Harmonization of dose expression is the key to dose adjustment

Greg Doruchowski
COMMISSION REGULATION 547/2011
labelling requirements for plant protection products

ANNEX I

Maximum dose per hectare per application shall be included on the packaging of plant protection products:
Field crops:

ground area = treated crop area

kg/ha ground = kg/ha treated crop area

Orchards / vineyards / plantations:

ground area ≠ treated plant area

kg/ha ground ≠ kg/ha treated crop area
Field crops:

ground area = treated crop area

kg/ha ground = kg/ha treated crop area

Orchards / vineyards / plantations:

ground area ≠ treated plant area

kg/ha ground ≠ kg/ha treated crop area
Spray volume = \frac{\text{nozzle flow rate} \times \text{number of nozzles} \times 600}{\text{working width} \times \text{travel velocity}}
Spray volume = nozzle flow rate * \textit{treated canopy height} * \textit{working width} * \textit{travel velocity} / row spacing * \textit{numer of nozzles} * 600
Spray volume = nozzle flow rate * \textbf{numen of nozzles} * 600 \textit{working width} * travel velocity

\textit{row spacing}

\textit{treated canopy height}

\textbf{Constant spray liquid deposit}

Spray volume \textit{LOW TREES} < Spray volume \textit{HIGH TREES}

Spray volume \textit{WIDE SPACING} < Spray volume \textit{Narrow SPACING}
Constant PPP initial deposit

PPP dose/ha ground LOW TREES < PPP dose/ha ground HIGH TREES
PPP dose/ha ground WIDE SPACING < PPP dose/ha ground NERROW SPACING
Constant dose/ha ground

PPP initial deposit $\text{LOW TREES}$ $>$ PPP initial deposit $\text{HIGH TREES}$

PPP initial deposit $\text{WIDE SPACING}$ $>$ PPP initial deposit $\text{NARROW SPACING}$
Reference units in the EU:

- ground area \([\text{kg/ha}]\): DK, FI, SE, LT, CZ, HU, PL, SI, SK, UK, FR
- spray volume \([\text{concentration \%}]\): ES, GR, HR, IT, PT, DK, FI, LT, NL
- canopy height - CH \([\text{kg/ha/m}_{\text{CH}}]\): DE, AT, (PL, SI, SE)
- leaf wall area - LWA \([\text{kg/10000 m}^2_{\text{LWA}}]\): BE, (LT, PL, SI, AT)
- tree row volume - TRV \([\text{kg/10000 m}^3_{\text{TRV}}]\): CH
- plant row \([\text{kg/100 m}_{\text{row}}]\): NO

Regulation (EC) 1107/2009 \(\Rightarrow\) PPP registration issues:

- zonal efficacy evaluation (collective evaluation of trials within the EPPO zones)
- mutual recognition of PPP authorizations
- labeling (with dose expression as used in the RR and max dose \([\text{kg-L/ha}]\)) at national level

need for HARMONIZATION
CZSC: As of 1 January 2018, efficacy trials in the Central Zone for pome fruit, grapes, and high-growing vegetables must use LWA as the efficacy unit of dose expression.

CZSC: From 1 January 2020, application dossiers for new products and new uses for these crops will only be accepted when the trials use LWA as the unit of dose expression.

CZSC: The conclusion does not affect national dose expression terms on product labels, and the rate per unit of ground area must still be given as this is required for risk assessments in other specialist areas.
Apple + pear: distribution of LWA in the EU registration zones

Common denominator well represents diverse pome fruit structures
Mean initial deposits obtained in 31 trials in apple orchards

\[ r^2 = 0.953 \]

Strong positive linear correlation between dose per unit area and deposit on targets in orchards

(KOCH, H. and WEISSER, P., 1995)
Dose expression

Why LWA?

Industry data (WOHLHAUSER, R., 2012

Hard to set accurate dose

Accurate MED setting
• logical and commonly accepted rule: *dose related to the target*
• good representation of diverse crop structures
• good correlation with deposit
• accurate determination of MED.
• easy comparison of efficacy data from individual trials
• simple and intuitive – fair chance to be accepted by applicators
• the first step to direct, systemwise dose adjustment
**Distribution of LWA by crops – all zones**

