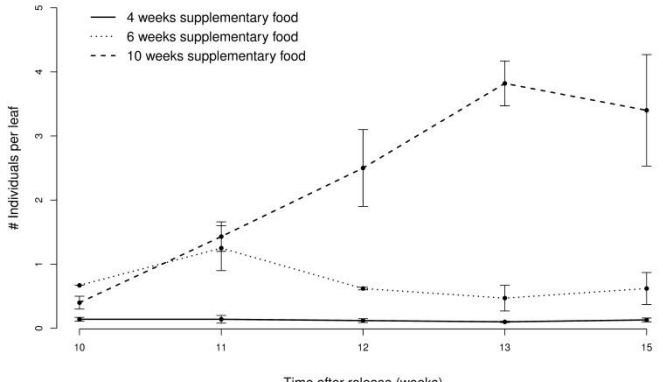
2. *Macrolophus pygmaeus*

- **Food supplements** **(Ephestia eggs and Artemia cysts)**

A. 1st generation



B. 2nd generation



Population dynamics of the 1st generation of *M. pygmaeus* (A) and 2nd generation (B) when provided with supplementary food during 4, 6 or 10 weeks

1st generation
Highest population with 6 and 10 weeks with supplemental food

2nd generation
Highest population with 10 weeks with supplemental food

2. *Macrolophus pygmaeus*

- **Other research topics**

Preference *T. absoluta* – whitefly (*T. vaporariorum*)

Fruit damage (yellow feeding marks, distortion => when population densities are very high e.g. 10 weeks of food suppl)

Side effects of Plant Protection Products

3. EPN

Former research on potential of EPN against *T. absoluta*

- **Batalla-Carrera et al. (2010)** Efficacy of entomopathogenic nematodes against the tomato leafminer *Tuta absoluta* in laboratory and greenhouse conditions. BioControl 55:523–530
- **Garcia-del-Pino et al. (2013)** Efficacy of soil treatments of entomopathogenic nematodes against the larvae, pupae and adults of *Tuta absoluta* and their interaction with the insecticides used against this insect. BioControl 58:723–731
- **Jacobson R and Martin G (2011)** A potential role for entomopathogenic nematodes within IPM of *Tuta absoluta* (Meyrick) on organic tomato crops. IOBC/WPRS Bull 68:79–83 (2011)

Former research on practical application of EPN in vegetables (nozzle type, spray volume, effect of adjuvants,…)

- **Beck B (2013)** Sustainable insect control in vegetables through optimized applications of entomopathogenic nematodes. Ghent, Belgium: Ghent University. Faculty of Bioscience Engineering.
- **Brusselman E (2011)** Optimizing the spray application of entomopathogenic nematodes in vegetables: from spray tank to nematode deposition. Ghent, Belgium: Ghent University. Faculty of Bioscience Engineering.





3. EPN

- **EPN species versus larval stage *T. absoluta***

T. absoluta larvae: **L1, L2, L3 and L4**

Larvae in **leaf disc** of 3 cm diameter (penetrated in leaf) (40 replicates)

EPN:

1. ***Steinernema carpocapsae*** (Carpocapsae-System, Biobest)
2. ***S. feltiae*** (Entonem, Koppert BV)
3. ***Heterorhabditis bacteriophora*** (B-green®, Biobest)

