

# **Harmonization of dose expression**

## **Dose conversion and adjustment**

**Greg Doruchowski**      - **InHort, PL**

on behalf of Expert Working Group:

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

**Field crops:**

ground area = treated crop area



L/ha ground = L/ha treated crop area



**Orchards / vineyards / plantations:**

ground area  $\neq$  treated plant area



L/ha ground  $\neq$  L/ha treated crop area



**Field crops:**

ground area = treated crop area



L/ha ground = L/ha treated crop area



**Orchards / vineyards / plantations:**

ground area  $\neq$  treated plant area



L/ha ground  $\neq$  L/ha treated crop area



## Fruit growing – 3D crops

Calibration formula:

$$\text{Spray volume} = \frac{\text{nozzle flow rate} * \text{number of nozzles} * 600}{\text{working width} * \text{travel velocity}}$$



## Fruit growing – 3D crops

Calibration formula:

$$\text{Spray volume} = \frac{\text{nozzle flow rate} * \text{treated canopy height} * \text{number of nozzles} * 600}{\text{working width} * \text{travel velocity} * \text{row spacing}}$$



# Fruit growing – 3D crops

Calibration formula:

$$\text{Spray volume} = \frac{\text{nozzle flow rate} * \text{number of nozzles} * 600}{\text{working width} * \text{travel velocity}}$$

*treated canopy height*

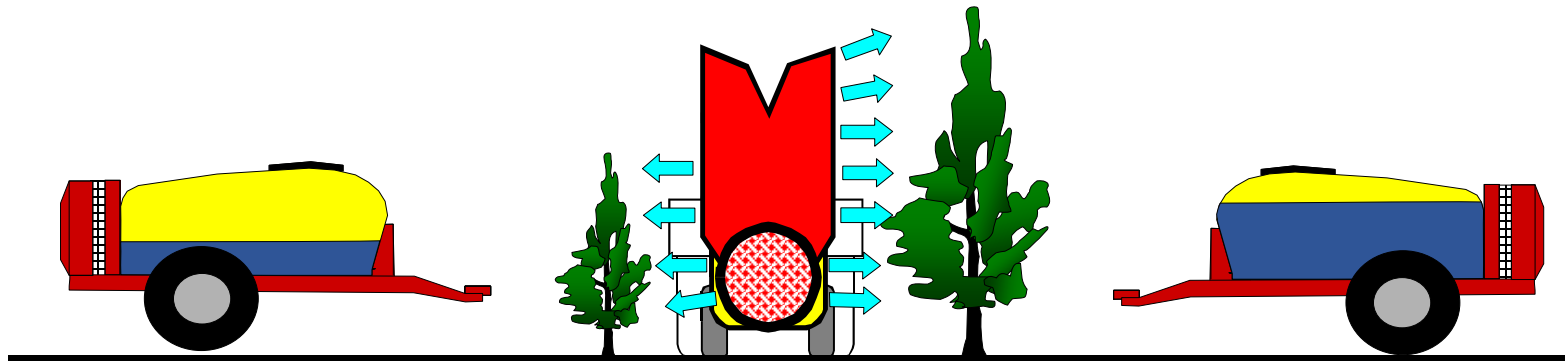
*row spacing*

Constant spray liquid deposit



Spray volume<sub>LOW TREES</sub> < Spray volume<sub>HIGH TREES</sub>

Spray volume<sub>WIDE SPACING</sub> < Spray volume<sub>NERROW SPACING</sub>



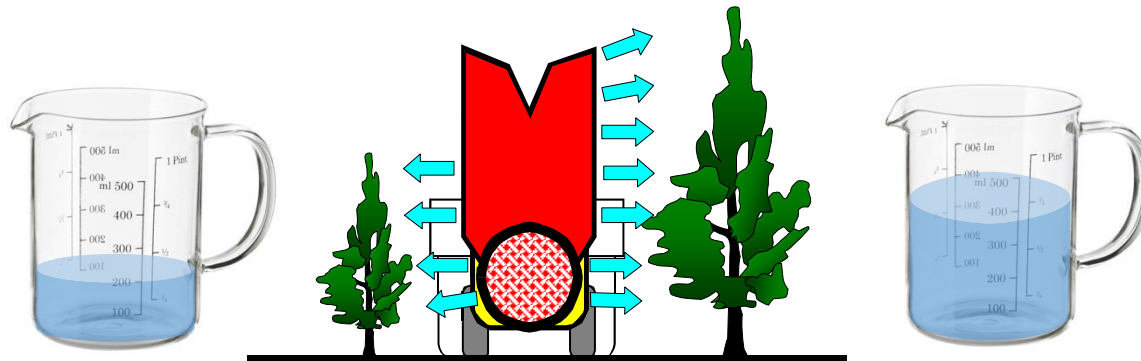
# Fruit growing – 3D crops

Dose recommendation:



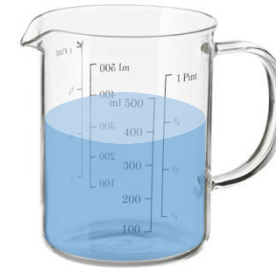
## Constant PPP initial deposit

PPP dose/ha ground <sub>LOW TREES</sub> < PPP dose/ha ground <sub>HIGH TREES</sub>  
PPP dose/ha ground <sub>WIDE SPACING</sub> < PPP dose/ha ground <sub>NARROW SPACING</sub>



# Fruit growing – 3D crops

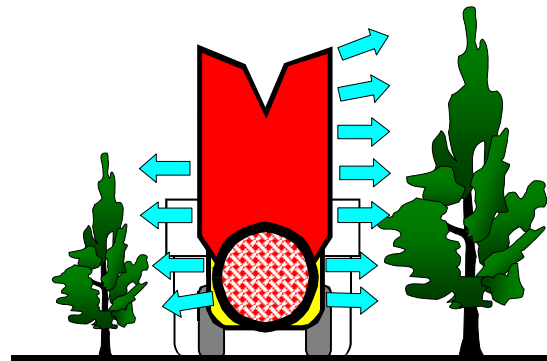
Dose recommendation:



Constant dose/ha ground

PPP initial deposit <sub>LOW TREES</sub> > PPP initial deposit <sub>HIGH TREES</sub>

PPP initial deposit <sub>WIDE SPACING</sub> > PPP initial deposit <sub>NERROW SPACING</sub>





# 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, pest/pathogen pressure, climatic factors)
- minimum variation in PPP deposit across a wide range of crop structures,