*Industry data (WOHLHAUSER, R., 2012 after Bayer CropScience AG)*

**Analysis Variable**: LWA calc Leaf wall area, calculated (m²/ha)

<table>
<thead>
<tr>
<th>Crop name</th>
<th>N Obs</th>
<th>Mean</th>
<th>Lower 95% CL for Mean</th>
<th>Upper 95% CL for Mean</th>
<th>25th Pctl</th>
<th>50th Pctl</th>
<th>75th Pctl</th>
<th>90th Pctl</th>
<th>95th Pctl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>900</td>
<td>13462</td>
<td>13226</td>
<td>13697</td>
<td>11000</td>
<td>13143</td>
<td>15000</td>
<td><strong>18462</strong></td>
<td>20000</td>
</tr>
<tr>
<td>Pear</td>
<td>321</td>
<td>13465</td>
<td>13023</td>
<td>13908</td>
<td>10476</td>
<td>13333</td>
<td>15333</td>
<td><strong>18400</strong></td>
<td>20000</td>
</tr>
<tr>
<td>Apricot</td>
<td>39</td>
<td>9200</td>
<td>8461</td>
<td>9939</td>
<td>7500</td>
<td>9020</td>
<td>11429</td>
<td>12000</td>
<td>12941</td>
</tr>
<tr>
<td>Nectarine</td>
<td>59</td>
<td>8770</td>
<td>7994</td>
<td>9546</td>
<td>7200</td>
<td>8000</td>
<td>10000</td>
<td>13333</td>
<td>15000</td>
</tr>
<tr>
<td>Peach</td>
<td>238</td>
<td>9565</td>
<td>9246</td>
<td>9885</td>
<td>8000</td>
<td>9798</td>
<td>10800</td>
<td>12500</td>
<td>14222</td>
</tr>
<tr>
<td>Cherry</td>
<td>149</td>
<td>11353</td>
<td>10722</td>
<td>11984</td>
<td>8889</td>
<td>11628</td>
<td>13333</td>
<td>15429</td>
<td>17143</td>
</tr>
<tr>
<td>Plum</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LWA = 18 000 m²/ha** ↔ \( \frac{\text{Canopy Height (CH)}}{\text{Row Spacing (RS)}} = 0,9 \)

*Why LWA?*

**Dose expression**

**max dose/ha ground on PPP label = dose / 18 000 m² LWA (r.w.c.)**
dose expression
PPP mass or volume unit (kg or L) linked to a certain reference unit

dose adjustment
determination (reduction or increase) of the PPP dose to obtain:

- sufficient level of PPP deposit to achieve an expected efficacy under specific circumstances (canopy size and density, application method, controlled organism, climatic factors)
- minimum variation in PPP deposit across a wide range of crop structures,
Dose expression

Harmonization

EPPO General Standard PP 1/239 (2)

Efficacy evaluation of plant protection products

Dose expression for plant protection products

• “... dose should be expressed in a format that is readily understood by users”

• reference units for 3D crops described and discussed
  - ground area
  - spray volume (concentration %)
  - canopy height - CH
  - leaf wall area - LWA
  - tree row volume - TRV
  - plant row

• crop structure parameters that need to be measured and recorded
  - cropping system (single or multiple rows);
  - distance between rows
  - distance between plants in the row
  - treated foliage height
  - mid-width of the canopy
  - BBCH growth stage at application
    as well as:
  - actual applied spray volume
  - information on the application equipment

• interconvertability between dose expressions for mutual recognition
Dose expression for plant protection products

Dose expression for plant protection products

Dose conversion diagram

Appendix 1

EPPO Standard PP1/239(2) after: Frießleben et al., 2007.
**Dose expression**

**Excel Tool for dose conversion**

- request from Organising Committee of EPPO Workshop:

<table>
<thead>
<tr>
<th>Concentration [%]</th>
<th>Ground Dose [kg/ha]</th>
<th>CH Dose [kg/ha/mCH]</th>
<th>LWA Dose [kg/10000m²LWA]</th>
<th>TRV Dose [kg/10000m²TRV]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15</td>
<td>0.450</td>
<td>0.15</td>
<td>0.263</td>
<td>0.438</td>
</tr>
<tr>
<td>0.15</td>
<td>0.450</td>
<td>0.15</td>
<td>0.263</td>
<td>0.438</td>
</tr>
<tr>
<td>0.15</td>
<td>0.450</td>
<td>0.15</td>
<td>0.263</td>
<td>0.438</td>
</tr>
<tr>
<td>0.15</td>
<td>0.451</td>
<td>0.15</td>
<td>0.263</td>
<td>0.438</td>
</tr>
<tr>
<td>0.15</td>
<td>0.451</td>
<td>0.15</td>
<td>0.263</td>
<td>0.438</td>
</tr>
</tbody>
</table>

**Post-Workshop EWG – Dose Conversion and Adjustment**

- Frank Meier-Runge - ECPA
- Santiago Planas - Univ. de Lleida, ES
- Patricia Chueca - IVIA, ES
- Antonio Miranda Fuentes - Univ. de Córdoba, ES
- Sébastien Codis - VigneVin, FR
- Paolo Marucco - DISAFA, IT
- Elena Gutiérrez - INIA, ES
- Evangelos Ch. Karanasios - BPI, GR
- Maria da Assunção Prates - DGAV, PT
- Riccardo Bugiani - Regione E-R, IT
- Greg Doruchowski - InHort, PL
Dose expression

Excel Tool for dose conversion & adjustment

- request from Organising Committee of EPPO Workshop
**DoConAd**

Dose Conversion & Adjustment Tool

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**Select AUTHORIZATION ZONE**: B - Central, BE, CZ, DE, IE, LU, NL, AT, PL, RO, SK, UK

