IPM strategy for control of the Western Corn Rootworm *Diabrotica virgifera virgifera* with dianem® (*Heterorhabditis bacteriophora*)

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Life Cycle Dvv

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Costs for crop rotation: 150-650 €/ha (Kehlenbeck, 2014)
Damage to the roots

www.e-nema.de oder https://www.youtube.com oder www.dianem.at
Despite the use of chemical control measures (neonicotinoides, tefluthrin, cypermethrin), severe damage is reported from Styria, Austria. **Without crop rotation** huge populations build up, which can hardly be controlled anymore. Even **with crop rotation**, control measures are needed to keep populations below the damage threshold.
# Chemical Control

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Description</th>
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<tr>
<td><strong>3 x Leaf Treatment (Neonics)</strong></td>
<td>- against adults</td>
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<td><strong>Seed Treatment (Neonics)</strong></td>
<td>- Cruiser, Poncho against larvae</td>
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<td><strong>Pyrethroid Granules</strong></td>
<td>- Tefluthrin, Cypermethrin</td>
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<td><strong>GMO-Maize</strong></td>
<td>- BT-gene Cry III and 4 other stakes</td>
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- **Maize plant 2 m high, high application costs**
- **Serious impacts on bees**
  Baned, review Jan 2017
- **High environmental toxicity** (earthworms) and irritating for users
- **Low tox, resistance already reported from USA**
Biological control with dianem®

The product dianem® contains:

Nematodes

Heterorhabditis bacteriophora

Symbiotic bacteria

Photorhabdus luminescens
The Dauer Juvenile

- Dauer Juveniles (DJ): enduring stage, ca. 0.6 mm
- Live from fat reserves
- Transport symbiotic bacteria in intestine
Life cycle

Bacteria proliferate and kill host within 2 days

Host consumed
DJs develop, which seek for new hosts

DJ infest host and release bacteria

Bacteria proliferate and kill host within 2 days

Nematodes feed on bacteria and reproduce

www.e-nema.de oder https://www.youtube.com oder www.dianem.at
Biotechnical production

Production EPN in sterile liquid culture of 1.000 - 65.000 ltr. scale
R&D e-nema

- Field trials since 2004 in A, HU, D and I
- Certified partners (CABI, AGES, Agricola, Sagea, LTZ)
- Always compared to chemical products
- In HU and A trials with artificial infestation of plants (100-300 eggs/plant) on rotated fields
- We assessed control of adults, ag chems provide root damage, but chemicals promote growth of roots
When to apply?

Investigations on nematodes persistence indicate that nematodes survive at high enough numbers for 4-6 weeks to control pest larvae at emergence in May/June.
Life Cycle Dvv

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Apply Dianem® with seed drilling machine

See: www.dianem.at or www.dianem.de

Liquid application:
2x10⁹ DJ ha⁻¹
in 200 ltr. water
Dose-mortality, CABI 2012 + 2014

CABI, HU (Mako, 2012)
(dianem® - *Heterorhabditis bact.* 1, 2 und 3 x 10^9/ha, Tefluthrin 13,3 kg/ha, Clothianidin-Saatgutbeize)
Dose-mortality, AGES 2013

Number of adults/plant

Numbers on bars: Control adults/plant (%)
Control (%) reduction of adult population
100-300 eggs/plant, $2 \times 10^9$ DJ/ha

Dianem® better, same or worse than chemical
Strategy without chemicals

- Tillage
- Fertilisation
- Variety
- Rotation
- Biological Control
Severe difference in lodging of different varieties
Damage on corn cob

Early flowering before maximum flight of adults will limit damage by adults.
Some crops attract Dvv and eggs are laid.

Current strategy: Crop other then maize every three years.

Control necessary

Oil Pumkin in Syria, Austria 2014
Dianem® is an effective and environmentally safe control measure

Provides sustainable control of Dvv

Subsequent use reduces population density

Easy to apply

More than 40 field trials with natural population support findings

Research (EU project Biocomes) provides strains with higher virulence

In future potential for dose reduction to better compete with chemicals

Belem: 50 €/ha

Sales DE: none (60ha), A: 25 ha, CZ, I: none
Thanks to:

Stefan Toepfer; CABI, HU
Gieselher Grabenweger, Andreas Kahrer, AGES, A
Peter Knuth, LTZ, DE
Karl Müller-Sämann, Jürgen Maier, cult-tec, DE
August Jost, Hermann Strasser und Hannes Rauch, A
Kurt Foltin, A
Urs Wyss, DE
Michael Lichtenberg, DE

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www.dianem.at
www.e-nema.de
Large scale trials with natural infestation in Styria since 2013

- Registration in A since 2013
- But AGES provides Art. 53 authorisation for Cypermethrin

Large cages

Small cages EU Project Inbiosoil
Evaluation with natural infestation

Number of adults on sticky trap until end of blossom

Evaluation of lodging in July

Evaluation of leaf damage
Field trial 2014 in Lichendorf, Styria

Number of adults/trap (mean of 3 traps in 3 weeks)

Lichendorf 1, Sorte: Maisadour RZ 340
Field trials 2015 in Unterschwarza, Styria

Number of adults/trap (mean of 9 traps)
Helicopter fotos, 2014
Field in Unterschwarza

Nematodes

Control