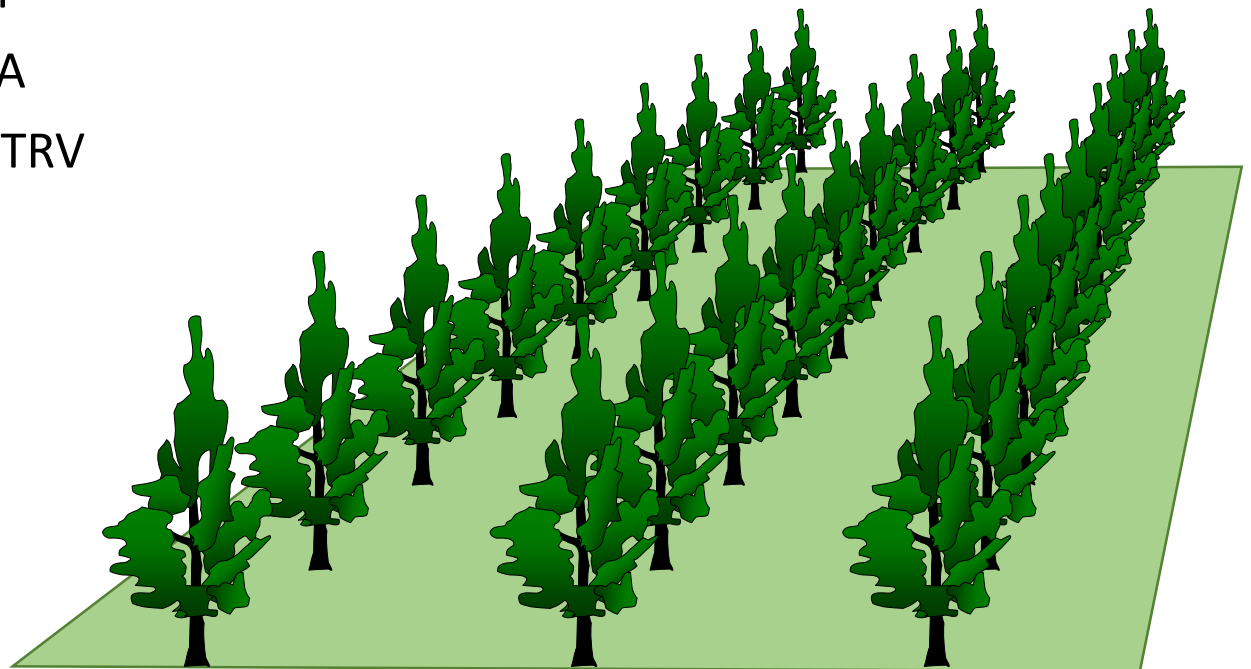


# dose expression

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



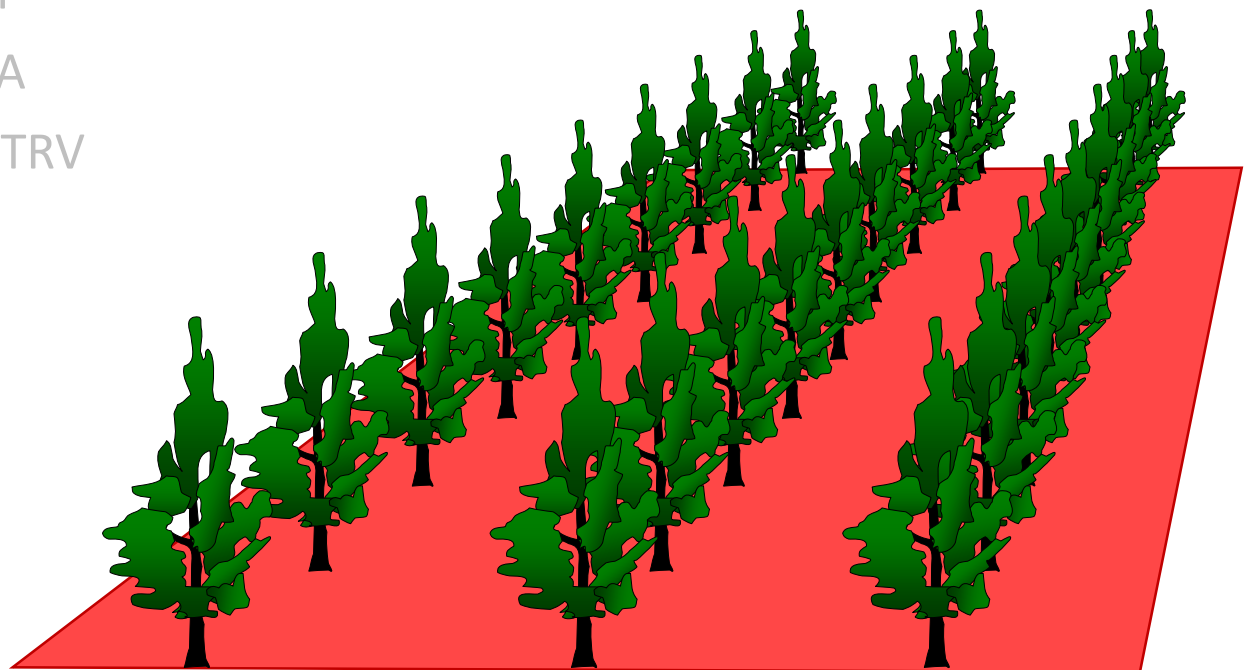
# dose expression

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



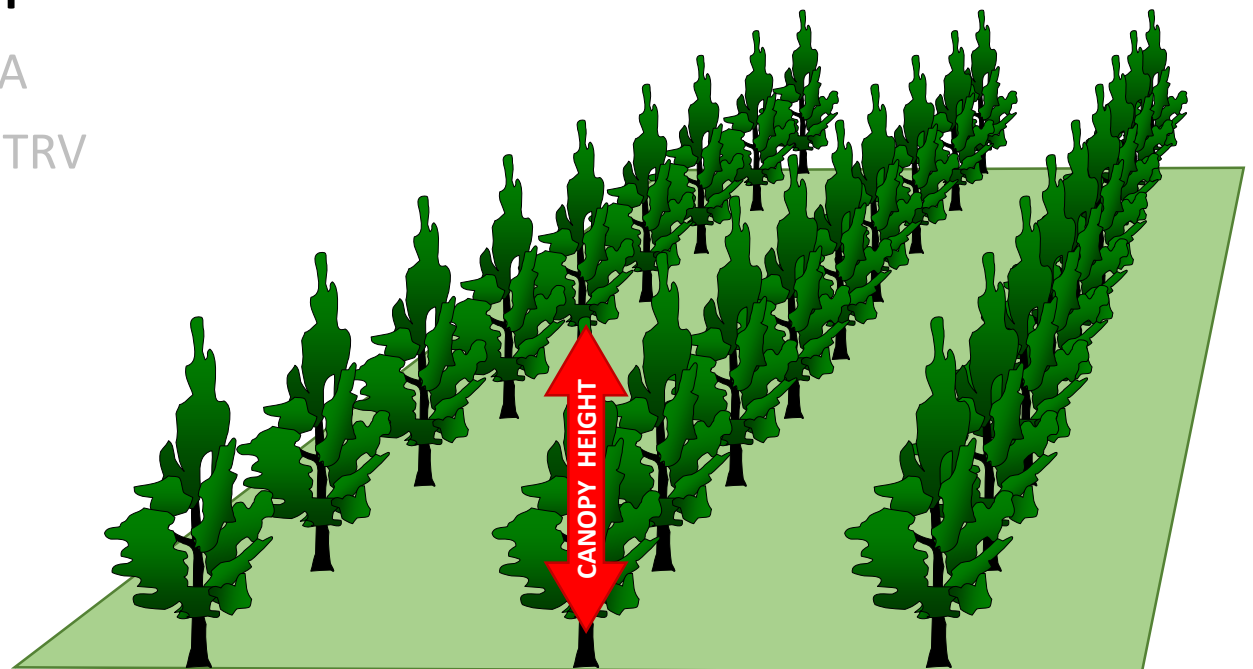
# dose expression

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**



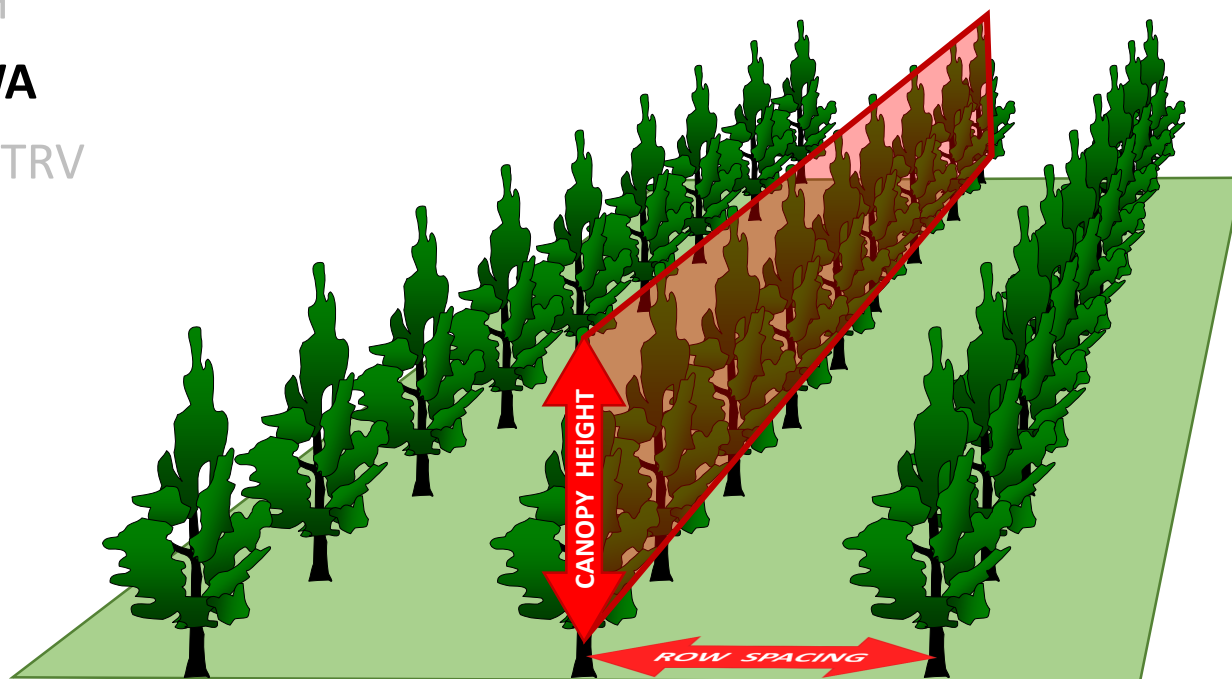
# dose expression

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

**Reference units in the EU:** (LT) • BE, (PL), (SI), (AT) • -

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