**Select APPLICATION TECHNIQUE**: DEFLECTOR - high deflectors - cross-flow discharge system

**Select CROP**: Apples - dwarf and hedgerow systems

**Select GROWTH STAGE**: Post-blossom & Fruit development - TREES: 71-75 / VINE: 71-79

---

**ENTER data regarding crop structure:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TREE HEIGHT (m) - TH (m)</td>
<td>3,50</td>
</tr>
<tr>
<td>GROUND to CANOPY distance - GC (m)</td>
<td>0,50</td>
</tr>
<tr>
<td>ROW spacing - R (m)</td>
<td>3,50</td>
</tr>
<tr>
<td>WIDTH of CANOPY - W (m)</td>
<td>1,20</td>
</tr>
</tbody>
</table>

**ENTER data regarding PPP application:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area to be sprayed - P (ha)</td>
<td>13,60</td>
</tr>
<tr>
<td>FIXED spray volume - Q (l/ha)</td>
<td>300,00</td>
</tr>
<tr>
<td>NOT ADJUSTED spray volume - Q (l/ha)</td>
<td>300,00</td>
</tr>
<tr>
<td>Sprayer tank capacity - V (l)</td>
<td>1000,00</td>
</tr>
</tbody>
</table>

**Dose calculator**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPLICATION FACTOR - AF **</td>
<td>0,85</td>
</tr>
<tr>
<td>CANOPY FACTOR - CF ***</td>
<td>0,70</td>
</tr>
</tbody>
</table>

**Correct dose by**: APPLICATION FACTOR

---

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CH - Canopy Height (m)</th>
<th>LWA - Leaf Wall Area (m²/ha)</th>
<th>TRV - Tree Row Volume (m³/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration [%]</td>
<td>0,150</td>
<td>0,150</td>
<td>0,150</td>
</tr>
<tr>
<td>Ground Dose [kg]</td>
<td>0,450</td>
<td>0,450</td>
<td>0,450</td>
</tr>
<tr>
<td>CH Dose [kg/ha/mCH]</td>
<td>0,150</td>
<td>0,150</td>
<td>0,150</td>
</tr>
<tr>
<td>LWA Dose [kg/10000m²LWA]</td>
<td>0,265</td>
<td>0,265</td>
<td>0,265</td>
</tr>
<tr>
<td>TRV Dose [kg/10000m³TRV]</td>
<td>0,438</td>
<td>0,438</td>
<td>0,438</td>
</tr>
</tbody>
</table>

**ENTER dose from the PPP label**

| Final Ground Dose [kg/ha]      | 0,450                  | 0,450                        | 0,450                         |
| Ground Dose NOT Corrected [kg/ha] | 0,450     | 0,450                        | 0,450                         |
| Final Concentration [%]        | 0,150                  | 0,150                        | 0,150                         |
| Total amount of PPP to be used [kg] | 6,120             | 6,120                        | 6,120                         |
| Amount of PPP per sprayer tank [kg] | 4 x 1,500 + 0,120 | 4 x 1,500 + 0,120           | 4 x 1,500 + 0,120            |
## Dose adjustment

### Factors determining dose adjustment

<table>
<thead>
<tr>
<th>Target</th>
<th>Plant Protection Product</th>
<th>Application technique</th>
<th>Weather Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Dimentions of target</strong>&lt;br&gt;   ➢ height&lt;br&gt;   ➢ width&lt;br&gt;   ➢ row spacing</td>
<td>• <strong>Type of product</strong>&lt;br&gt;   ➢ fungicide&lt;br&gt;   ➢ insecticide&lt;br&gt;   ➢ acaricide</td>
<td>• <strong>Sprayer type</strong>&lt;br&gt; • <strong>Nozzle type</strong></td>
<td>➢ Air temperature&lt;br&gt; ➢ Relative humidity&lt;br&gt; ➢ Wind velocity&lt;br&gt; ➢ Cloud cover&lt;br&gt; ➢ Haze</td>
</tr>
<tr>
<td>• <strong>Canopy density</strong>&lt;br&gt;   ➢ LAI $[\text{m}^2/\text{m}^2]$&lt;br&gt;   ➢ projected area [%]&lt;br&gt;   ➢ area density $[\text{m}^2/\text{m}^3]$&lt;br&gt;   ➢ pictogram</td>
<td>• <strong>Purpose of treatment</strong>&lt;br&gt;   ➢ preventive&lt;br&gt;   ➢ curative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <strong>Growth stage</strong>&lt;br&gt;   ➢ BBCH&lt;br&gt;   ➢ selected from list of options</td>
<td>• <strong>Mode of action</strong>&lt;br&gt;   ➢ contact&lt;br&gt;   ➢ systemic&lt;br&gt;   ➢ translaminar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <strong>Specie / Variety of crop</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <strong>Controlled pest or pathogen</strong>&lt;br&gt;   ➢ level of infection risk&lt;br&gt;   ➢ level of infection or infestation&lt;br&gt;   ➢ stage of development&lt;br&gt;   ➢ dynamics of development&lt;br&gt;   ➢ behaviour&lt;br&gt;   ➢ place and mode of feeding</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dose adjustment
Decision support tools

- DOSAVIÑA
- OPTIDOSE
- PACE
- DOSAGE ADAPTE