The dose expression dilemma. State of the art in Europe

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Contents:

1. Background (terms & definitions)

Dose expression: *The unit in which the dose is expressed (i.e.: L/ha – g/L)*

Dose rate: *The amount of product necessary to achieve the required efficacy*

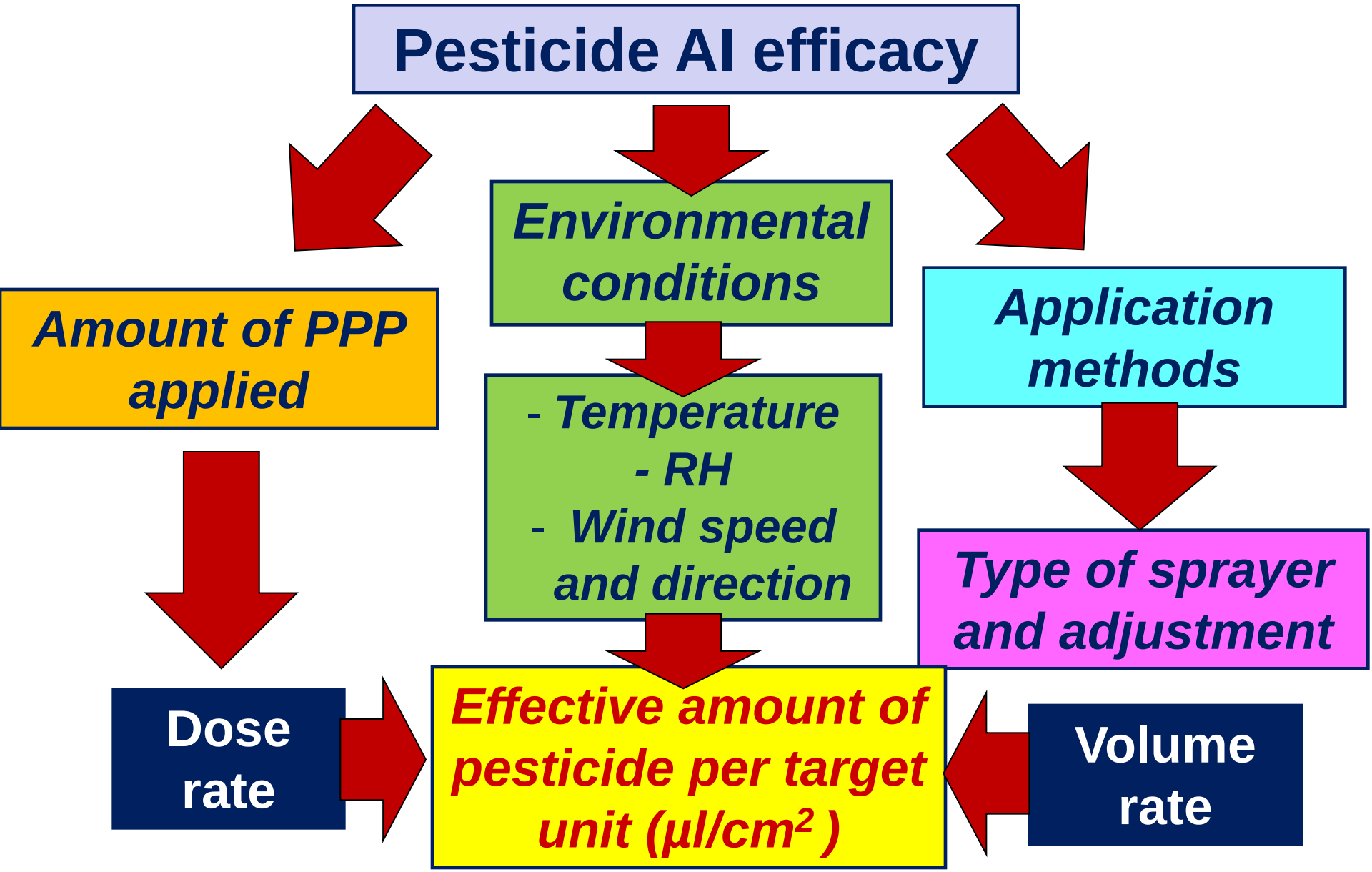
Dose rate adjustment: *The Dose rate periodical adjustment in function of the target surface development or the disease pression*