**kg or L/10 000 m<sup>2</sup> LWA**



$$\text{LWA} = 2 * \frac{\text{canopy height [m]}}{\text{row spacing [m]}} * 10\,000 \text{ m}^2$$

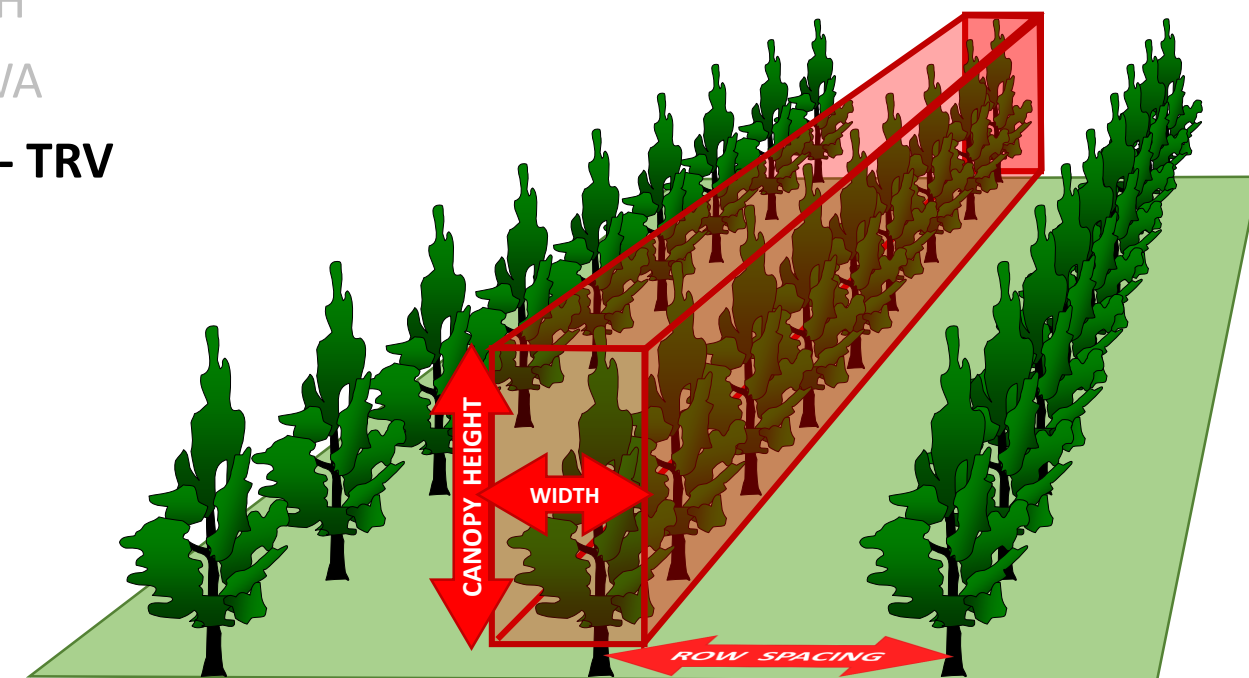
# dose expression

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

## Reference units in the EU: CH

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

**kg or L/10 000 m<sup>3</sup> TRV**



$$\text{TRV} = \frac{\text{canopy height [m]} * \text{canopy width [m]}}{\text{row spacing [m]}} * 10\,000 \text{ m}^2$$

