

Optimisation of formulation technology for entomopathogenic nematodes applied against foliar pests

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Why nematodes on the leaf?

- EPN can be integrated with other biological insecticides and are rated harmless to beneficial insects
- Boring or mining insects can be actively controlled
- Many insects have developed resistance against insecticides, EPN is a novel alternative insecticide on foliage
- Market augmentation lowers the costs for EPN

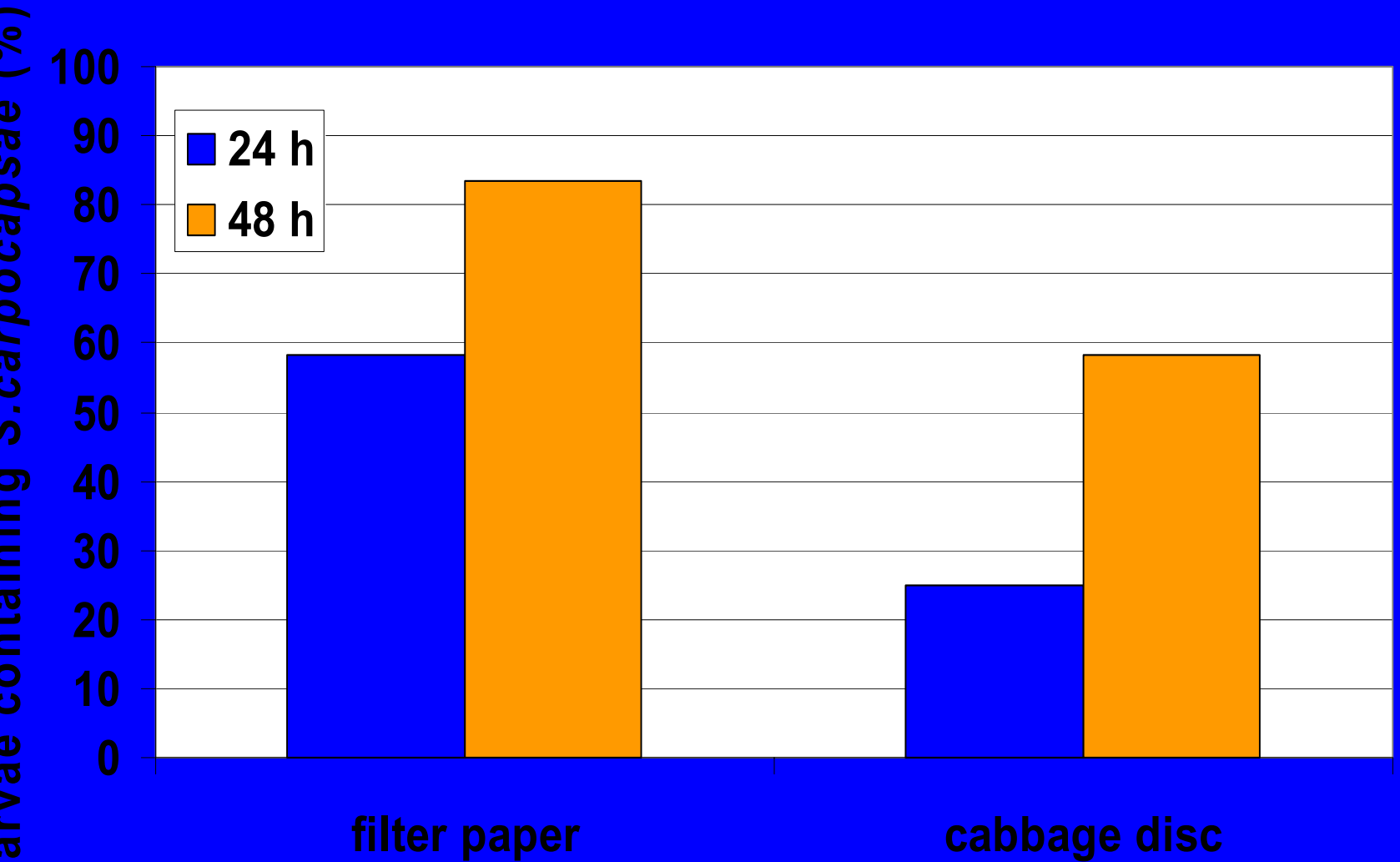
Constraints with nematode foliar application

