A proposal for dose expression & dose adjustment in the EU-Southern Zone

DOSA3D system

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EPPO Workshop on harmonized dose expression for the zonal evaluation of plant protection products in high growing crops

Viena, 2016-10-18/20
Production area for EU Member States (ha)

- Olive (2012)
- Citrus (2012)
- Almonds (2015)
- Grapes (2013)
- Deciduous fruits (2012)

Source: EUROSTAT - Extracted on: 2016-10-08
Hedgerow

Stone fruits, October 2016 ES-Sunyer
Orchards with isolated trees (traditional)

Almonds, May 2016 ES-Sunyer

Olives, August 2016 ES-Tortosa
Globular shaped near hedgerow

Citrus, August 2016 ES-Tortosa

Hazelnuts, August 2016 ES-Puigpelat

3.0 m

4.0 m
Hedgerows for pome & stone fruits
Extreme differences on training systems between crops
Should they be protected with the identical amount of pesticide?

4.0 m between rows
Extreme differences on training systems within crops
Should they be protected with the identical amount of pesticide?

4.0 m between rows
Extreme differences on training systems & cropping practices within crops 
Do they be protected with the identical amount of pesticide?
Differences on training & pruning practices within crops
Should these vineyards be protected with the identical amount of pesticide?

2.7 – 3.0 m between rows
Extreme differences through growing stages

Peach, from March to October 2016 ES-Sunyer
Summary

• Cropping structures in SZ: extreme differences
• **Spraying equipment & penetrability**
• Principles for dose expression and dose adjustment
• From DOSAFRUT to DOSA3D
• Conclusions & proposal
ABS
Efficiency = 40-55%
1200 L ha⁻¹

ABS w/ defectors
Efficiency = 60-70%
800 L ha⁻¹

August 2014 ES-Tortosa

July 2013. ES-Alcarràs
Hydraulic nozzles
Efficiency = 50-75%
300 L ha⁻¹

Pneumatic nozzles
Efficiency = 60-80%
180 L ha⁻¹
Penetrability
leaf deposition vs. depth

(ng/dm²) / (g/ha)

Canopy depth (m)

- vine
- apple
- pear
- citrus

EU-FP3 CT-1304 Project AIR (1994-97)
Two sides - penetrability

Volume rate: 669 ÷ 730 L/ha
Trials (n = 6)

Volume rate: 60 ÷ 144 L/ha
Trials (n = 9)

Volume rate: 375 ÷ 701 L/ha
Trials (n = 8)

Volume rate: 1016 - 2605 L/ha
Trials (n = 4)

EU-FP3 CT-1304 Project AIR (1994-97)
Leaf deposition for early & full leaf stages

Volume rate: 800 L ha⁻¹
Leaf deposition early & full leaf stages
Summary

• Cropping structures in SZ: extreme differences
• Spraying equipment & penetrability
• **Principles for dose expression and dose adjustment**
• From DOSAFRUT to DOSA3D
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Background paper for the EPPO Workshop on harmonized dose expression for the zonal evaluation of plant protection products in high growing crops

Prepared by Gabriele Kovacs and Gregor Kral

- the ideal method for expression of the dose should take account of the total leaf area in relation to the field area but should be sufficiently simple to be understandable on the product label and practical for farmers. It should also take account of the efficiency of spraying techniques.

However, the meeting could not agree on a single system of expression of the dose.
Previous works - PULVEXACT Project (2002-2006)

LIDAR data recording for structures characterization (more than 55 orchards & vineyards)
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LIDAR data recording for structures characterization (more than 55 orchards & vineyards)
OPTIDOSA Project (2007-10)
Real LAI measuring & crop parameters correlation

Picking-up leaves to measure leaf area index (LAI)

Pear (n=17)
Apple (n=18)
Peach (n=1)
Grapevine (n=19)
Leaf Wall Area (LWA)

Fruit & grapevines (n=55)

$$R^2 = 0.48$$

LAI measured
Tree Row Volume (TRV)

Fruit & grapevines (n=55)

\[ R^2 = 0.68 \]

TRV (m³ ha⁻¹)

LAI measured

OPTIDOSA Project (2007-10)
Canopy solid housing (CSH)
Canopy solid housing (CSH) \[ h_z = h \times (100 - \% \text{ gaps}) \]

LAI = f(height, width, porosity)
Canopy solid housing (CSH)