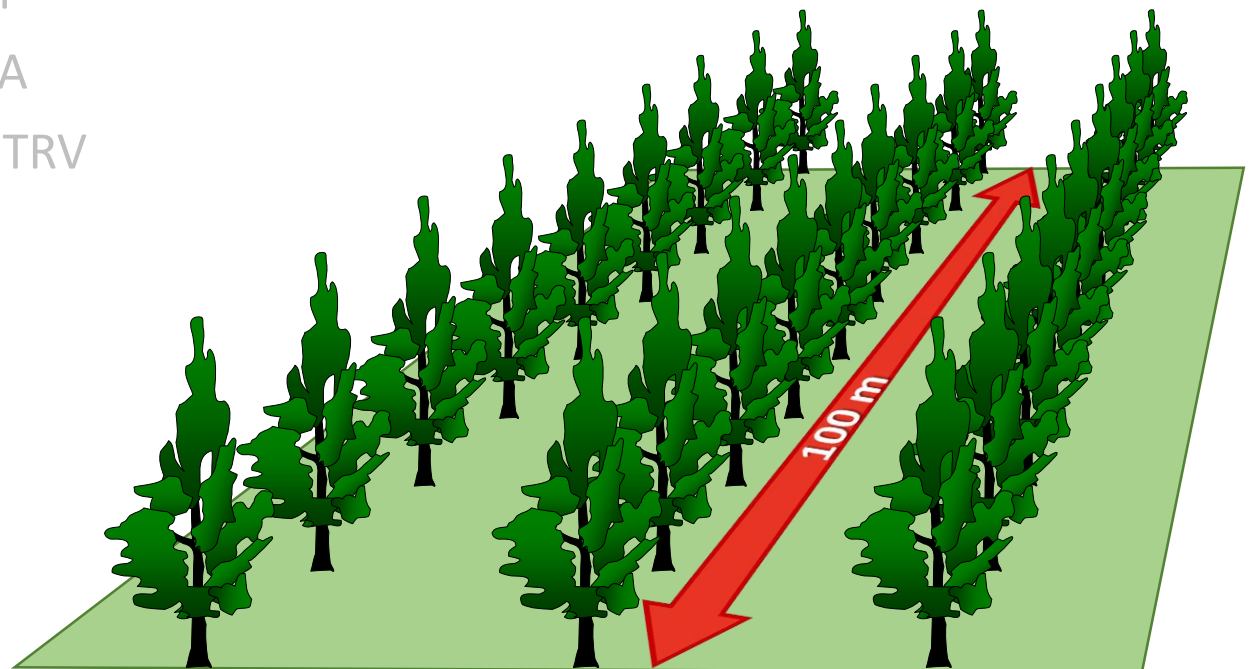
# dose expression

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 m 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

# HARMONISABLE

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

mutual  
recognition

National assessment =>  
registration with label  
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advice for farmers

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National assessment =>  
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recommendation

advice for farmers

Farmers'  
practice

national legislation \* local practice \* growers' awareness and preferences

# Harmonisation

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

Efficacy evaluation of plant protection products

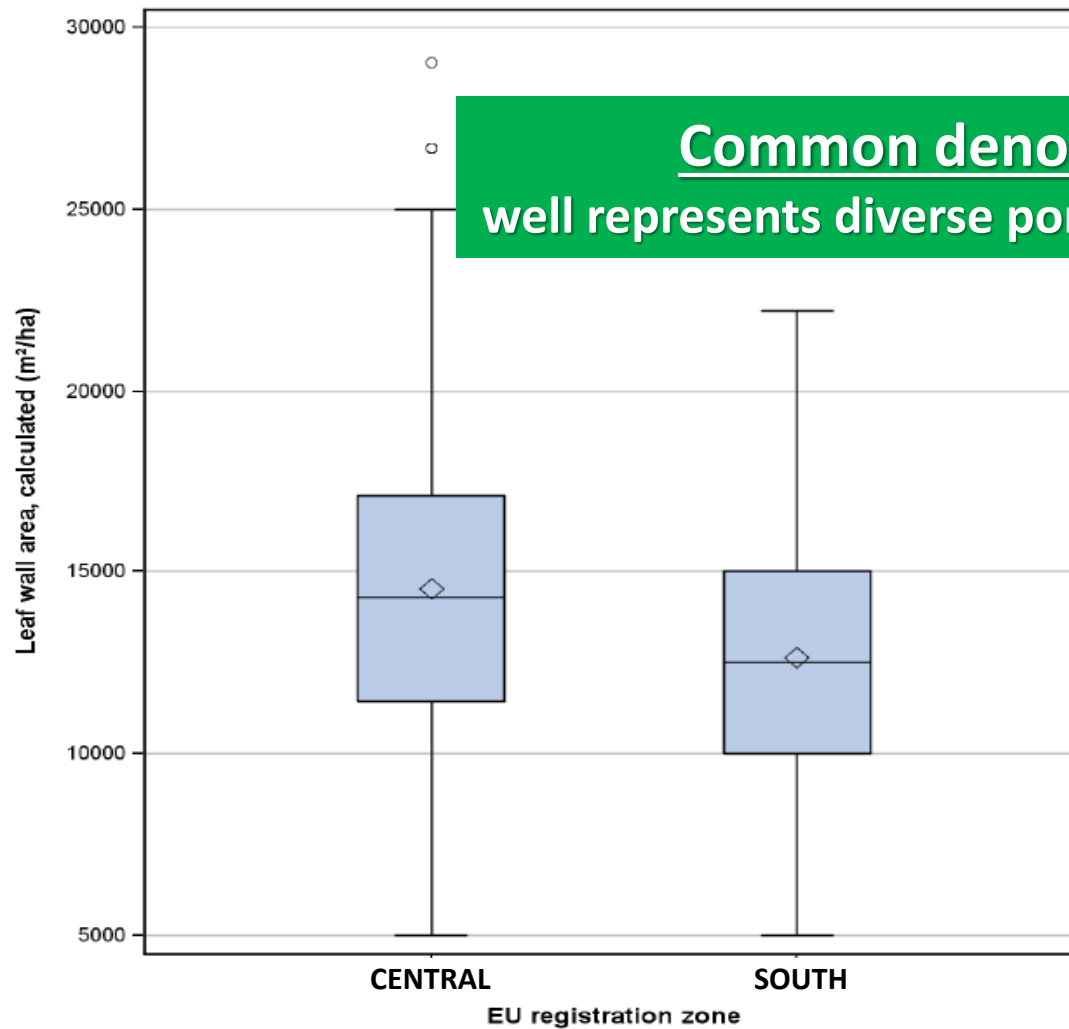
***Dose expression for plant protection products***

