Worker re-entry exposure within the framework of the BROWSE project

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Bystanders, Residents, Operators and Workers
Exposure models for plant protection products

SEVENTH FRAMEWORK PROGRAMME
Theme: Environment (including climate change)
Project nr: 265307

• 1 January 2011 – 30 June 2014
• Total budget 2.6m euro (EU contribution 2m)
• Project website: www.browseproject.eu
Partners:

- Food and Environment Research Agency, UK
- Alterra-PRI, The Netherlands
- Benaki Phytopathological Institute, Greece
- NIAB (The Arable Group), UK
- TNO, The Netherlands
- Ghent University, Belgium
- Universita Cattolica del Sacro Cuore, Italy
- University of Newcastle, UK
Goals of BROWSE

- To develop improved *exposure models* to assess the risks from exposure to plant protection products (PPPs) for:
  - Operators (WP1)
  - Workers (WP2)
  - Bystanders and residents (WP3)
Introduction

Modelling approach

Output
A worker exposure scenario is a combination of a crop group and a worker task.

**Outdoor scenarios**
- Harvesting orchard fruit
- Pruning orchard fruit
- Thinning orchard fruit
- Harvesting grapes

**Indoor scenarios**
- Harvesting soft fruit
- Harvesting ornamentals
- Harvesting fruiting veg
Exposure routes

- **ORAL EXPOSURE**
- **INHALATION EXPOSURE**
- **DERMAL EXPOSURE**

hand-to-mouth contact
Introduction

Modelling approach

Output
The conceptual model starts from the application of a substance. The initial deposit on the crop leads to contact with the crop, which can result in dermal exposure or hand-to-mouth contact, leading to oral exposure. The concentration in air at re-entry can lead to inhalation exposure. The volatilisation and dispersion of the substance modelled by PEARL(-OPS) can also contribute to exposure. The absorbed amount is the final outcome of the exposure pathways.
Four modules are combined in the software to estimate exposure from the different exposure routes.
Dermal exposure: basic model

DFR
Dislodgeable Foliar Residue

DE
Dermal exposure

TC = DE (µg/h)/DFR (µg/cm²)
Transfer coefficient
Dermal exposure is the result of contact with PPP residue on the crop.

Contact  Residue  Duration  Clothing/PPE
Dermal exposure is the result of contact with PPP residue on the crop

Expressed by transfer coefficient
- New set of defaults based on up-to-date literature analysis
- Defaults from EFSA or U.S. EPA
- User input

Expressed by dislodgeable foliar residue (DFR)
- Modelled by PEARL
- User input
Dermal exposure is the result of contact with PPP residue on the crop.

Duration of exposure
- Defaults based on survey data
- User input

Predefined options available
  → linked to coverage factors and migration factors
Inhalation exposure is the result of the inhalation of air with PPP residues

\[ IE = \text{AirC}_t \times \text{BR} \times T \times (\text{PF}_{\text{RPE}}) \]

- \text{AirC}_t = \text{concentration in air at re-entry (µg/m}^3\text{)}
- \text{BR} = \text{breathing rate (m}^3/\text{h)}
- \text{T} = \text{duration of exposure (h/d)}
- \text{PF}_{\text{RPE}} = \text{penetration factor (%)}
Inhalation exposure is the result of the inhalation of air with PPP residues

Modelled by
- PEARL-OPS for outdoor scenarios
- Modified version of PEARL for indoor scenarios

**Concentration air**
- From Exposure Factors Handbook
- User input

**Breathing rate**

**Duration**
Hand-to-mouth contact leads to oral exposure

Modelled by dermal exposure module

Exposure hands  Contact  Duration

Defined by:
Fraction of hand in contact with mouth
Hand-to-mouth transfer efficiency
Number of contacts – 1/hr
PEAR provides an estimate of the DFR and the concentration in the air under outdoor conditions.

Meteorological data over 5 year time period
- 6 locations in 3 EU zones
- Simulates one application every week in period April-September

Distribution of 120 data points
- Acute exposure: averaged over a single day
- Longer term exposure: averaged over longer period
indoor provides an estimate of the DFR and the concentration in the air under greenhouse conditions.

Greenhouse climate data of 1 week
Based on measured data from tomato greenhouses

Single point estimate
Acute exposure: averaged over a single day
Longer term exposure: averaged over longer period
PEARL indoor is able to provide reasonable estimates of the PPP concentrations in greenhouse air.

Example for fenpropimorph.

