Harmonization of dose expression is the key to dose adjustment

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Field crops:

ground area = treated plant area

Orchards / vineyards / plantations:

ground area ≠ treated plant area
**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
PPP mass or volume unit (kg or L) linked to a certain reference unit

Reference units in the EU:
• ground area
• spray volume (concentration %)
• canopy height - CH
• leaf wall area - LWA
• tree row volume - TRV
• plant row
**dose expression**

PPP mass or volume unit (kg or L) linked to a certain reference unit

**Reference units in the EU:**
- DK, FI, LT • CZ, HU, PL, SI, SK, UK • FR

- **ground area**
- spray volume (concentration)
- canopy height - CH
- leaf wall area - LWA
- tree row volume - TRV
- plant row

**kg or L/ha ground**
dose expression
PPP mass or volume unit (kg or L) linked to a certain reference unit

Reference units in the EU: DK, FI, LT ● NL ● ES, GR, HR, IT, PT

- ground area
- spray volume (concentration)
- canopy height - CH
- leaf wall area - LWA
- tree row volume - TRV
- plant row

kg or L/100 L spray volume (%) + spray volume (max) and/or + max dose/ha ground
**dose expression**
PPP mass or volume unit (kg or L) linked to a certain reference unit

**Reference units in the EU:**
- DE, AT, (PL), (SI)

- ground area
- spray volume (concentration)
- **canopy height - CH**
- leaf wall area - LWA
- tree row volume - TRV
- plant row

**kg or L/ha ground and m CH**
**dose expression**

PPP mass or volume unit (kg or L) linked to a certain reference unit

**Reference units in the EU:**

- ground area
- spray volume (concentration)
- canopy height - CH
- leaf wall area - LWA
- tree row volume - TRV
- plant row

\[
LWA = 2 \times \frac{\text{canopy height [m]}}{\text{row spacing [m]}} \times 10\,000\,m^2
\]
dose expression
PPP mass or volume unit (kg or L) linked to a certain reference unit

Reference units in the EU:
• ground area
• spray volume (concentration)
• canopy height - CH
• leaf wall area - LWA
• tree row volume - TRV
• plant row

\[
TRV = \frac{\text{canopy height [m]} \times \text{canopy width [m]}}{\text{row spacing [m]}} \times 10 000 \text{ m}^2
\]
dose expression

PPP mass or volume unit (kg or L) linked to a certain reference unit

Reference units in the EU: NO, SE

• ground area
• spray volume (concentration)
• canopy height - CH
• leaf wall area - LWA
• tree row volume - TRV
• plant row

• kg or L/100 m² tree row
**dose expression**
PPP mass or volume unit (kg or L) linked to a certain reference unit

**Reference units in the EU:**

- **ground area**
  - DK, FI, LT, CZ, HU, PL, SI, SK, UK, FR
- **spray volume (concentration %)**
  - ES, GR, HR, IT, PT, DK, FI, LT, NL,
- **canopy height – CH**
  - DE, AT, (PL, SI)
- **leaf wall area – LWA**
  - BE, (LT, PL, SI, AT)
- **tree row volume - TRV**
  - CH
- **plant row**
  - NO, SE

**Regulation (EC) 1107/2009 (entry into force: 14 June 2011) => 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 [kg-L/ha]) at national level

**need for HARMONISATION**
Ad hoc panel on Expression of Dose Rate - Paris, May 29, 2001

Tree Fruit Dose Expression and Adjustment Discussion Group - Wageningen, May 15, 2009

ECPA Efficacy Expert Group (EffEG) and EPPO representatives - Brussels, October 19, 2011
  • roadmap for revision of **EPPO General Standard PP 1/239 - Dose expression for plant protection products** (first published in 2005)

EPPO General Standards Meeting - Milan, March 7-9, 2012
  • draft of the revised tandard sent to MS for consultation

  • draft standard re-discussed, modified and approved

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**EPPO** - European and Mediterranean Plant Protection Organization

**ECPA** – European Crop Protection Association
Harmonisation

**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 listed 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**
Harmonisation

**EPPO General Standard PP 1/239 (2)**

Efficacy evaluation of plant protection products

*Dose expression for plant protection products*

Dose conversion diagram

*Appendix 1*

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

EPPO General Standard PP 1/239 (2)
Efficacy evaluation of plant protection products

*Dose expression for plant protection products*

For the mutual recognition converting is also possible

"...from the doses expressed on the approved label in one country assuming this relates to a **known standard structure** and where relevant to a **specific growth stage**."
Harmonisation

Why?