- **„... 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**

# Why LWA ?

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

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

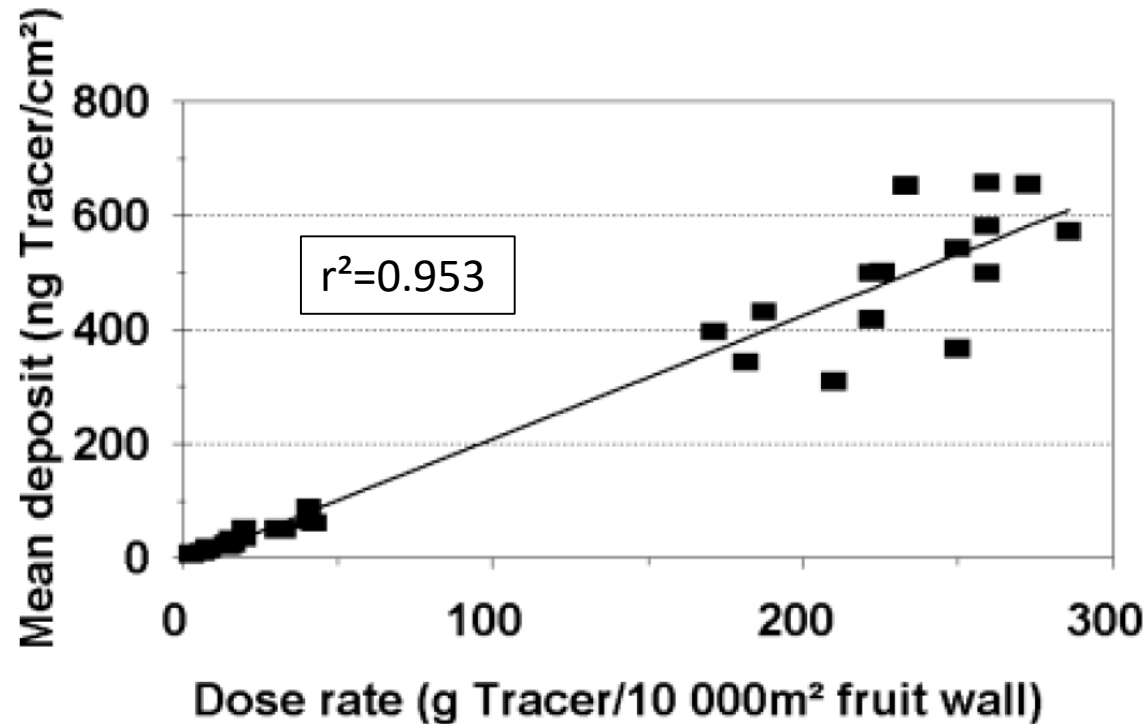


Common denominator  
well represents diverse pome fruit structures

# Why LWA ?

## Mean initial deposits obtained in 31 trials in apple orchards

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

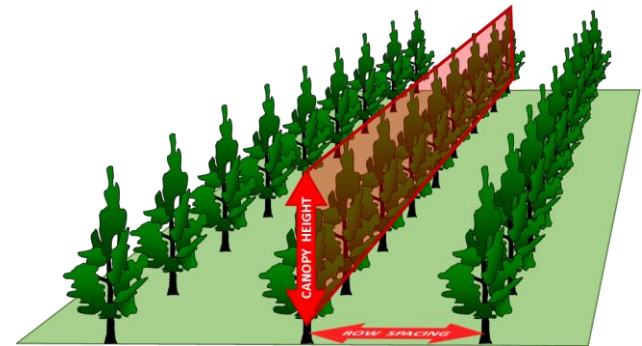
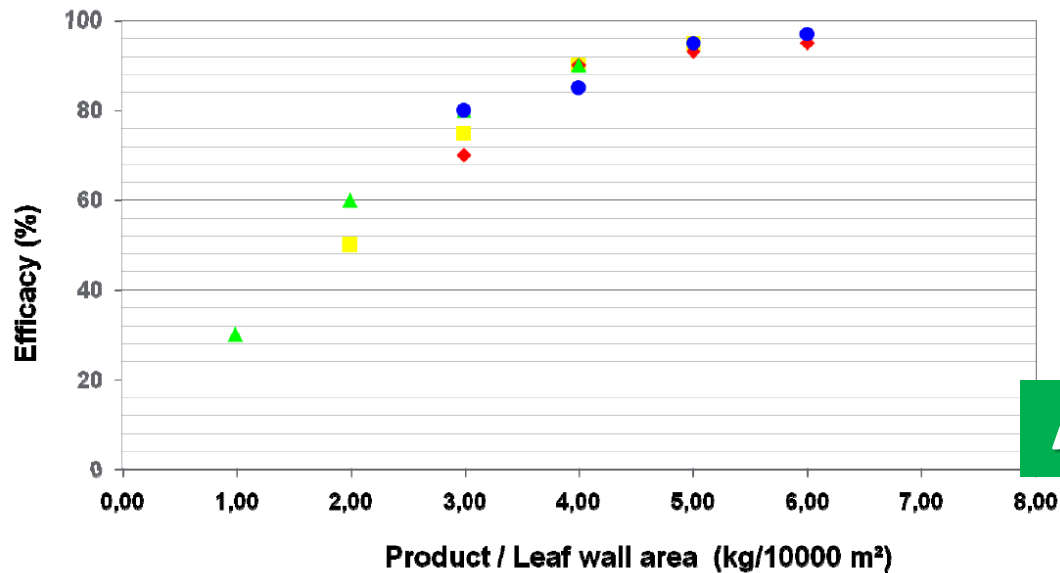
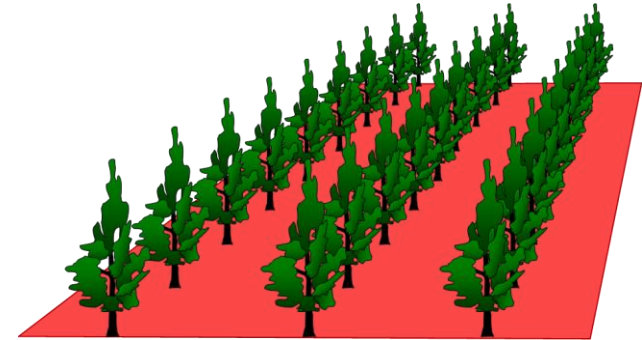
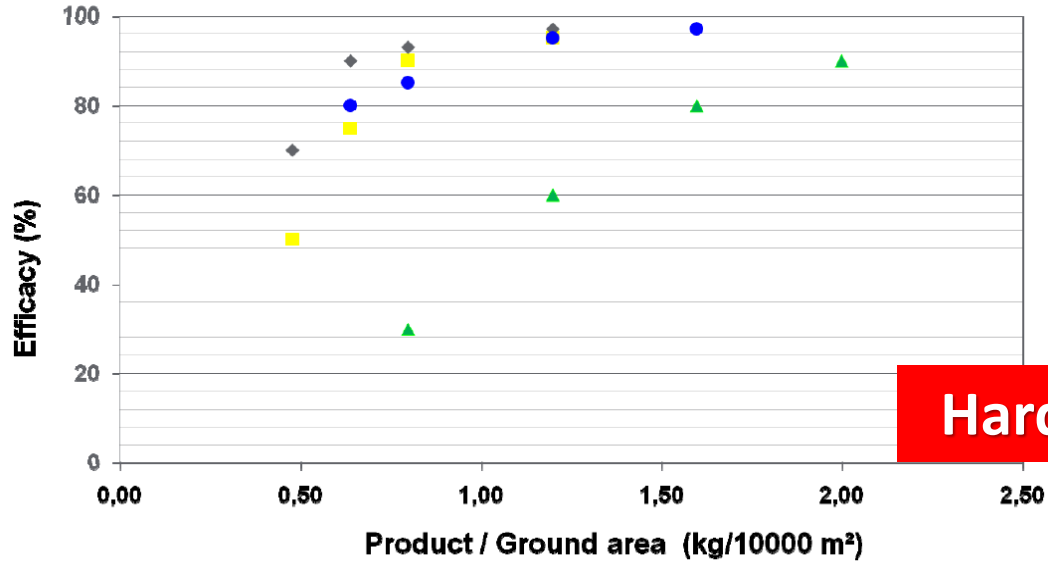


