Biological control of the Western Corn Rootworm (Diabrotica v. virgifera) by entomoparasitic nematodes

Grabenweger G. & Pilz C. & Heimbach U. & Kahrer A.
Contents

• Previous studies on entomoparasitic nematodes (=EPN): *Heterorhabditis bactriophora* in laboratory → more field trials were necessary

• Objectives

  1. Improvement of trial design: artificial infestations with *Diabrotica* eggs

  2. Test of different formulations

  3. Test of different application rates

• Conclusion and discussion
Materials & Methods

• Experimental Design:
  - 200m² randomized field plots, 5 replications; Deutsch Jahrndorf, high Diabrotica population, irrigation, treated control: Clothianidin

• Artificial infestation of maize plants with Diabrotica-eggs:
  - Adults are caught in the year before, oviposition in laboratory, earth containing eggs was stored near the field plots, portioned, delivered beneath the ground near 3 plants per plot shortly before natural hatch

• Experimental period: 3 years (2009-2011), 4 experiments

• Experimental independant variables:
  - Larval densities: Plants were infested artificially at varying rates of Diabrotica eggs
  - Formulations of EPN: Suspension (500l/ha), Granular (10kg/ha), Seed treatment; all formulations were provided by e-nema (company)
  - Application rates of EPN: 1.3 to 2.7 Billions (Milliarden) Nematodes/ha
Materials & Methods (Assessments)

- Hatched beetles:
  - Cages (tents) were imposed on infested and treated maize plants at the beginning of adult hatch. Beetles were counted weekly for 2 months long.

- Root rating of damages (node injury scale), carried out in August.

- Persistence of EPN in the soil:
  - Mixed sample for each plot, living baits (*Galleria* or *Tenebrio*) added, stored for one week at 25°, infested larvae were submersed in water for validation.
Trial 1 (2010)
Application: **1.3 Billions** (Milliarden) EPN/ha
Infested artificially at 3 rates

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Adults/Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>a</td>
</tr>
<tr>
<td>Clothianidin coated</td>
<td>a</td>
</tr>
<tr>
<td>Clothianidin granules</td>
<td>a</td>
</tr>
<tr>
<td>EPN suspended</td>
<td>ab</td>
</tr>
<tr>
<td>EPN granules</td>
<td>ab</td>
</tr>
</tbody>
</table>

Good survival of beetles, only few significant results, application rate was too low
Trial 1 (2010)
Application: **1.3 Billions** (Milliarden) EPN/ha
Infested artificially at 3 rates

![Graph showing node injury for different treatments.](image)

**Treatment**

- Control
- Clothianidin coated
- Clothianidin granules
- EPN suspended
- EPN granules
Trial 2 (2010)
Application: **1.3 Billions** (Milliarden) EPN/ha
Infested artificially with 300 eggs/plant
Trial 2 (2010)
Application: **1.3 Billions** (Milliarden) EPN/ha
Infested artificially with 300 eggs/plant

**Node Injury**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>EPN suspended</th>
<th>EPN granules</th>
<th>Clothianidin</th>
</tr>
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<tbody>
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<td>0.30</td>
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<tr>
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<td></td>
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<td>0.12</td>
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<td>0.12</td>
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</tbody>
</table>

a, b, ab indicate significant differences at the 0.05 level.
Trial 3 (2011)
Application: 2 Billions (Milliarden) EPN/ha
Infested artificially at 2 rates
Trial 3 (2011)
Application: 2 Billions (Milliarden) EPN/ha
Infested artificially at 2 rates
Trial 4 (2009)
Application: **2.7 billions** (Milliarden) EPN/ha
Infested **additionally** with 300 eggs per plant

![Graph showing beetles/plant counts for different treatments: Control, EPN suspended, EPN granules, and Clothianidin.](image-url)
Trial 4 (2009)
Application: **2.7 billions** (Milliarden) EPN/ha
Infested additionally with 300 eggs / plant

Node-injury-scale

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>EPN suspended</th>
<th>EPN granules</th>
<th>Clothianidin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Node-injury-scale</td>
<td>2.4</td>
<td>1.4</td>
<td>1.5</td>
</tr>
</tbody>
</table>

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Persistence/Establishment of EPNs

Longterm establishment is possible if diabroticalarvae are available.
Conclusions

- **Experimental Design – artificial infestation with eggs**: 500 eggs/plant are appropriate for reasonable results (survival of ~10%)

- **Formulation of EPNs**: Suspension of Nematodes in water showed good effectivity; other formulations were not supported by the company later on

- **Application Rate**
  - High concentrations of EPNs (2.7 Billions/ha) during sowing of the maize reduced the numbers of hatched adults significantly and reduced also root damages (Trials in 2009). They showed equal effectivity in respect to hatched adults as Clothianidin treated seeds
Conclusions (continued)

- **Application Rate**

  - Low concentrated EPNs (1.3 Billions/ha), irrespective of their formulation were inappropriate for an efficient control (hatched beetles) in 2010. Further trials (2010, 2011) with a moderate concentration (2 Billions/ha) lead to similar results.

  - **Seed treatment with clothanidin** (=treated control) showed best results in respect of prevention of root damage (according node injury scale).
Conclusions (continued)

- **Overall effectivity of measures** against corn root worms: a total eradication was not possible neither by EPNs nor by Clothianidin

- **Influence of measures on yield**: None of the tested measures showed influence on the yield: most probably due to irrigation
Thanks to our staff members

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Helmut Klapal
Alois Egartner
Kristin Schwabe

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Many thanks for your attention

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