• progres towards sustainable use of PPPs
• taking the target as a reference (eg. LWA)
• obtaining reliable efficacy data
• precise determination of MED
• easy comparing and evaluation of efficacy values
• help for regulators (registration authorities)
• platform for dose adjustment
• raising growers’ awareness
• upgrading local practices
Harmonisation

Considered at different levels

**European Zonal level** => *PPP evaluation*
- between national registration authorities
- at PPP approval stage
  - efficacy assessment: BAD, MED
  - Risk assessment: toxicology, ecotoxicology, residues, e-fate

**National level** => *national registration and label*
- between PPP manufacturers
- at the stage of PPP registration/introduction
  - efficient use of PPP
  - dose adjustment
Zonal efficacy trials => Trial reports: reference units and crop structure parameters

Zonal efficacy evaluation (BAD / dRR) => RR & Final Conclusion

National assessment => registration with label recommendation

advice for farmers

Farmers’ practice

national legislation * local practice * growers’ awareness and preferences
Harmonisation

EPPO Workshop

http://archives.eppo.int/MEETINGS/2016_conferences/dose_expression.htm

• Presentations
  ➢ meaning and status of harmonisation
  ➢ industry perspective
  ➢ implementation of dose adjustment schemes

• Results of questionnaire circulated to the EU authorization zones prior to the Workshop

• Conclusions and recommendations from WGs
  ➢ pome fruit
  ➢ grapevine
  ➢ high growing vegetables
  ➢ olive and citrus
Harmonisation

EPPO Workshop

Questionnaire:

➢ dose expression used in different 3D crops (efficacy assessment and registration)
➢ parameters characterizing crop structure in trial reports
➢ intention to change the dose expression towards LWA
➢ training systems and estimated LWA ranges for different 3D crops
➢ application techniques
➢ feasibility of using harmonised dose (eg. LWA) for evaluations in the EU
➢ other comments
Harmonisation

EPPO Workshop – WG discussion

Glossary of terms

- explicity of terms
- clear definitions, eg.:
  - canopy height & treated canopy height & plant height
  - leaf wall area (LWA) & treated leaf wall area (TLWA)
  - mid-width of the canopy crop
  - row spacing
Harmonisation

EPPO Workshop – WG discussion

Measurement of crop and application parameters:

• How?
  – SOP guideline (*standard operation procedure*)
  – Sample size

• What?

  **TODAY**
  – Actual treated height
  – Actual treated length
  – Actual spray volume
  – Actual spray concentration
  – Number of treated rows,
  – Number of treated sides
  – Conversion in /ha LWA
  – Sprayer type – plus additional parameter
  – Nozzle brand, type, seize and model
  – Pressure at the manometer
  – Description of the vertical boom
    (number/spacing of nozzles)
  – BBCH growth of the crop
  – Distance between rows
  – Distance in the rows

  **FUTURE**
  – Arrangement in rows (single, double, isolated plants)
  – Target of the protected plant (brunch zone, trunk)
  – Travel speed of sprayers

  **PROPOSED SOP**
  – Maximum height of the plant
  – Height and mid-with of the treated canopy
  – Pruning and training system

  **LONG TERM OBJECTIVES**
  – Quality and uniformity of spray coverage
  – Crop porosity
  – Leaf canopy density
  – LAI
Conclusions:

**LWA** - agreed as an appropriate PPP dose expression for a harmonized European zonal evaluation procedure regarding wall-like crop structures: hedgerow pome and stone fruit, grapevine and high growing vegetables

- also for double rows
- not always for isolated trees
- not for „home and garden”

LWA may also be a reference for spray volume

Kg or L/ha ground – not to be used in the zonal efficacy evaluation of PPPs (not linked to crop) but reported in the GAP table for tox, fate and ecotox risk assessments (max dose/ha ground corresp. with r.w.c. LWA)

For globular trees (citrus, olive, stone fruit) – canopy width to be included in dose expression

Acceptable more than one dose expression on the PPP label
Conclusions:

• Glossary of terms needed

• Measure and record (BAD, dRR) all necessary crop parameters for dose conversion

• Guideline for measurements to be developed (SOP)

• Spray volume expression: /LWA and /ha

• Industry and research data compiled and analysed for dose adjustment

• Excel tool for dose conversion and dose adjustments
Why LWA?