Concentration (µg/m³)

Hours after application

- run 5
- Center - high
- Aisle - high
- Center - low
- Aisle - low

modelled

measured
Introduction

Modelling approach

Outputs
Example for harvesting of orchard fruit

Task: harvesting
Crop: apple

Body parts making contact: upper body
Normal clothing: long sleeved shirt and trousers
PPE: none
Example for harvesting of orchard fruit

Assessment tab

- **Assessment** tab
  - Scenario selection
  - Toxicological reference values
  - Absorption factors and inputs for oral exposure

- **Product information**
  - Product name: Product
  - Active substance name: Ansee 500 SC

N.B. Browse software is only applicable to products that are applied with water as the carrier.
Example for harvesting of orchard fruit
Scenario tab

**inputs for the PEARL-OPS model**

<table>
<thead>
<tr>
<th>Environment</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind speed at 2m above ground</td>
<td>2.8 m/s</td>
</tr>
<tr>
<td>Crop height</td>
<td>1.5 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Applications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application type</td>
<td>Single</td>
</tr>
<tr>
<td>Applications made during longer term assessment period</td>
<td>3</td>
</tr>
<tr>
<td>Longer term exposure assessment period</td>
<td>1 Month</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vapour Exposure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop/meteorology combination</td>
<td>Central - Germany</td>
</tr>
<tr>
<td>Treated area</td>
<td>200m x 200m m²</td>
</tr>
<tr>
<td>Molar mass</td>
<td>248.0 g/mol</td>
</tr>
<tr>
<td>Saturated vapour pressure</td>
<td>2.0E-5 Pa</td>
</tr>
<tr>
<td>Temperature at which vapour pressure was measured</td>
<td>25.0 °C</td>
</tr>
<tr>
<td>Water solubility</td>
<td>1800.0 mg/l</td>
</tr>
<tr>
<td>Temperature at which water solubility was measured</td>
<td>25.0 °C</td>
</tr>
<tr>
<td>Log10 of Kow</td>
<td>1.32</td>
</tr>
</tbody>
</table>
Example for harvesting of orchard fruit
Worker tab
Example for harvesting of orchard fruit
Calculating...
Example for harvesting of orchard fruit

Results tab

<table>
<thead>
<tr>
<th>Exposure route</th>
<th>Acute</th>
<th>Exposure (mg/kg bodyweight/day)</th>
<th>Absorbed amount (mg/kg bodyweight/day)</th>
<th>Proportion of A/NOEL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dermal (hands)</td>
<td>0.968</td>
<td>0.0966</td>
<td>4.84</td>
<td></td>
</tr>
<tr>
<td>Dermal (body bare)</td>
<td>0.218</td>
<td>0.0218</td>
<td>1.09</td>
<td></td>
</tr>
<tr>
<td>Dermal (body clothed)</td>
<td>0.682</td>
<td>0.0682</td>
<td>3.41</td>
<td></td>
</tr>
<tr>
<td>Dermal (total)</td>
<td>1.87</td>
<td>0.187</td>
<td>9.54</td>
<td></td>
</tr>
<tr>
<td>Ingestion</td>
<td>0.00338</td>
<td>0.00338</td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td>Inhalation</td>
<td>0.0000582</td>
<td>0.0000582</td>
<td>0.00491</td>
<td></td>
</tr>
<tr>
<td><strong>Acute</strong></td>
<td><strong>1.87</strong></td>
<td><strong>0.191</strong></td>
<td><strong>9.53</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposure route</th>
<th>Longer term</th>
<th>Exposure (mg/kg bodyweight/day)</th>
<th>Absorbed amount (mg/kg bodyweight/day)</th>
<th>Proportion of A/NOEL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dermal (hands)</td>
<td>0.937</td>
<td>0.0937</td>
<td>4.69</td>
<td></td>
</tr>
<tr>
<td>Dermal (body bare)</td>
<td>0.211</td>
<td>0.0211</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>Dermal (body clothed)</td>
<td>0.662</td>
<td>0.0662</td>
<td>3.31</td>
<td></td>
</tr>
<tr>
<td>Dermal (total)</td>
<td>1.81</td>
<td>0.181</td>
<td>9.05</td>
<td></td>
</tr>
<tr>
<td>Ingestion</td>
<td>0.00376</td>
<td>0.00376</td>
<td>0.188</td>
<td></td>
</tr>
<tr>
<td>Inhalation</td>
<td>0.0000572</td>
<td>0.0000572</td>
<td>0.00336</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1.81</strong></td>
<td><strong>0.185</strong></td>
<td><strong>9.24</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Acute exposures are expressed as a proportion of the AADAP; longer term exposures are expressed as a proportion of the AADAP.
Example for harvesting of orchard fruit

Comparison with existing models

Absorbed dose (mg/kg body weight/day)

- BROWSE acute (1 day)
- BROWSE longer term (1 month)
- EUROPOEM
- U.S. EPA
Level of conservatism

Defaults provided for many parameters
  – aimed at overall realistic worst-case

Many parameters allow user input
  – drop-down menu
  – within given range
Advantages of the BROWSE model

BROWSE... has a user-friendly software?

- provides an estimate of DFR
- includes inhalation and oral exposure
- estimates acute and longer term exposure
- takes account of regional and gender differences
- provides defaults but also allows user input
Questions?