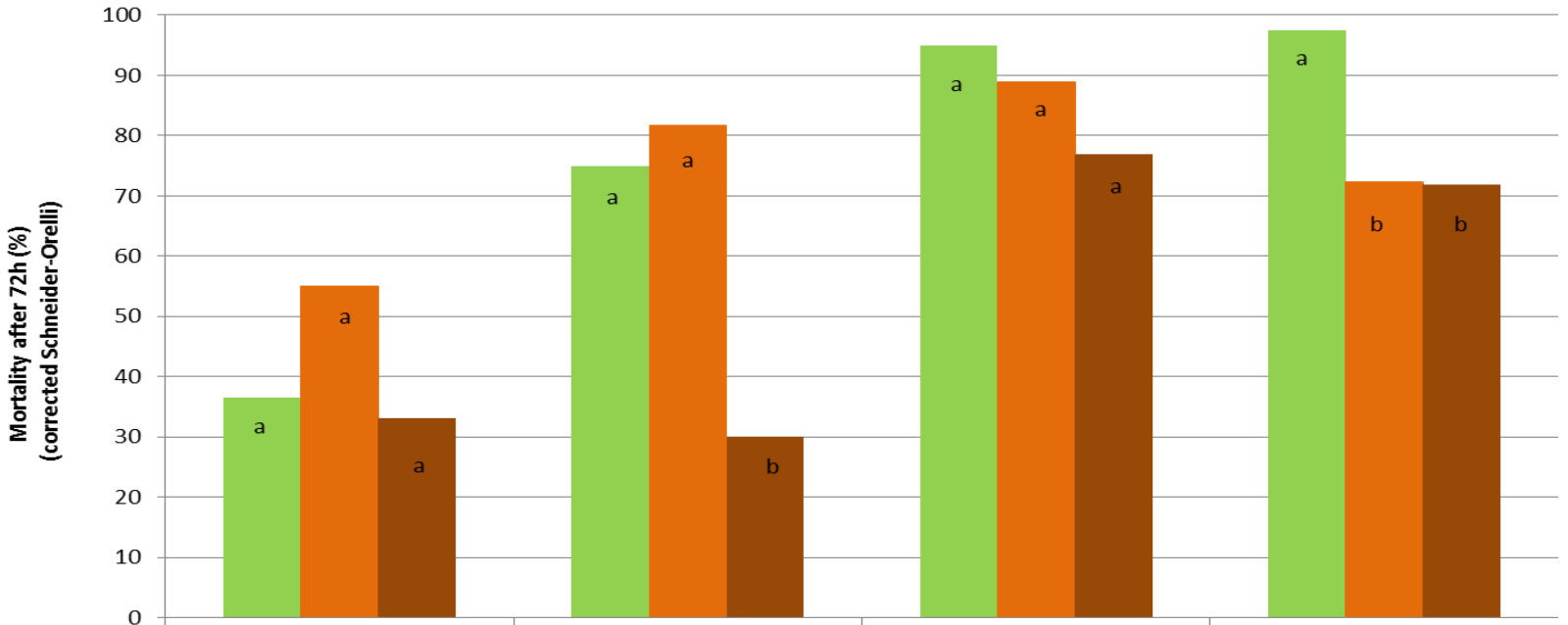
Dosage: **27.3 EPN/cm²** (=5 000 000 EPN/L*546 L/ha*10^{-8})

After spraying in incubator at 25 °C and 65 % R.H.

Evaluation after 72h: **mortality** and **living larvae** checked for **EPN presence**

3. EPN

- **EPN species versus larval stage *T. absoluta***



	L1	L2	L3	L4
Steinernema carpocapsae	36,5	74,9	94,9	97,4
S. feltiae	55,1	81,7	88,9	72,2
Heterorhabditis bacteriophora	33,1	29,9	76,8	71,8

All tested species effective against larval stages of *T. absoluta* => complementary to *Macrolophus pygmaeus*

Highest mortality rate for L3 and L4

3. EPN

- **EPN species most effective at 18 and 25 °C**

T. absoluta larvae: **L3**

Larvae in **leaf disc** of 3 cm diameter (penetrated in leaf) (40 replicates)

EPN:

1. ***Steinernema carpocapsae*** (Carpocapsae-System, Biobest)
2. ***S. feltiae*** (Steinernema-System, Biobest)
3. ***Heterorhabditis bacteriophora*** (B-green, Biobest)

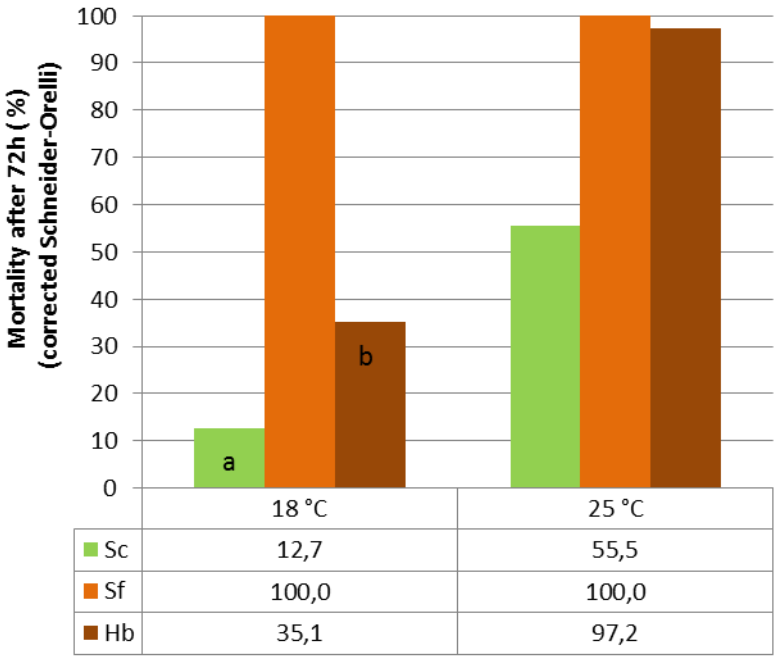
Dosage: **27.3 EPN/cm²** (=5 000 000 EPN/L*546 L/ha*10^{-8})