Volume rate: *The amount of water used to apply the requested dose*

Volume rate adjustment: *The Volume rate periodical adjustment in function of the target surface development*

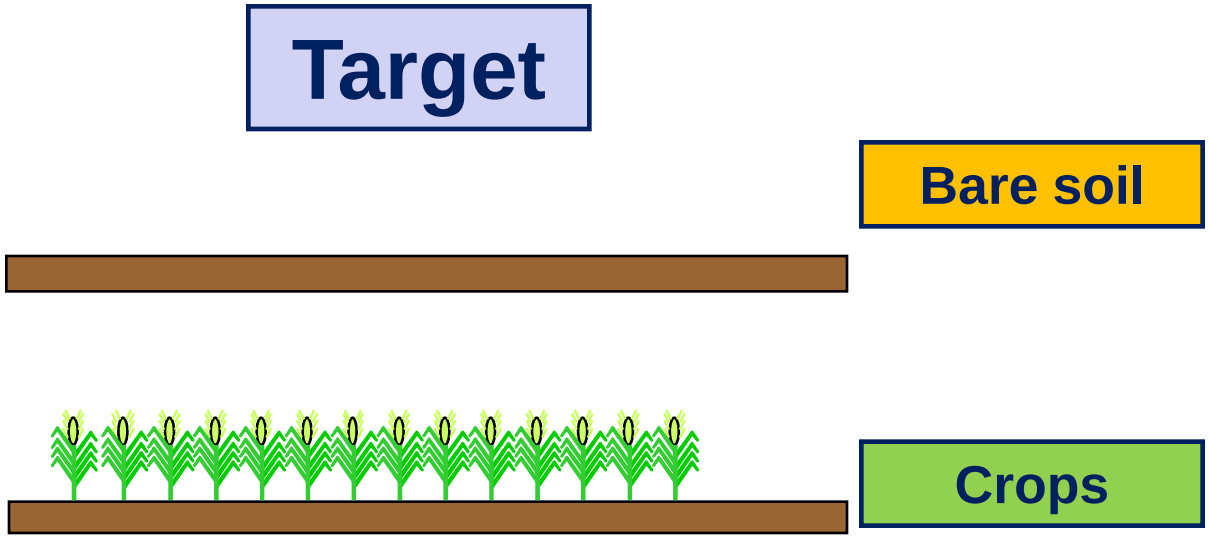
Amount of pesticide for target unit: *Amount of pesticide that reach and remain on the target (µl/cm^2)*