Strong positive linear correlation

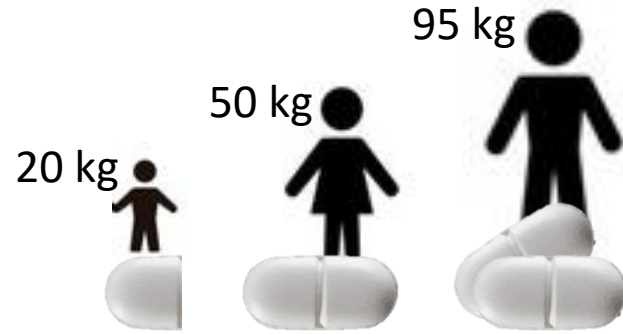
between dose per unit area and deposit on targets in orchards

# Why LWA ?

Industry data (WOHLHAUSER, R., 2012)



## 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 ?

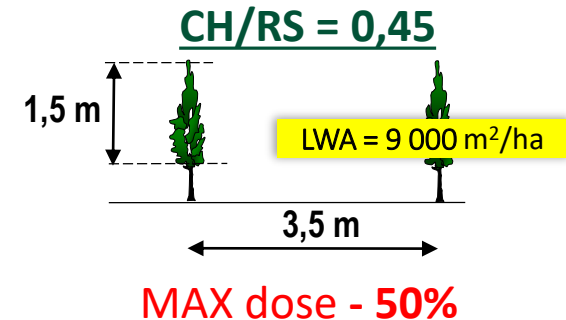
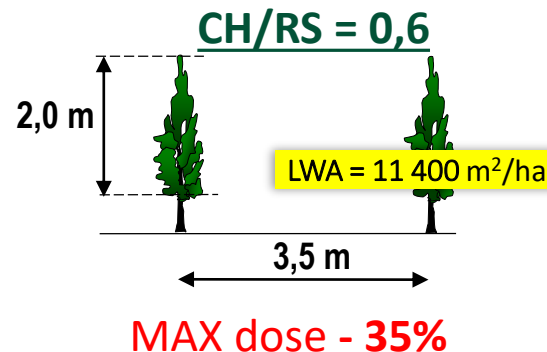
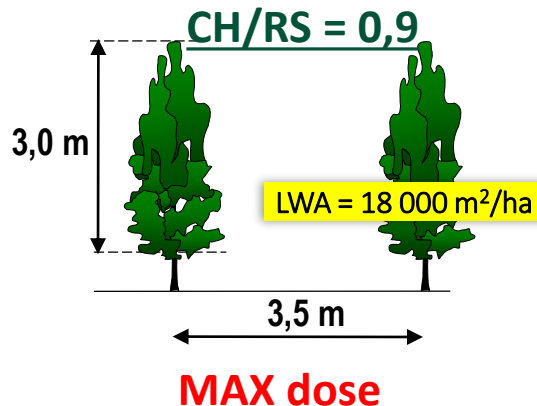
max dose/ha ground on PPP label => LWA = 18 000 m<sup>2</sup>/ha (r.w.c.)

## Distribution of LWA by crops – all zones

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

Analysis Variable : LWA_calc Leaf wall area, calculated (m <sup>2</sup> /ha)									
Crop name	N Obs	Mean	Lower 95% CL for Mean	Upper 95% CL for Mean	25th Pctl	50th Pctl	75th Pctl	90th Pctl	95th Pctl
Apple	900	13462	13226	13697	11000	13143	15000	18462	20000
Pear	321	13465	13023	13908	10476	13333	15333	18400	20000
Apricot	39	9200	8461	9939	7500	9020	11429	12000	12941
Nectarine	59	8770	7994	9546	7200	8000	10000	13333	15000
Peach	238	9565	9246	9885	8000	9798	10800	12500	14222
Cherry	149	11353	10722	11984	8889	11628	13333	15429	17143
Plum	1							15556	17143

$$LWA = 18\,000 \text{ m}^2/\text{ha} \Leftrightarrow \frac{\text{Canopy Height (CH)}}{\text{Row Spacing (RS)}} = 0,9$$





