Spreading predictions of the Western corn rootworm in Germany until 2021

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Introduction

• in 1992, first detection in Europe (Belgrade Airport in Serbia)

• rapid expansion in Europe
  – active by flying
  – passive by means of transport

• spread distance in Europe varies by years and from region to region
  – influenced by regional conditions

• lacking knowledge of dispersal in Germany and the influence of control measures on the spread distance

→ development of a dispersal model
Dynamic dispersal model

• the model based on published data and knowledge of the historical dispersal

• the model is a raster model
  – uniform square grid cells
  – each grid cell amount to 2.3 km

• each grid cell is again spilt in polygons
  – contain crops on field level

• the time step of the model is one year
Dynamic dispersal model

SITUATION OF DIABROTICA

Legend:
- process (algorithm, data processing)
- expert knowledge (literatur, experiments, assumption)
- georeferenced data (input) primary and secundary data, transnational
- georeferenced data (output) new generate data set
Situation of Diabrotica

- all beetles within a grid cell disperse uniformly over the polygons with maize
  - from monoculture to first year maize
  - different stages of development

- the most eggs are laid uniformly over the polygons with maize (98 %)

- the other 2 % of the eggs are homogeneously laid in all other fields

- no eggs are laid in forest, urban and sea areas
Dynamic dispersal model

- **Initial infestation**
- **Historical situation**
  - **Corn growing data**
  - **Population growth**
    - **Population density**
  - **Georeferenced data** (input)
  - **Arable land**
    - **Natural barriers**
      - **Expert knowledge** (biology of diabrotica)
      - **Expert knowledge** (empirical)
      - **Migratory flights**
      - **Regional ways of spread**

**Legend:**
- **Process** (algorithm, data processing)
- **Expert knowledge** (literature, experiments, assumption)
- **Georeferenced data** (input) primary and secondary data, transnational
- **Georeferenced data** (output) new generate data set
Regional spread

- Regional spread is divided into two parts
  - regional dispersal
  - transregional dispersal
Dynamic dispersal model

**Legend:**
- **process** (algorithm, data processing)
- **expert knowledge** (literatur, experiments, assumption)
- **georeferenced data** (input) primary and secondary data, transnational
- **georeferenced data** (output) new generate data set
Long Distance Flight

• begin by a higher population density than the regional spread
• longer than the regional spread
• dispersal in Europe reaches distances of up to 80 km (Kiss et al. 2005)
• range of dispersal follows a density function
• Beetles were detected in 130 m (Gray, 2001)
  → forest, urban and sea areas are no barriers
• The most females were mated at that time of dispersal (Coats et al., 1996)
  → colonization is possible
Dynamic dispersal model

legend:

- process
  (algorithm, data processing)

- expert knowledge
  (literatur, experiments, assumption)

- georeferenced data (input)
  primary and secondary data, transnational

- georeferenced data (output)
  new generate data set
Global spread

- introductions near airports, railway stations and motorway service areas
- all introduction in the model are successful
  - only cells with maize are cells where introductions could be possible
- three introductions per year
  - 2 introductions in 2010 and 2011
  - 5 introductions in 2012
<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Beetles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>6,650</td>
</tr>
<tr>
<td>Baden-Württemberg</td>
<td>6,121</td>
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<tr>
<td>Bavaria</td>
<td>174</td>
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<tr>
<td>Hesse</td>
<td>354</td>
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<td>Rhineland-Palatinate</td>
<td>1</td>
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<tr>
<td>North Rhine-Westphalia</td>
<td>0</td>
</tr>
</tbody>
</table>

Authors: Krügener, Baufeld, Rischewski; based on data provided by regional plant protection services.
Predicted scenarios in ten years

- Growth factor: 5
  - 350 cells

- Growth factor: 7.5
  - 2371 cells

- Growth factor: 10
  - 6485 cells

Beetles per ha:
- 1.000 - 9999.999
- 10000.000 - 79999.999
- 80000.000 - 319999.999
- 320000.000 - 2514367.876
Predicted scenarios in twenty years

- growth factor: 5
  - 5576 cells

- growth factor: 7.5
  - 27229 cells

- growth factor: 10
  - 33277 cells

beetles per ha

- 1.000 - 9999.999
- 10000.000 - 79999.999
- 80000.000 - 319999.999
- 320000.000 - 2514367.876
Predicted scenarios in ten years

efficiency: 60%
144 cells

efficiency: 70%
66 cells

efficiency: 90%
0 cells

beetles per ha
- 1,000 - 9,999,999
- 10,000,000 - 79,999,999
- 80,000,000 - 319,999,999
- 320,000,000 - 2,514,367,876
Conclusion and forecast

• the spread of the beetle is 18.5 time faster by a growth factor of 10 than by a growth factor of 5 after ten years

• the use of control measures result in a decline of the infestation
  – an efficiency of 60 and 70% add up to a reduction of the infestation
  – an efficiency of 90% result in a dramatic decrease of the infestation

• further scenarios
  – integration of the climate
  – altered densities for the initial spread

• validation of the model
  – only possible with future spread
Thank you for your attention