- Nematode survival on foliage (UV-radiation, heat and drought)
- Dose transfer and distribution on leaf
 - Loss of viability by the use of application devices
 - Sedimentation of nematodes in tank mixes
 - Nematode run-off from foliage

Improving EPN efficacy on foliage

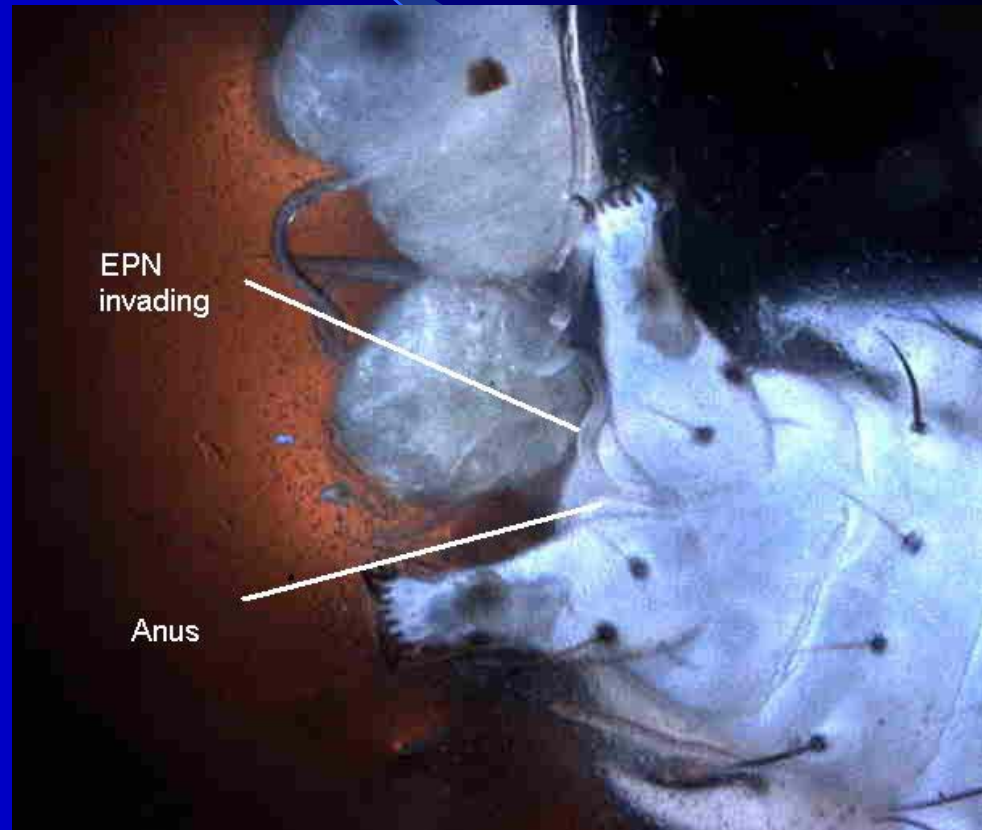
- Use of anti-desiccants *e.g.* „Folicote“
- Alginate pellets with phagostimulants against *Helicoverpa armigera* and *Spodoptera* spp.
- Optimisation of distribution on the leaf using surfactants, polymers and modified application devices
- Support of EPN mobility on foliage for active invasion into *Plutella xylostella*

Impact of feeding on EPN efficacy against *Plutella xylostella*



Invasion of *Steinernema carpocapsae* into *Plutella xylostella* larva

- Trachea seem too small for EPN to pass
- Oral penetration is prevented by larvae
- Successful invasion was only observed via the anus