1. Background



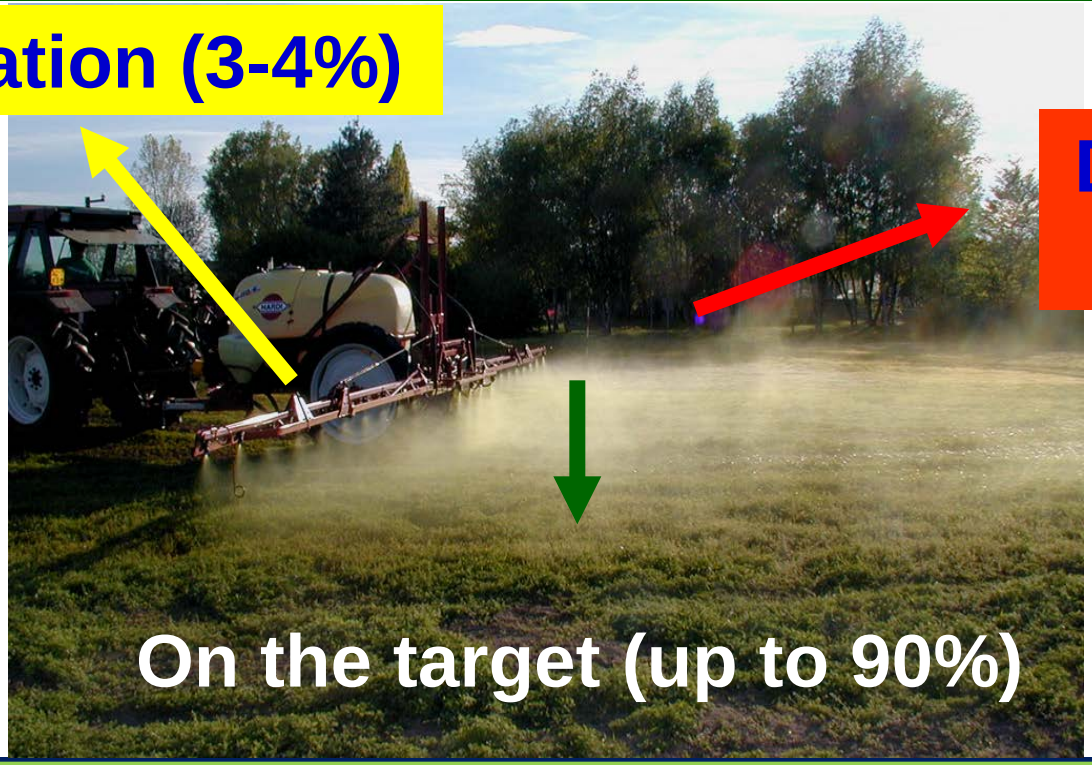
1. Background

Pesticide application on field crops



- Target surface generally well known
- Not large crop (target surface) difference along treatment periods
- EU common dose rate expression (l or kg/ha)
- Generally reduced out of the target pesticide application

1. Background



Limited difficulties in determining

Pesticide efficacy

Risk assessment

1. Background

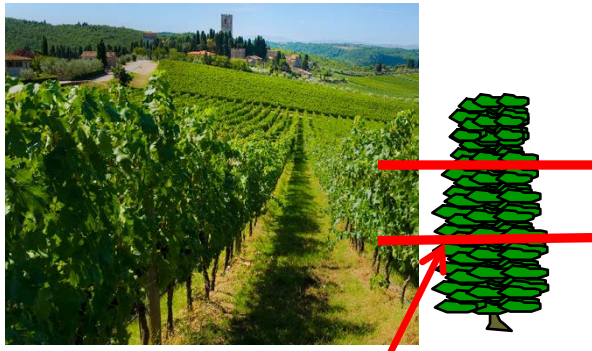
Pesticide application on bush and tree crops (3D)

