Challenges in worker exposure assessment in Europe

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Summary

Methodology

INSHT exposure studies

Mitigation measures
DFR factors

- Dose
- Application equipment
- Foliar structure
- Growth stage
- Dissipation
- Timing and Nº of applications
Default 3 µg/cm² (per kg a.s./day)

- Based on EUROPOEM II (90th %ile)
- Overprotective?
  New DB: 2.8 µg/cm² (75th %ile)
- Appropriate for a wide variety of crops?
  See DFR factors
- Normalization based on mass per unit area better than mass per volume applied?
DFR dissipation factors

- Climatic factors (T, %RH, rain, sunlight)
- Active substance
- Type of formulation
- Leaf texture
- Crop metabolism
- Timing and Nº of applications

Graph showing DFR over time with different replicates.
Default dissipation: \( T_{1/2} = 30 \text{ days} \)

- Conservative approach followed
- Based on published data (Willis and Mac Dowell, 1987 and USDA ARS)
- Decay curve. Sometimes complex curves
  \( \log(\text{DFR}_t) = \alpha - \beta t; \log(\text{DFR}_t) = \alpha - \beta \log(t); \) etc.
- Data is needed
DFR Higher Tier. Ad hoc studies

Active substances

Formulations

Crops

DFR or dissipation from other parts of the crop

Dissipation from other studies (soil, water, etc.)
Tier 3. Ad hoc studies

- Europoem II reentry report (Annex I). DFR Data (from ARTF)
- CEN/TR 15278:2005, Workplace exposure - Strategy for the evaluation of dermal exposure;
Degree

- Height and density of the crop

Frequency and nature

- Activities: pruning; thinning; leaf pulling; harvesting, etc.
- Worker behavior
<table>
<thead>
<tr>
<th>Crop</th>
<th>Nature of task</th>
<th>TC (cm²/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>Reach/pick</td>
<td>2.500</td>
</tr>
<tr>
<td>Tree fruits</td>
<td>Search/reach/ pick</td>
<td>4.500</td>
</tr>
<tr>
<td>Grapes</td>
<td>Harvesting and other activities (e.g. leaf pulling and tying)</td>
<td>10.100</td>
</tr>
<tr>
<td>Strawberries</td>
<td>Reach/pick</td>
<td>3.000</td>
</tr>
<tr>
<td>Ornamental</td>
<td>Cut/sort/ bundle/carry</td>
<td>5.000</td>
</tr>
<tr>
<td>Golf course, turf or other sports lawns</td>
<td>Maintenance</td>
<td>2.500</td>
</tr>
<tr>
<td>General</td>
<td>Inspection, irrigation</td>
<td>1.400</td>
</tr>
</tbody>
</table>
Time of exposure

- **GUIDANCE OF EFSA (Journal 2014;12(10):3874)**
  - 8 hours for activities such as harvesting, cutting, thinning, etc.
  - 2 hours for crop inspection or irrigation activities

- **CFT/EFSA/PPR/2010/04 (CAPEX)**
  - 7 hours; BROWSE project
  - Pilot surveys

- **US EPA**
  - 8 hours
  - ARTF / NAWS / Exposure rate / Multiday exposure
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3rd International Fresenius Conference "Worker, Operator, Bystander and Resident Exposure and Risk Assessment"
2 and 3 December 2014. Mainz. Germany
INSHT worker exposure studies

Tying and pruning tomato in greenhouses

Harvesting cucumber in greenhouses

Tying and harvesting eggplant in greenhouses
Tying and pruning tomato

- Active substance: Spiromesifen
- $T = 4$ hours
- Quantifiable exposure results only in outer samples (Day 1 workers 2 and 10 excluded)
- Higher contact during pruning
- $E_{hands} > E_{lower\ legs} > E_{chest} > E_{forearms}$. Non exposure on head

$$\text{Log}(\text{DFR}) = -0.1963x + 2.1428$$

$T_{1/2} = 1.5$ days
Harvesting cucumber

- Active substance: Piridaben
- T = 4 hours
- Highest DFR$_0$ results
- Quantifiable exposure results only in outer samples
- E upper body > lower body (Crop height=2.5m)

Log(DFR) = -$0.279t + 2.4079$

$T_{1/2} = 1.1$ days
Tying and harvesting eggplant

- Active substance: Clorantraniliprol
- $T = 6.5$ hours
- Lowest DFR\(_0\) results
- Highest contact (crop height, leaf area and fruit location). Highest exposure results
- Quantifiable exposure results only in outer samples

\[
\text{Log}(\text{DFR}) = -0.1015x + 1.525 \\
T_{1/2} = 3.0 \text{ days}
\]
### INSHT worker exposure studies