# Harmonisation

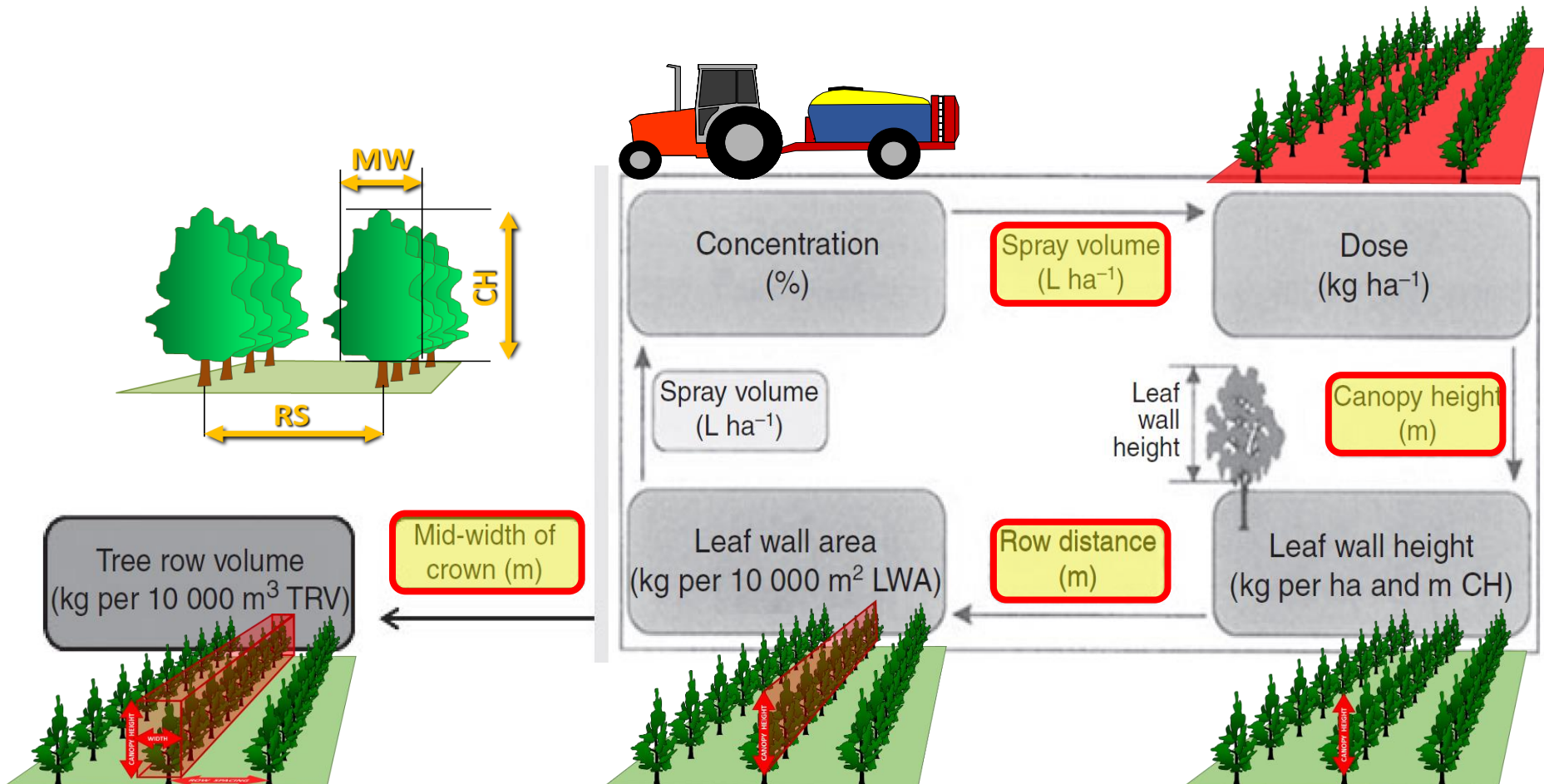
## EPPO General Standard PP 1/239 (2)

Efficacy evaluation of plant protection products

### *Dose expression for plant protection products*

### Dose conversion diagram

Appendix 1

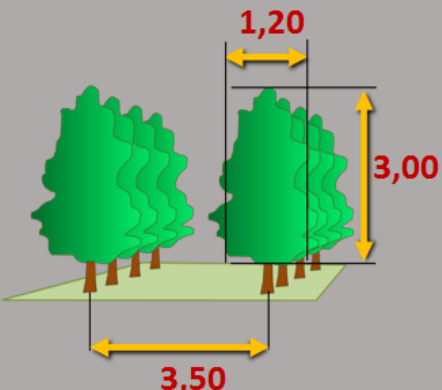


# Excel Tool for dose conversion

- request from Organising Committee of EPPO Workshop:

**Dose converter**

Spray volume [l/ha]



Concentration [%]	Ground Dose [kg/ha]	CH Dose [kg/ha/mCH]	LWA Dose [kg/10000m <sup>2</sup> LWA]	TRV Dose [kg/10000m <sup>3</sup> TRV]
<input type="text" value="0,15"/>	<input type="text" value="0,450"/>	<input type="text" value="0,150"/>	<input type="text" value="0,263"/>	<input type="text" value="0,438"/>
<input type="text" value="0,15"/>	<input type="text" value="0,450"/>	<input type="text" value="0,150"/>	<input type="text" value="0,263"/>	<input type="text" value="0,438"/>
<input type="text" value="0,15"/>	<input type="text" value="0,450"/>	<input type="text" value="0,150"/>	<input type="text" value="0,263"/>	<input type="text" value="0,438"/>
<input type="text" value="0,15"/>	<input type="text" value="0,451"/>	<input type="text" value="0,150"/>	<input type="text" value="0,263"/>	<input type="text" value="0,438"/>
<input type="text" value="0,15"/>	<input type="text" value="0,451"/>	<input type="text" value="0,150"/>	<input type="text" value="0,263"/>	<input type="text" value="0,438"/>



# Excel Tool for dose conversion & adjustment

- request from Organising Committee of EPPO Woprkshop

**DoConAd**  
DOSE CONVERSION & ADJUSTMENT TOOL

Select AUTHORISATION ZONE: 2 - Central: BE, CE, DE, IE, LU, NL, AT, PL, RO, SI, SK, UK

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

Select CROP: Apple - dwarf and hedgerow systems

Select GROWTH STAGE: Post-blossom & fruit development - TR45, TR75 / V16, TR75

**ENTER data regarding crop structure:**

Tree height (m) - TH: 3,50  
 $LWA = \frac{2 * (TH-GC) * 10000}{R}$

Canopy density (m³/m³) - CD: 0,50  
 $TRV = \frac{(TH-GC) * W * 10000}{R}$

Row spacing - R (m): 3,50  
 Row width of canopy - W (m): 1,20

**ENTER data regarding PPP application:**

Area to be sprayed - P (ha): 13,60

FIXED spray volume - Q (l/ha): 300,00  
CLEAR if you want spray volume TO BE ADJUSTED