Target

crop

Portion of crop

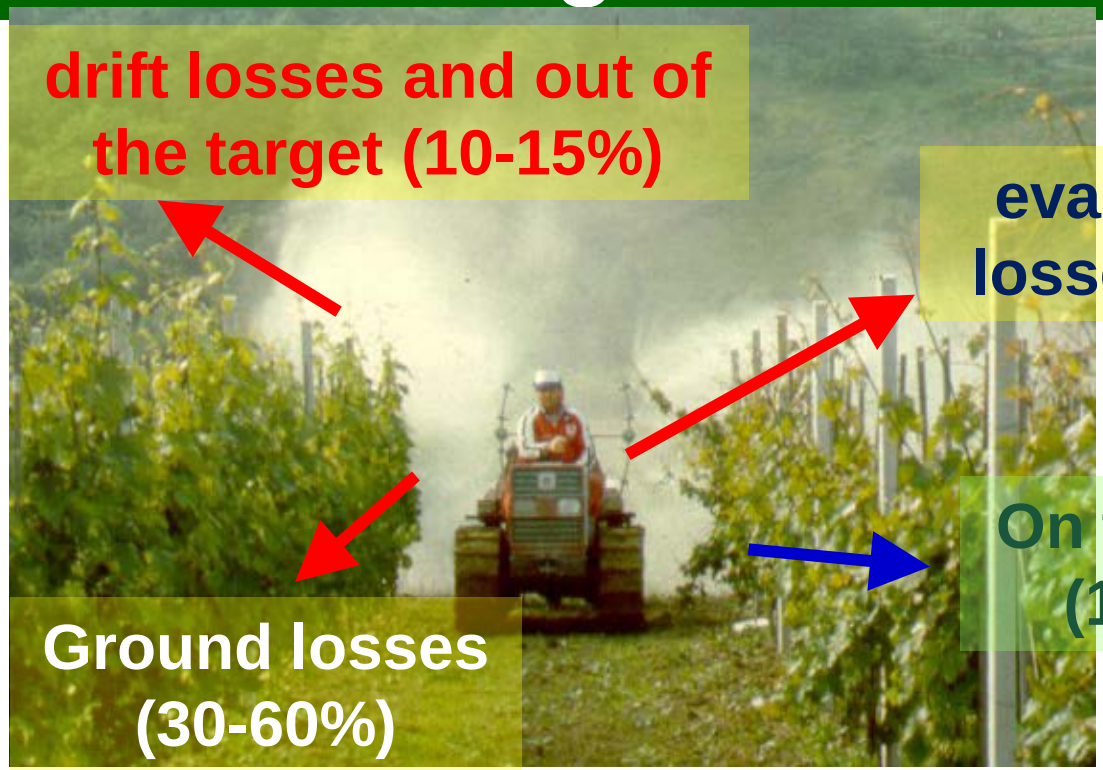
Vine plants trained at Alberello



Grapes band

- **Target surface not well defined and known**
- **Big difference target surface between the same crops and along treatment periods**
- **No common EU dose rate expression**
- **Generally high out of target pesticide application**

1. Background



High difficulties in determining

Pesticide efficacy

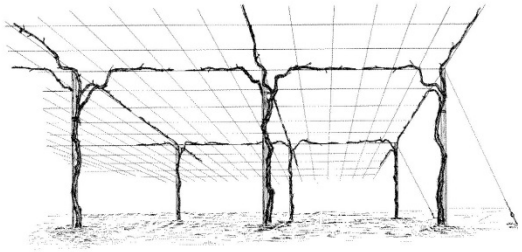
Risk assessment

Vineyard training systems in Spain

VINEYARD TRAINING SYSTEMS IN ITALY

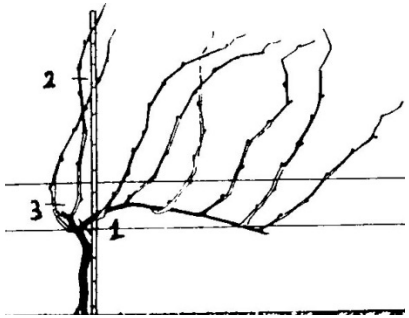
The vineyard training systems more spread in Italy are:

TENDONE **21%**

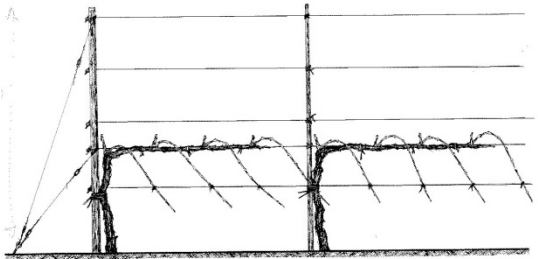


ALBERELLO **20%**

GUYOT **15%**

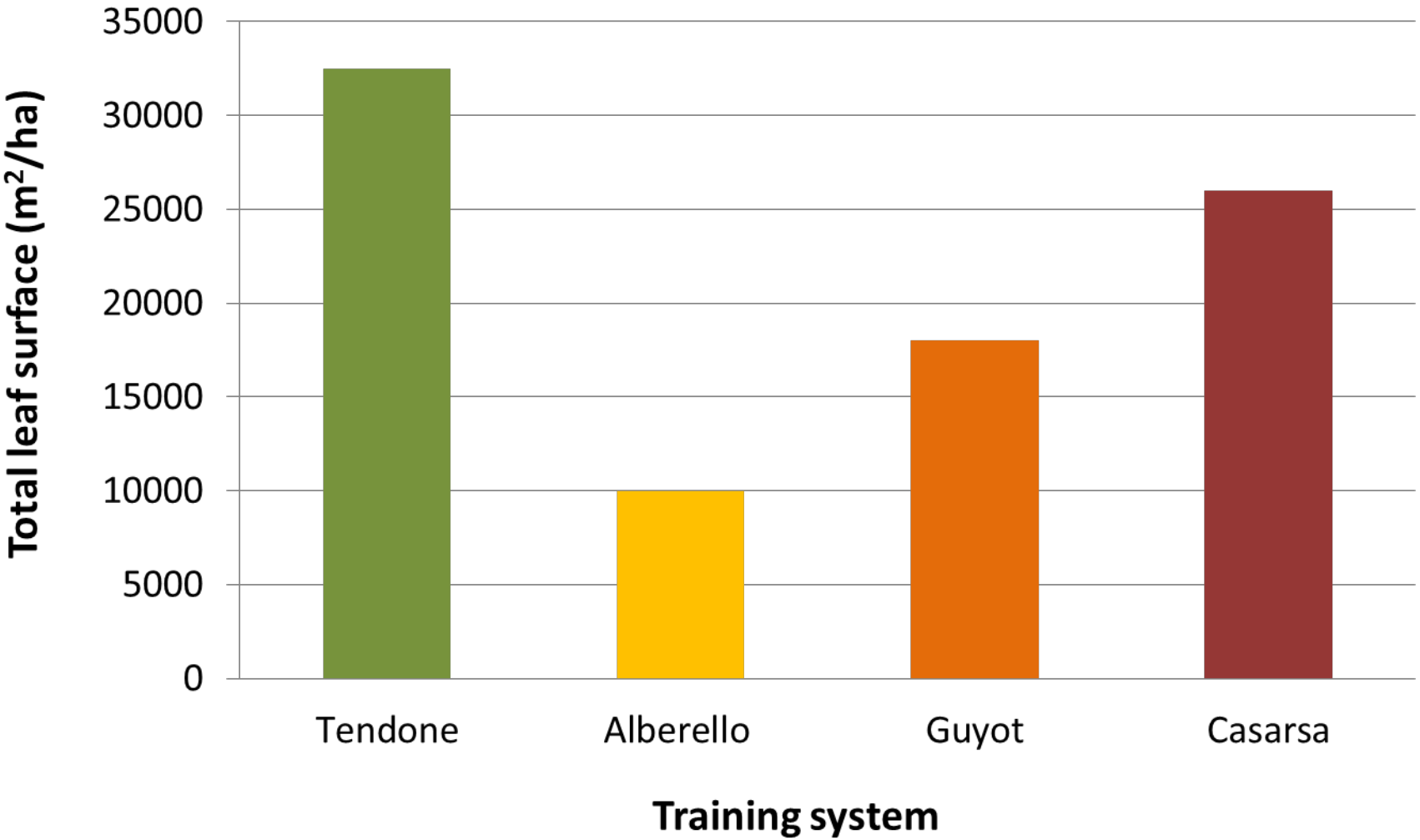


SYLVOZ/CASARSA **7%**