Improvement of EPN efficacy by surfactant-polymer-formulation (SPF)

- 0.3% surfactant and 0.3% viscid polymer (xanthan gum) reduce the LD₅₀ from 13 to 1 *S. carpocapsae* / *P. x.* larva and the LT₅₀ from 42 to 22 h
- 0.05% xanthan gum prevent EPN sedimentation for > 1 h
- 0.2% xanthan gum diminish EPN loss by run-off from 70 to < 20%

Can the SPF improve EPN efficacy against other insects?

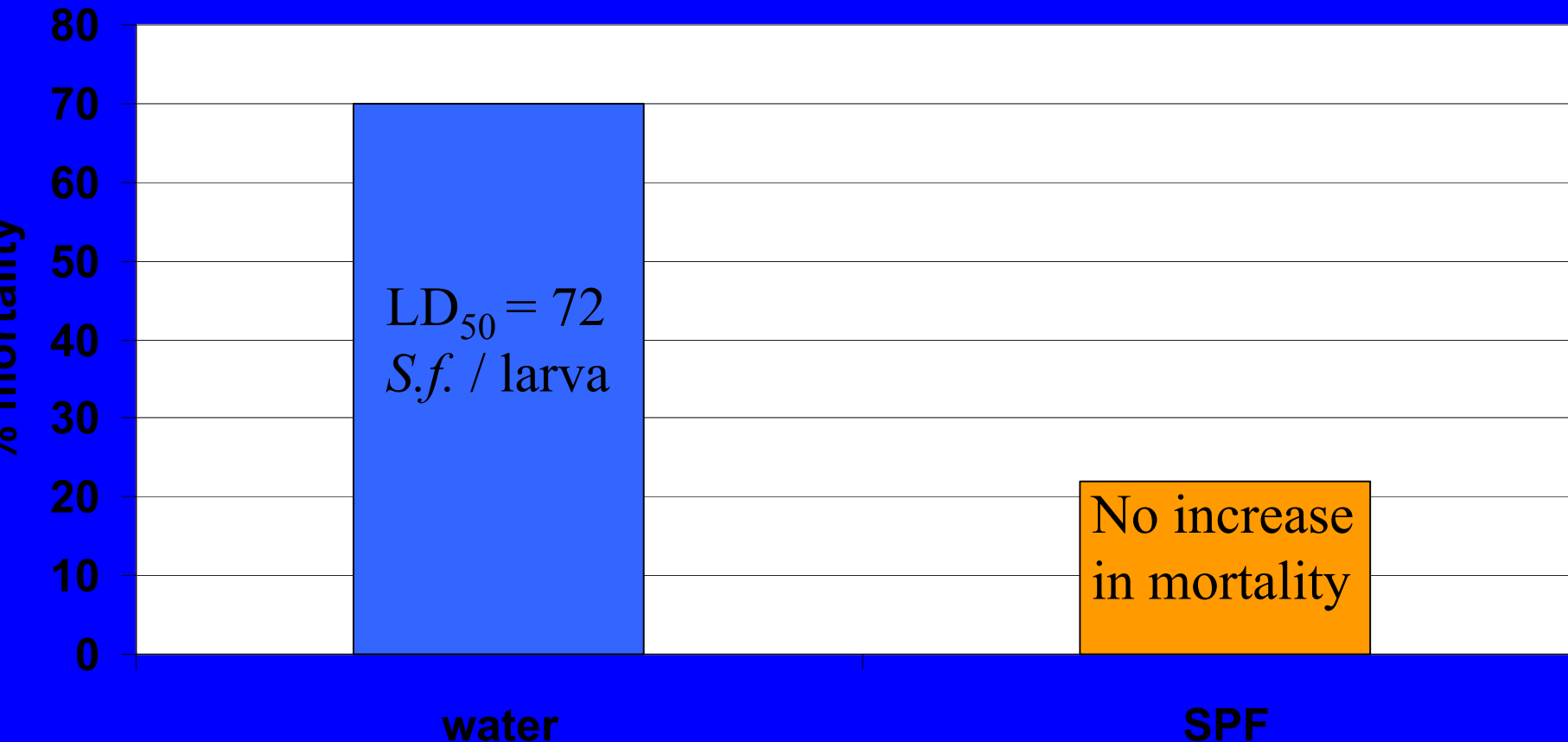
- *Heliothis virescens* takes up EPN orally, enhanced EPN mobility might increase invasion via trachea, mouth and anus



