Implementation of the EFSA guidance on covered crops at member state level

Developments in the Netherlands

25 September 2015, Louise Wipfler
Set up

- Background of the Dutch greenhouse scenarios
- Greenhouse scenarios overview
- The Greenhouse Emission Model (GEM)
- Results of calculations with example substances
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Horticulture in the Netherlands

- About 11,000 ha horticultural activity
  - Floriculture and pot plants: ca 6,300 ha
  - Vegetables: ca 4,700 ha
- Mainly glasshouses, permanent structures with additional light, that can be heated, shaded and ventilated (high tech and automated)
- 75% soilless (substrate), 25% soil-bound
- Horticulture in a water rich environment
Example crops grown in substrate and soil bound grown crops

<table>
<thead>
<tr>
<th>Soilless</th>
<th>Soil bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>Chrysanthemum</td>
</tr>
<tr>
<td>Cucumbers</td>
<td>Alstroemeria</td>
</tr>
<tr>
<td>Sweet pepper</td>
<td>Freesias</td>
</tr>
<tr>
<td>Bulb flowers</td>
<td>lilies</td>
</tr>
<tr>
<td>Pot plants</td>
<td>Other cut flowers</td>
</tr>
<tr>
<td>Roses</td>
<td>Beans</td>
</tr>
<tr>
<td>Conifers</td>
<td>Carrots</td>
</tr>
<tr>
<td>Aubergine</td>
<td>Leek</td>
</tr>
<tr>
<td>lettuce</td>
<td>cabbage</td>
</tr>
</tbody>
</table>
Background of scenario development

- Generally excepted scenario’s for exposure due to PPP use in greenhouses not available in NL and EU
- Current Dutch authorisation procedures use a fixed emission percentage of 0.1% (as in drift)
  - Not in line with major emission routes
  - Likely to underestimate emissions from greenhouses
- Two scenario’s were developed:
  - soil-bound crops
  - crops grown on substrate
Set up

- Background of the Dutch greenhouse scenarios
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- Results of calculations with example substances
Scenarios soil-bound: endpoints

- Protection goals: surface water and groundwater
- Predicted Environmental Concentrations (PEC):
  - 90th overall percentile of annual peak concentration in surface water. Time weighted averaged concentrations are calculated over the selected year.
  - 90th overall percentile average groundwater concentration at 1 m depth
Scenarios soil-bound: drivers for emission

- Irrigation and application management
- Crop type
- Soil characteristics
- Hydrological situation
Scenarios soil-bound: differences with field situation

- Controlled irrigation → less temporal variability
- Higher temperatures
- Top soil enriched with organic matter
- Groundwater level controlled by drains
- Production year around
- Annual sterilization of the soil
Scenarios soil-bound: main features

- Model crop: Chrysanthemum
- Excess irrigation water: 30% (realistic worst case) annual irrigation 1000 mm
- OM enriched top 30 cm of the soil
- Selection of 90th percentile weather year

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Soil type</th>
<th>Groundwater level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water</td>
<td>heavy clay (macropores)</td>
<td>between 80-120 cm below soil surface</td>
</tr>
<tr>
<td>Groundwater</td>
<td>light sandy clay</td>
<td>Deep groundwater</td>
</tr>
</tbody>
</table>
Scenarios soil-bound

- **Models:**
  - WATERSTREAM model: irrigation, evapotranspiration & temperatures in greenhouse
  - PEARL: PEC groundwater and emission to surface water
  - TOXSWA: PEC in surface water

- **Recommendations:**
  - Sterilization: degradation is likely lower than in field situation. Use of adjustment factor (10) for DegT50.
  - Higher tier: DegT50 can be measured in greenhouse soils
Scenarios soilless: endpoints

- Protection goal: surface water

- Predicted Environmental Concentrations (PEC):
  - Either 50th or 90th overall percentile annual peak concentration in surface water. Time weighted averaged concentrations are calculated over the selected year.
Scenarios soilless: conceptual model

- Closed loop systems (water recirculation is compulsory)
- Water management of grower is very important
- Mayor emission routes:
  - Discharge of deteriorated water (high sodium levels)
  - Filter rinsing water
- Limitation on water discharge due to new directive on nutrients

- Predominant irrigation:
  - drip irrigation
  - Ebb/flow (tables)
## Scenarios soilless: 4 crop classes

<table>
<thead>
<tr>
<th>Crop class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>main crop</strong></td>
<td>Rose</td>
<td>Tomato</td>
<td>Sweet pepper</td>
<td>Ficus</td>
</tr>
<tr>
<td><strong>Other crops</strong></td>
<td>Gerbera, starting material vegetables</td>
<td>Cucumber, herbs</td>
<td>Aubergine, strawberry</td>
<td>Pot plants, floriculture, other flower crops</td>
</tr>
<tr>
<td><strong>Annual water demand</strong></td>
<td>8250 m³/ha</td>
<td>7670 m³/ha</td>
<td>6530 m³/ha</td>
<td>4640 m³/ha</td>
</tr>
<tr>
<td><strong>Threshold Sodium level</strong></td>
<td>4 mmol/L</td>
<td>8 mmol/L</td>
<td>8 mmol/L</td>
<td>6 mmol/L</td>
</tr>
<tr>
<td><strong>Mean annual discharge</strong></td>
<td>720 m³/ha</td>
<td>450 m³/ha</td>
<td>430 m³/ha</td>
<td>205 m³/ha</td>
</tr>
</tbody>
</table>
Example discharge patterns

tomato

tsweet pepper
Scenarios soilless: models

- WATERSTREAM model: water demand, filter discharge, discharge of deteriorated water & temperatures
- Substance Emission Model: fate in recirculation water, concentration in discharged water
- TOXSWA: PEC in surface water
Substance Emission Model: lay-out