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

Apple + pear: distribution of LWA in the EU registration zones

Common denominator well represents diverse pome fruit structures
Why LWA?

Mean initial deposits obtained in 31 trials in apple orchards

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

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

Industry data (WOHLHAUSER, R., 2012)

Hard to set accurate dose

Accurate MED setting
Why LWA?

- 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
- perfect tool for direct (systemic) dose adjustment
Why LWA?

max dose/ha ground on PPP label ⇒ LWA = 18 000 m²/ha (r.w.c.)

Distribution of LWA by crops – all zones

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

<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>18462</td>
<td>20000</td>
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<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>18400</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>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LWA = 18 000 m²/ha ⇔ \[
\frac{\text{Canopy Height (CH)}}{\text{Row Spacing (RS)}} = 0.9
\]

CH/RS = 0.9

MAX dose

LWA = 18 000 m²/ha

CH/RS = 0.6

MAX dose - 35%

LWA = 11 400 m²/ha

CH/RS = 0.45

MAX dose - 50%

LWA = 9 000 m²/ha
Excel Tool for dose conversion

- request from Organising Committee of EPPO Workshop:

<table>
<thead>
<tr>
<th>Spray volume [l/ha]</th>
<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>300,00</td>
<td>0,15</td>
<td>0,450</td>
<td>0,150</td>
<td>0,263</td>
<td>0,438</td>
</tr>
<tr>
<td></td>
<td>0,15</td>
<td>0,450</td>
<td>0,150</td>
<td>0,263</td>
<td>0,438</td>
</tr>
<tr>
<td></td>
<td>0,15</td>
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<td>0,451</td>
<td>0,150</td>
<td>0,263</td>
<td>0,438</td>
</tr>
</tbody>
</table>

[Diagram of Dose Converter]
Excel Tool for dose conversion & adjustment

- request from Organising Committee of EPPO Workshop
Excel Tool for dose conversion & adjustment

**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**
<table>
<thead>
<tr>
<th>ENTER data regarding crop structure:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree Height (m) - TH [m]</td>
<td>3.50</td>
</tr>
<tr>
<td>Branch to Canopy distance - BC [m]</td>
<td>0.50</td>
</tr>
<tr>
<td>Row Spacing - R [m]</td>
<td>3.50</td>
</tr>
<tr>
<td>Mid-Width of Canopy - W [m]</td>
<td>1.20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENTER data regarding PPP application:</th>
<th></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>APPLICATION FACTOR - AF **</th>
<th>0.85</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANOPY FACTOR - CF ***</td>
<td>0.70</td>
</tr>
</tbody>
</table>

** AF takes into account application technique  
*** CF takes into account the growth stage and canopy density of the defined crop

<table>
<thead>
<tr>
<th>ENTER dose from the PPP label</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration [%]</td>
<td>0.150</td>
</tr>
<tr>
<td>Ground Dose [kg/ha]</td>
<td>0.450</td>
</tr>
<tr>
<td>CH Dose [kg/ha/mCH]</td>
<td>0.150</td>
</tr>
<tr>
<td>LWA Dose [kg/10000m²LWA]</td>
<td>0.265</td>
</tr>
<tr>
<td>TRV Dose [kg/10000m²TRV]</td>
<td>0.438</td>
</tr>
</tbody>
</table>

| Final Ground Dose [kg/ha]      | 0.450 |
| Ground Dose NOT Corrected [kg/ha] | 0.450 |
| Final Concentration [%]        | 0.150 |
| Total amount of PPP to be used [kg] | 6,120 |
| Amount of PPP per sprayer tank [kg] | 4 x 1,500 + 0.120 |
thank you ;(-)