- *Brassica pekinensis* leaflets were treated with *S. feltiae* at variable dose in water or SPF
- Single 2-3rd instar *H. virescens* larvae were added to 6 cm dishes
- 48 h incubation at 25°C and 80% RH

Effect of the SPF on EPN efficacy against *H. virescens*

Efficacy of 100 *Steinernema feltiae* / larva (n=3)



Hypothesis for negative effect of the SPF

- EPN specific: within the SPF *S. feltiae* act differently compared to *S. carpocapsae*
- Plant specific: the leaf structure of *Brassica pekinensis* inhibits the mobility of nematodes
- Insect specific: *H. virescens* avoid the SPF

Conclusion

- EPN can be used as an alternative insecticide against foliar pests, but
- foliar application technology has to be specified for each crop and pest
- Improvements for active invasion are promising

Future research plan at the Imperial College London in cooperation with Prof. Denis Wright

- Development of robust EPN application protocols for optimised leafminer (*Liriomyza* spp.) control
- Optimisation of the LD_{50} and the LT_{50} using the SPF
- Considering different leaf structures of crop plants
- Investigation of possible side effects of EPN and the formulation on major parasitoid species of leafminers

Liriomyza huidobrensis

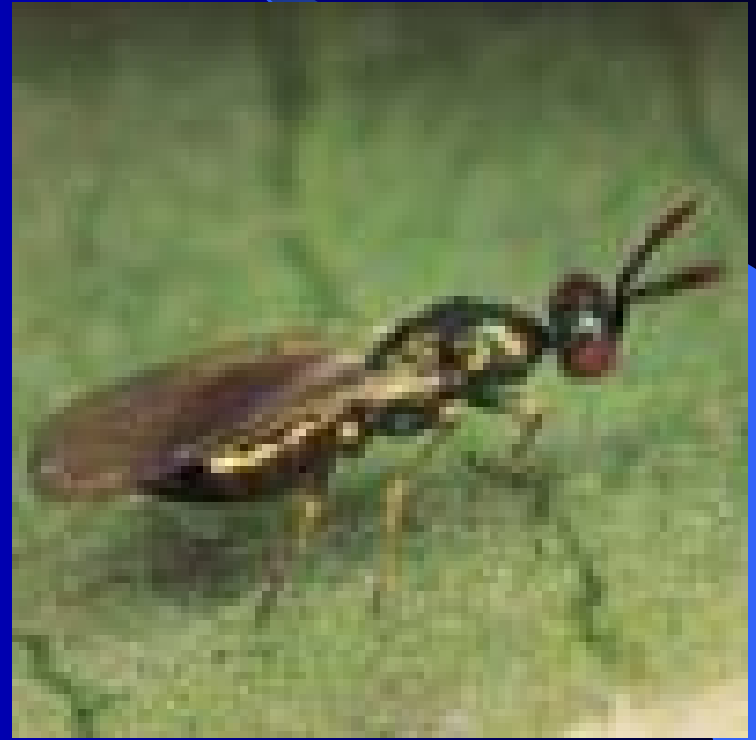
- *L. huidobrensis* has quarantine status in northern parts of Europe
- Develops resistance
- Difficult to control due to mining in the leaf tissue
- Polyphagous pest
- Larvae are actively invaded by nematodes via the anus