Greenhouse model lay-out for application via nutrient solution scaled to 1 ha. Reservoir volumes in m³.
Substance Emission Model: PPP fate

- Number of connected ideally mixed tanks (fixed lay-out)
- Degradation via first order kinetics, formation of metabolites
- Plant uptake assumed to depend on Kow of PPP (Briggs)
- Differentiation between shielded slabs and ebb/flow systems (pot plants)
- Sorption considered to soil for pot plant cultivation only
- Application via nutrient solution (dripping) or via spraying, fogging or low volume mister
- PPP exchange with greenhouse air and condensation water
- Discharge to surface water depends on crop class (rose, tomato, sweet pepper or ficus)
Soilless: recommendations

- Degradation rates:
  - First tier: use hydrolysis as basis for degradation rates in recirculation water.
  - Higher tier: measure DegT50 in the recirculation water

- Mitigation option:
  - higher tier option: discharge via water purification system

- Use outside NL:
  - Check carefully whether scenarios can be used

- General:
  - Testing the applied (fate) models against data
Surface water concentrations (1)

- NL specific ditch receives water from greenhouses: point source
- TOXSWA model used to calculated concentrations
- Parameterisation the same for all scenarios

PPP fate processes in TOXSWA
Set up

- Background of the Dutch greenhouse scenarios
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The GEM software

- PEC calculation for soil-bound and soilless cultivation
- Scenarios are largely predefined.
- Main forms:
  - Manage projects
  - Manage assessments

Structure:

- SPIN database
- GEM database
- SPIN user-interface
- GEM user-interface
- WATER-STROMEN model
- Substance Emission Model
- PEARL calling SWAP
- TOXSWA

Reports

Graphs
User defined options

- Cultivation type
- Substance properties
- Crop type
- Application scheme
- Mitigation
- Output
Set up

- Background of the Dutch greenhouse scenarios
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- Results of calculations with example substances
Results example calculations: soil-bound

<table>
<thead>
<tr>
<th>Substance name</th>
<th>90\textsuperscript{th} overall percentile leaching concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kremsmünster-winter cereals</td>
</tr>
<tr>
<td>FOCUS A</td>
<td>143.66</td>
</tr>
<tr>
<td>FOCUS B</td>
<td>147.7</td>
</tr>
<tr>
<td>FOCUS C-metabolite</td>
<td>96.51</td>
</tr>
<tr>
<td>FOCUS D</td>
<td>95.9</td>
</tr>
</tbody>
</table>

\textit{90\textsuperscript{th} percentile concentrations of the FOCUS substances A to D, while using the adjustment factor}
35 realistic PPP-crop combinations were assessed
27 exceeded the authorisation criterion (90$^{th}$ percentile)
17 needed a reduction percentage > 90%
Calculations based on hydrolyses as degradation process: no microbial degradation considered
Authorisation criterion was based on first tier effect assessment: higher tier effect assessment will lead to more combinations that pass the criterion
Results example calculations soilless (2)

- **A** = Acaricide, **I** = insecticide, **F** = fungicide, **PGR** = plant growth regulator
Results example calculations soilless (2)

- A = Acaricide, I = insecticide, F = fungicide, PGR = plant growth regulator

15 of the 35 cases treatment is needed > 95%
Summary

- GEM is a tool that enables the calculation of PECs for Dutch greenhouses:
  - For soil-bound crops and groundwater
  - For soil-bound crops and surface water
  - For soilless crops and surface water

- These scenarios are based on realistic emission routes and state-of-the-art knowledge on greenhouse production systems.

- The use of these scenarios will probably lead to a higher risk associated with PPP use than before, especially for soilless grown crops.

- The use of higher tier options is possible but need further elaboration and testing.
Main collaborators

- **WG soilless:**
  - Ton van der Linden, RIVM, NL
  - Erik van Os, WUR Greenhouse Horticulture, NL
  - Adi Cornelese, Ctgb, NL
  - Daniel Ludeking, WUR Greenhouse Horticulture, NL
  - Tycho Vermeulen, WUR Greenhouse Horticulture, NL

- **WG Soil-bound:**
  - Aaldrik Tiktak, PBL, the Netherlands
  - Wim Voogt, WUR Greenhouse Horticulture, the Netherlands
  - Adi Cornelese, Ctgb, NL

- **Software development:** Mechteld ter Horst & Arjan de Jong, Alterra Wageningen UR, NL

Background reports and software: www.pesticidemodels.eu