After spraying in incubator at 18 or 25 °C and 65 % R.H.

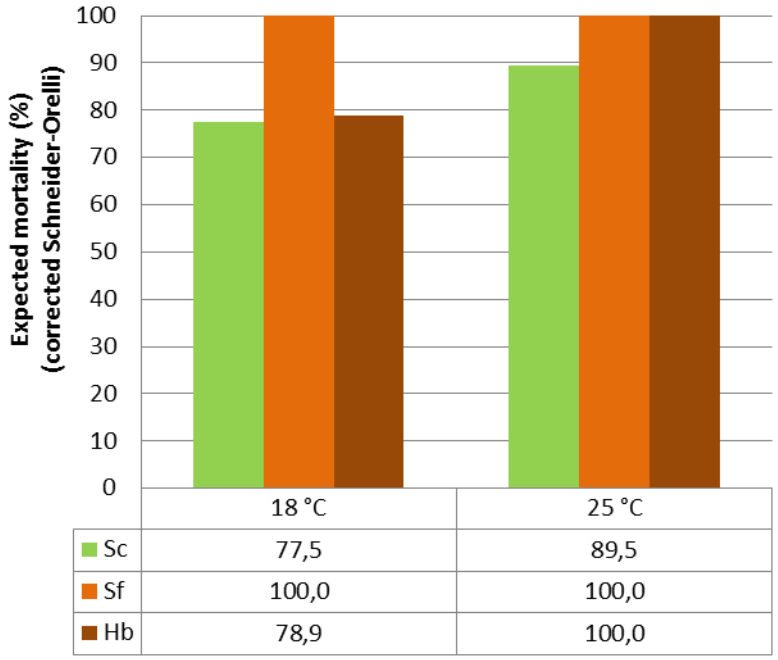
Evaluation after 72h: **mortality** and **living larvae** checked for **EPN presence**

3. EPN

- **EPN species most effective at 18 and 25 °C**



	18 °C	25 °C
Sc	12,7	55,5
Sf	100,0	100,0
Hb	35,1	97,2



	18 °C	25 °C
Sc	77,5	89,5
Sf	100,0	100,0
Hb	78,9	100,0

At 25°C: after 72h hightest mortality by *Steinernema feltiae and Heterorhabditis bacteriophora*

At 18°C: after 72h highest mortality by *S. feltiae*

IPM *Tuta absoluta*

Cold tolerance

- Supercooling point
- Lethal time
- Reproductive diapause
- Winterfield trial

Macrolophus pygmaeus

- Predation capacity
- Time of release
- Food Supplements
- Other

Entomopathogenic nematodes (EPN)

- EPN species
- Temp °C

CONCLUSIONS

T. absoluta **survives crop-free period in winter time when greenhouse is kept frost free (2-3 weeks)**

T. absoluta **needs to be controlled towards the end of the season**

Also nymphs contribute to control

Predation mainly on eggs, less frequently on smaller larvae

Appropiate population density needed (mininum population or treshold still to be defined)

As 2nd line of defense against larvae

More tests needed in the greenhouse

Ongoing Research

- ***Macrolophus pygmaeus***

- Minimum population needed to control *T. absoluta*

- Predation preference *T. absoluta* – whitefly

- **EPN**

- Greenhouse trials

- Side-effects on *M. pygmaeus*

- **Survey** on IPM-implementation => research driven by growers' demand
- **Sustainable/IPM strategy for growers (decision tree)**

Thank you

agency for Innovation
by Science and Technology

UNIVERSITEIT GENT

ILVO
Institute for Agricultural and Fisheries Research

PROEFSTATION VOOR DE GROENTETEELT

PROEFCENTRUM HOOGSTRATEN