Parasitoids of *L. huidobrensis*



Dacnusa sibirica

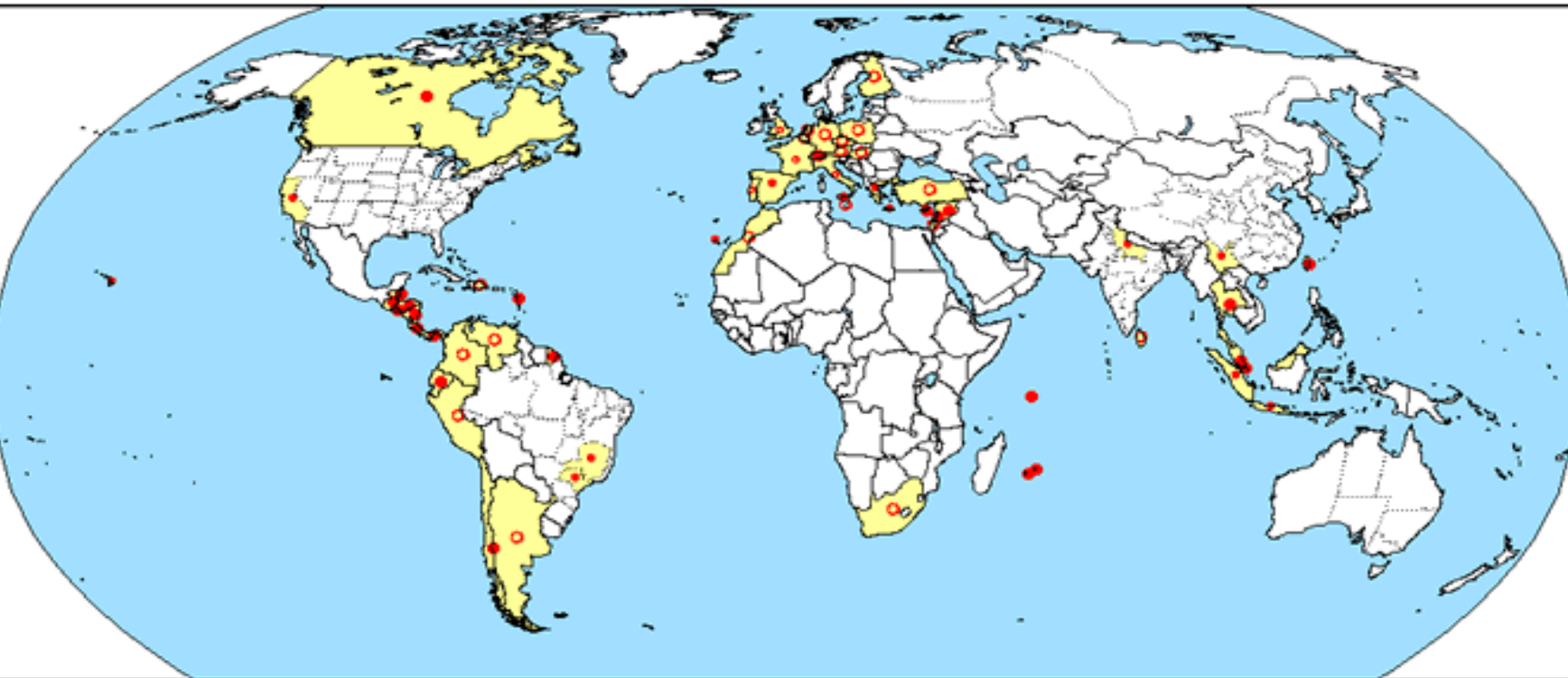


Diglyphus begini

L. huidobrensis appearance

Distribution Maps of Quarantine Pests for Europe

Liriomyza huidobrensis



National record



Subnational record



Present

Present only in some areas

Thank you for your attention!



**Interested? - We still look for
technical and financial support**