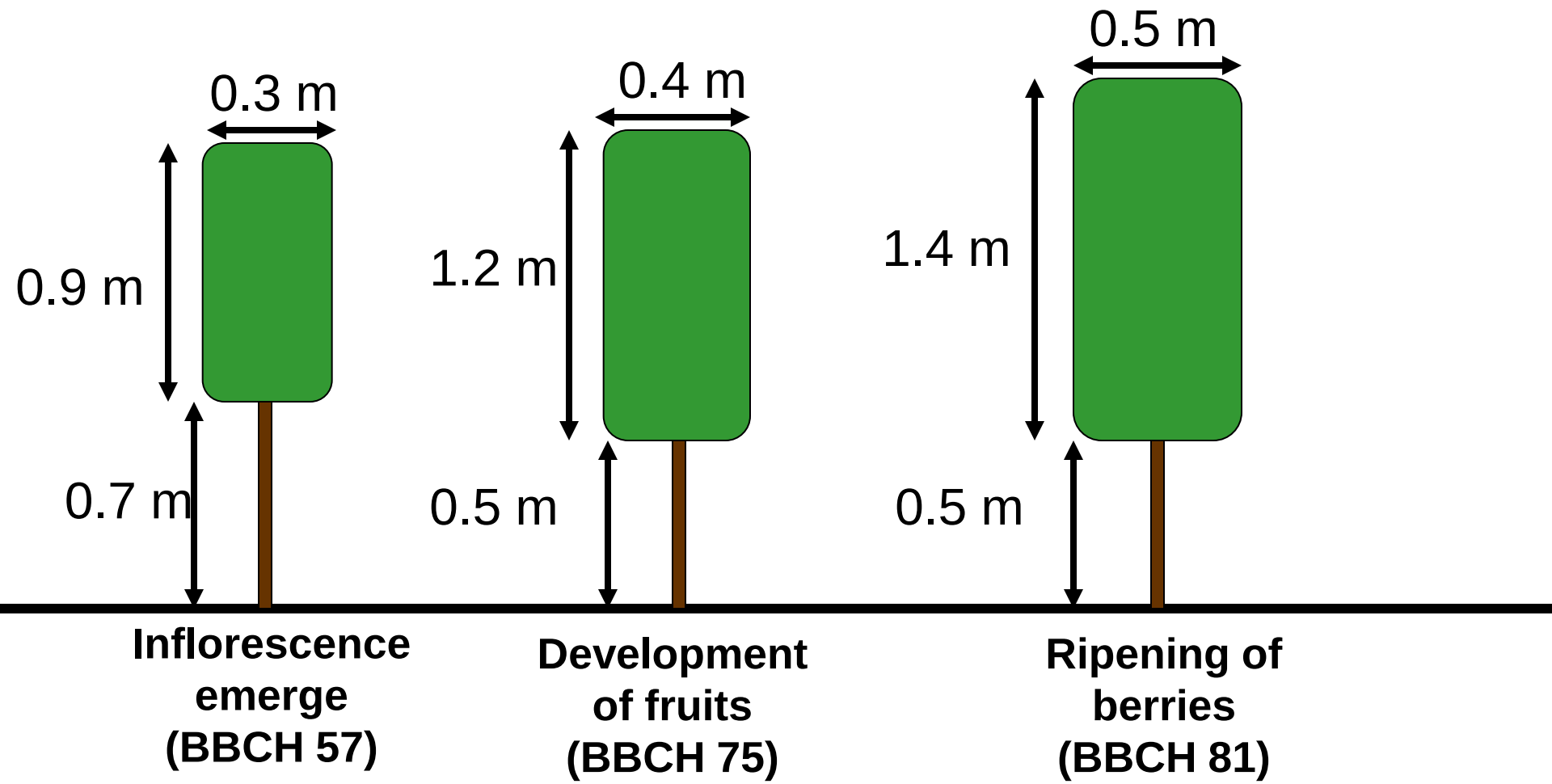
1. Background

Example of the target surface according to the training system (measured at the ripening of berries growth stage, BBCH = 81)