NOT ADJUSTED spray volume - Q (l/ha): 300,00 (by LWA)

Sprayer tank capacity - V (l): 1000,00

**Dose calculator**

APPLICATION FACTOR - AF \*\*\*: 0,85  Correct dose by APPLICATION FACTOR

CANOPY FACTOR - CF \*\*\*: 0,70  Correct dose by CANOPY FACTOR

	CH - Canopy Height [m]	LWA - Leaf Well Area [m²/ha]	TRV - Tree Row Volume [m³/ha]
	3,00	17 142,86	10 285,71

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

	Concentration [%]	Ground Dose [kg/ha]	CH Dose [kg/ha/mCH]	LWA Dose [kg/10000m²LWA]	TRV Dose [kg/10000m³TRV]
ENTER dose from the PPP label	0,150	0,450	0,150	0,263	0,438
Final Ground Dose [kg/ha]	0,450	0,450	0,450	0,451	0,451
Ground Dose Corrected by AF and CF [kg/ha]	0,268	0,268	0,268	0,268	0,268
Final Concentration [%]	0,089	0,089	0,089	0,089	0,089
Total amount of PPP to be used [kg]	3,641	3,641	3,641	3,648	3,646
Amount of PPP per sprayer tank [kg]	4 x 0,893 + 0,071	4 x 0,893 + 0,071	4 x 0,893 + 0,071	4 x 0,894 + 0,072	4 x 0,894 + 0,071

**Dose converter**

Spray volume [l/ha]: 300,00

	Concentration [%]	Ground Dose [kg/ha]	CH Dose [kg/ha/mCH]	LWA Dose [kg/10000m²LWA]	TRV Dose [kg/10000m³TRV]
	0,15	0,450	0,150	0,263	0,438
	0,15	0,450	0,150	0,263	0,438
	0,15	0,450	0,150	0,263	0,438
	0,15	0,451	0,150	0,263	0,438
	0,15	0,451	0,150	0,263	0,438



# 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

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- *BPI, GR*

Maria da Assunção Prates

- *DGAV, PT*

Riccardo Bugiani

- *Regione E-R, IT*

Greg Doruchowski

- *InHort, PL*



Select **AUTHORISATION ZONE** B - Central: BE, CZ, DE, IE, LU, HU, NL, AT, PL, RO, SI, 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

# DoConAd

DOSE CONVERSION & ADJUSTMENT TOOL

## ENTER data regarding crop structure:

TREE HEIGHT (total) - TH [m] **3,50**

GROUND-to-CANOPY distance - GC [m] **0,50**

ROW spacing - R [m] **3,50**

Mid-WIDTH of CANOPY - W [m] **1,20**

$$LWA = \frac{2 * (TH-GC) * 10000}{R}$$

$$TRV = \frac{(TH-GC) * W * 10000}{R}$$

RESET

## ENTER data regarding PPP application:

Area to be sprayed - P [ha] **13,60**

FIXED spray volume \* - Q [l/ha] **300,00**

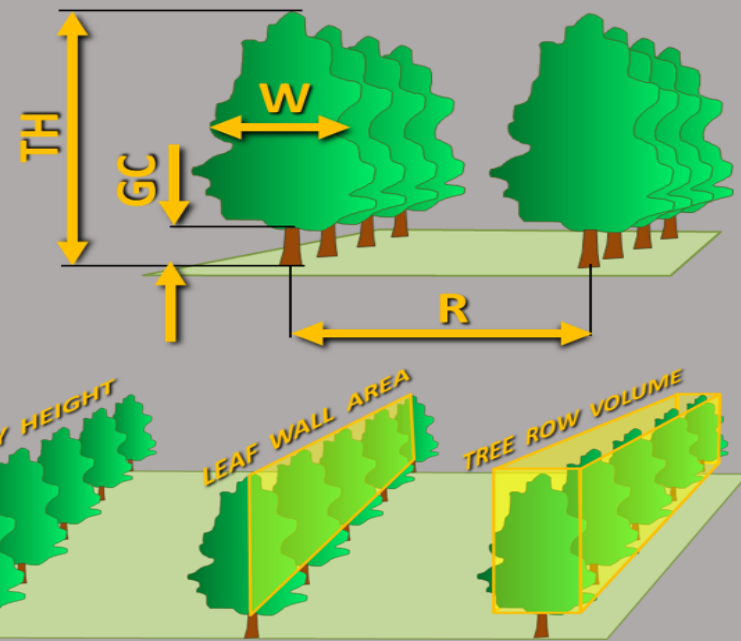
NOT ADJUSTED spray volume - Q [l/ha] **300,00**

Sprayer tank capacity - V [l] **1000,00**

CLEAR if you want spray volume TO BE ADJUSTED

by LWA

RESET



# Dose calculator

APPLICATION FACTOR - AF \*\* **0,85**

CANOPY FACTOR - CF \*\*\* **0,70**

- Correct dose by APPLICATION FACTOR
- Correct dose by CANOPY FACTOR

CH - Canopy Height [m]	LWA - Leaf Wall Area [m <sup>2</sup> /ha]	TRV - Tree Row Volume [m <sup>3</sup> /ha]
<b>3,00</b>	<b>17 142,86</b>	<b>10 285,71</b>

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

	Concentration [%]	Ground Dose [kg/ha]	CH Dose [kg/ha/mCH]	LWA Dose [kg/10000m <sup>2</sup> LWA]	TRV Dose [kg/10000m <sup>3</sup> TRV]
<b>ENTER dose from the PPP label</b>	<b>0,150</b>	<b>0,450</b>	<b>0,150</b>	<b>0,265</b>	<b>0,438</b>
Final Ground Dose [kg/ha]	<b>0,450</b>	<b>0,450</b>	<b>0,450</b>	<b>0,454</b>	<b>0,451</b>
Ground Dose NOT Corrected [kg/ha]	<b>0,450</b>	<b>0,450</b>	<b>0,450</b>	<b>0,454</b>	<b>0,451</b>
Final Concentration [%]	<b>0,150</b>	<b>0,150</b>	<b>0,150</b>	<b>0,151</b>	<b>0,150</b>
Total amount of PPP to be used [kg]	<b>6,120</b>	<b>6,120</b>	<b>6,120</b>	<b>6,178</b>	<b>6,127</b>
Amount of PPP per sprayer tank [kg]	<b>4 x 1,500 + 0,120</b>	<b>4 x 1,500 + 0,120</b>	<b>4 x 1,500 + 0,120</b>	<b>4 x 1,514 + 0,121</b>	<b>4 x 1,502 + 0,120</b>

RESET



*EPPO Workshop on harmonized dose expression for the zonal evaluation of plant protection products in high growing crops - Vienna, 18/20 October, 2016*

**thank you ;-)**