<table>
<thead>
<tr>
<th>CROP</th>
<th>TASK</th>
<th>EUII. PTL</th>
<th>STDY. PTL</th>
<th>EUII.TBE</th>
<th>EPA TBE</th>
<th>STDY. TBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>Tying</td>
<td>1500/1989</td>
<td>660/750</td>
<td>1100</td>
<td>70</td>
<td>2094</td>
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<tr>
<td>Tomato</td>
<td>Pruning</td>
<td>2981</td>
<td>5800</td>
<td>2500</td>
<td>550</td>
<td>471/608/727</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Harvesting</td>
<td>804/1002/1676</td>
<td>2500</td>
<td>550</td>
<td>471/608/727</td>
<td></td>
</tr>
<tr>
<td>Eggplant</td>
<td>Tying</td>
<td>3624</td>
<td>5800</td>
<td>2500</td>
<td>550</td>
<td>2660</td>
</tr>
<tr>
<td>Eggplant</td>
<td>Harvesting</td>
<td>6416/7685</td>
<td>5800</td>
<td>550</td>
<td>2660</td>
<td>3520/4536</td>
</tr>
</tbody>
</table>

**EUII. PTL.** Potential exposure from EUROPOEMII report.
**EUII.TBE.** Total body exposure (arms, body and legs covered) from EUROPOEMII report.
**EPA TBE.** Total body exposure (arms, body and legs covered) from ExpoSAC 2011. US EPA.
**STDY. PTL.** Potential exposure from INSHT studies.
**STDY. TBE.** Total body exposure (arms, body and legs covered) from INSHT studies.
Post-harvest worker exposure

Worker exposure during leaf pulling and harvesting grapes
Post-harvest exposure. Current approach

\[
\text{DFR} \times \text{TC} \times \text{T} = \text{DE}
\]

\[
\begin{align*}
\text{MRL} & : \\
& \begin{cases}
(5 	ext{ µg/cm}^2) \\
(201.1 \text{ cm}^2) \\
1800/\text{h}
\end{cases} \\
& \begin{cases}
(\% \text{ in contact}) \\
4.2 \% \\
(15200 \text{ cm}^2/\text{h}) \\
8 \text{ h}
\end{cases}
\end{align*}
\]

\[
\begin{align*}
& = \text{DE} \\
& = 600 \text{ mg/day}
\end{align*}
\]
Post-harvest exposure. Current approach-Pilot study

Pilot study

DFR

TC

T

DE

Nº/Kg
Área(cm²)

Nº/h
% in contact

5
µg/cm²

15,200
cm²/h

8 h

600
mg/day

0.91
µg/cm²

370
cm²/h

8 h

2.69
mg/day

3rd International Fresenius Conference “Worker, Operator, Bystander and Resident Exposure and Risk Assessment”
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INSHT exposure studies

Mitigation measures
Preventive aspects in EU legislation related to worker exposure

SAFE PRODUCT
- Regulation (EU) 1107/2009. Placing PPP on the market
- Regulation (EU) 546/2011. Uniform principles
- Regulation (EU) 284/2013. data requirements of PPP

SAFE USE
- Directive 2009/128/EU. Sustainable use of PPP
- Directive 89/391/CEE. Occupational SH
- Directive 98/24/EC. SH & chemicals
- Directive 2004/37/EC SH & carcinogens and mutagens

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Preventive aspects in EU legislation related to worker exposure

Regulation 1107/2009. Placing PPP on the market
- High level of protection of human health: a priority over the objective of improving plant production

Regulation 546/2011. Uniform principles
- Re-entry periods must be realistic

Regulation 284/2013. Data requirements of PPP
- PPE should be effective and readily obtainable, feasible to be used and will be worn habitually by workers
Preventive aspects in EU legislation related to worker exposure

**Directive 128/2009**

- Whereas 12. Sustainable use related to workers safety and health legislation
- Article 12. Use of pesticides minimised or prohibited when accessible to agricultural workers

**Real Decreto 1311/2013**

- Deposits on leaf surfaces completely dried
- Information when workers are allowed to re-enter
- Sings in GH and stores and in unclosed areas for bystanders and residents
Mitigation measures

Personal Protective Equipment

- CFT/EFSA/PPR/2010/04 (CAPEX)
- Chemical protective gloves? (Martin Roff (HSL), 2014)
- Common assessment errors: PF applied to TC (body covered)

Reentry period

- The minimum time (hours or days) following application of a pesticide at which workers may safely re-enter agricultural fields
- Reentry period calculator
- Multiple reentry periods

Duration of exposure

- Multiple task could be done per shift in some crops
### Challenges

<table>
<thead>
<tr>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection/production of data on specific TC and DFR values</td>
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<tr>
<td>DFR default values for each crop/growth stage group</td>
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<tr>
<td>DFR normalization based on mass per volume applied</td>
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<tr>
<td>Higher tier assessment. DFR and dissipation extrapolations</td>
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<tr>
<td>Data on inhalation and oral exposure</td>
</tr>
<tr>
<td>Data on crop activities (duration, how and when, PPE used, etc.)</td>
</tr>
<tr>
<td>Dermal absorption of PPP dried dilutions</td>
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<tr>
<td>Awareness training programs for workers and advising programs to employers</td>
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</tbody>
</table>
THANK YOU FOR YOUR KIND ATTENTION

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