Fruit & grapevines (n=55)

\[ R^2 = 0.86 \]

<table>
<thead>
<tr>
<th></th>
<th>LWA</th>
<th>TRV</th>
<th>CSH</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.48</td>
<td>0.68</td>
<td>0.86*</td>
</tr>
</tbody>
</table>

(DOSA3D)

OPTIDOSA Project (2007-10)
Summary

- Cropping structures in SZ: extreme differences
- Spraying equipment & penetrability
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DOSAFRUT

Determining the application volume rate of pesticide treatments in fruit orchards


1.1. Orchard to be sprayed 1.2. Product to be applied 1.3. Level of difficulty 1.4. Application parameters 1.5. Weather conditions

1.1. Orchard to be sprayed

Crop: Pear

Variety: 

Framework of plantation:

Row spacing: 4.0 m

Tree spacing: 3.0 m

Orchard density: 833 trees/ha

Plot identification: 

Postal code: 

Information of interest

You can use a reference name or the geographical coordinates.

www.dosafrut.es
Hypothesis for effective dose deposition
1. High density net: min 100 impacts cm\(^{-2}\)
2. Robustness, mean droplet dimension: 225 µm Ø

=> Base dosing: 0.6 µL cm\(^{-2}\) = 60 L ha\(^{-1}\)

\[
V(L ha^{-1}) = 60 \times 2 \times LAI = 120 \times LAI
\]
\[ V = \max \left[ 100 \times h; \ (120 \times LAI)/E \right] \]

**Efficiency (E) = 40 ÷ 80%**

- Canopies structure
- Sprayer & nozzles performance
- Operating parameters (air flow rate, forward speed)
- Pest with additional volume requirements (R)
- Action of adjuvants (Co)
DOSAFRUT validation trials (2009 - 2016)
Bioefficacy (27) & chemical residues on fruits (7)
Crop dimensions and leafiness *(pear orchard, cv. Williams)*

![Crop dimensions and leafiness graph](chart.png)
Ex.: Spray applications (7) during the growing season (*pear orchard, cv. Williams*)
Ex. Effect of dose adjustment on the number of *P. piri* larvae per shoot

Generalised linear model with longitudinal data

\[
\log(\mu) = \beta_0 + \beta_1(\text{application}) + \beta_2(\text{date}) + \beta_3(\text{application} \times \text{date})
\]

<table>
<thead>
<tr>
<th>Estimation</th>
<th>P value</th>
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<tr>
<td>$\beta_1$</td>
<td>-0.76</td>
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</tbody>
</table>

Standard application: $\beta_0 = 0$
Ex.: Spray applications (7) during the growing season *(pear orchard, cv. Williams)*
Conversion between models of dose expression

DOSA3D (L ha⁻¹)

Crop factor (CF)
- BBCH / LAI / Leafiness (m²/m³)

Spraying factor (SF)
- Efficiency

Concentration (%)
(kg/L)

Liquid volume (L ha⁻¹)

Crop area
(kg ha⁻¹)

Canopy height
(kg ha⁻¹ m⁻¹)

1 / Canopy height (m)

Distance between rows (m) / 2

Canopy width (m)

Tree Row Volume
(kg ha⁻¹) / (m³ ha⁻¹)

Leaf Wall Area
(kg ha⁻¹) / (10⁶ m² LWA ha⁻¹)

2 / Canopy width(m)
**Example of label for one product**

<table>
<thead>
<tr>
<th>Canopy width</th>
<th>Volume rate (L ha⁻¹) for each 1 m of canopy height</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.0 m</td>
<td>150-330</td>
</tr>
<tr>
<td>1.0 - 2.0 m</td>
<td>225-400</td>
</tr>
<tr>
<td>&gt;2.0 m</td>
<td>300-450</td>
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</tbody>
</table>

Volume rate: adjust to the *crop stage* and *spraying efficiency*

For more accurate adjustment use officially recognized tools
Conclusions & proposal

LWA can be useful in the NZ & CZ where very narrow structures predominate.
To be reflexive before the introduction in the SZ: not the only method.
In the SZ, to recommend the dose by means:
  • Concentration (%) + Volume rate (L ha⁻¹)
& adjusting the volume rate to:
  • mid height
  • mid width
  • leafiness (growing stage or estimated porosity)
For more accurate adjusting (spraying efficiency):
  • Use officially recognized tools on internet / App mobile (ongoing)
Thanks!!!