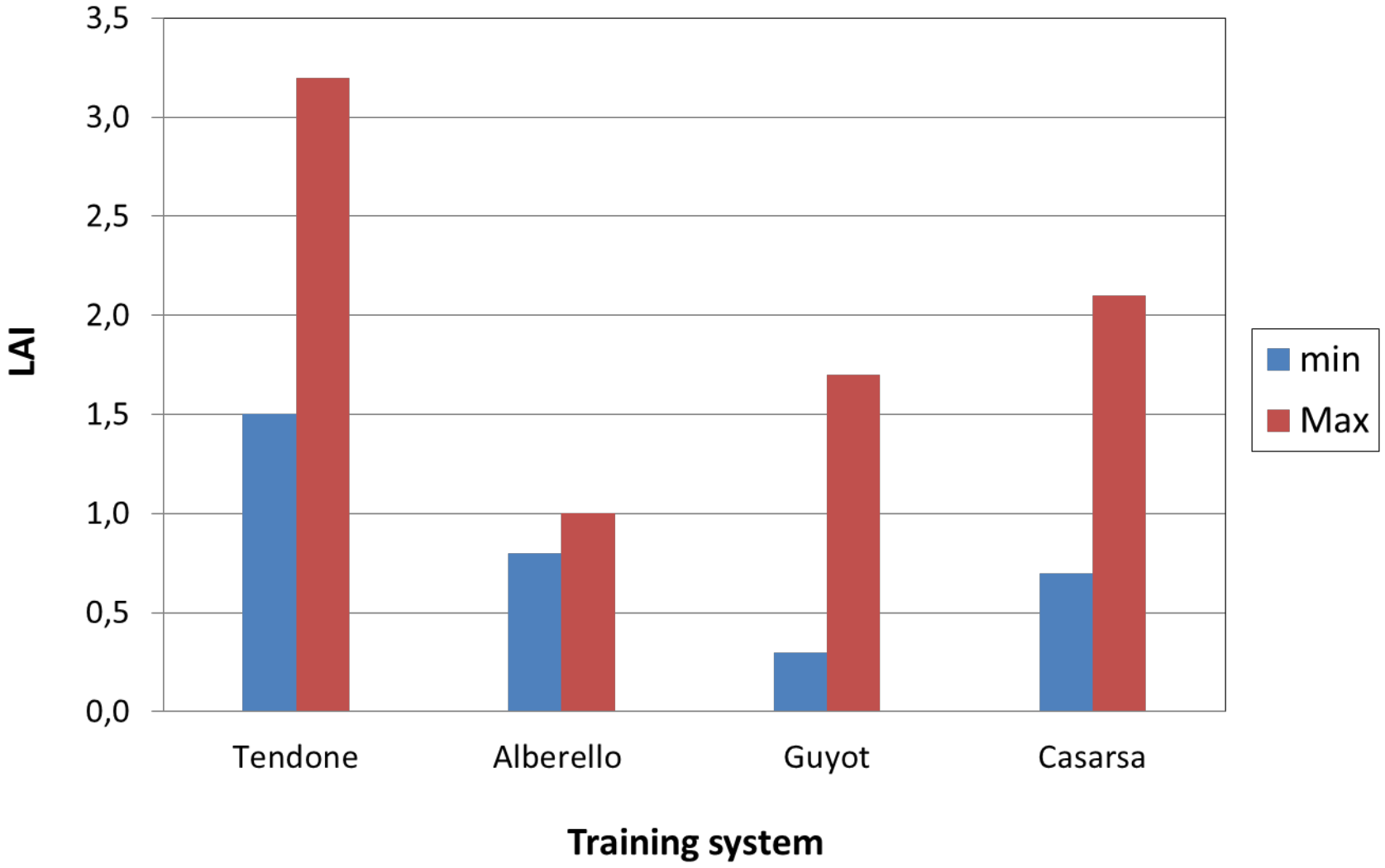
1. Background

EXAMPLE OF THE EVOLUTION OF THE CANOPY SIZE IN A VINEYARD **GUYOT** TRAINED

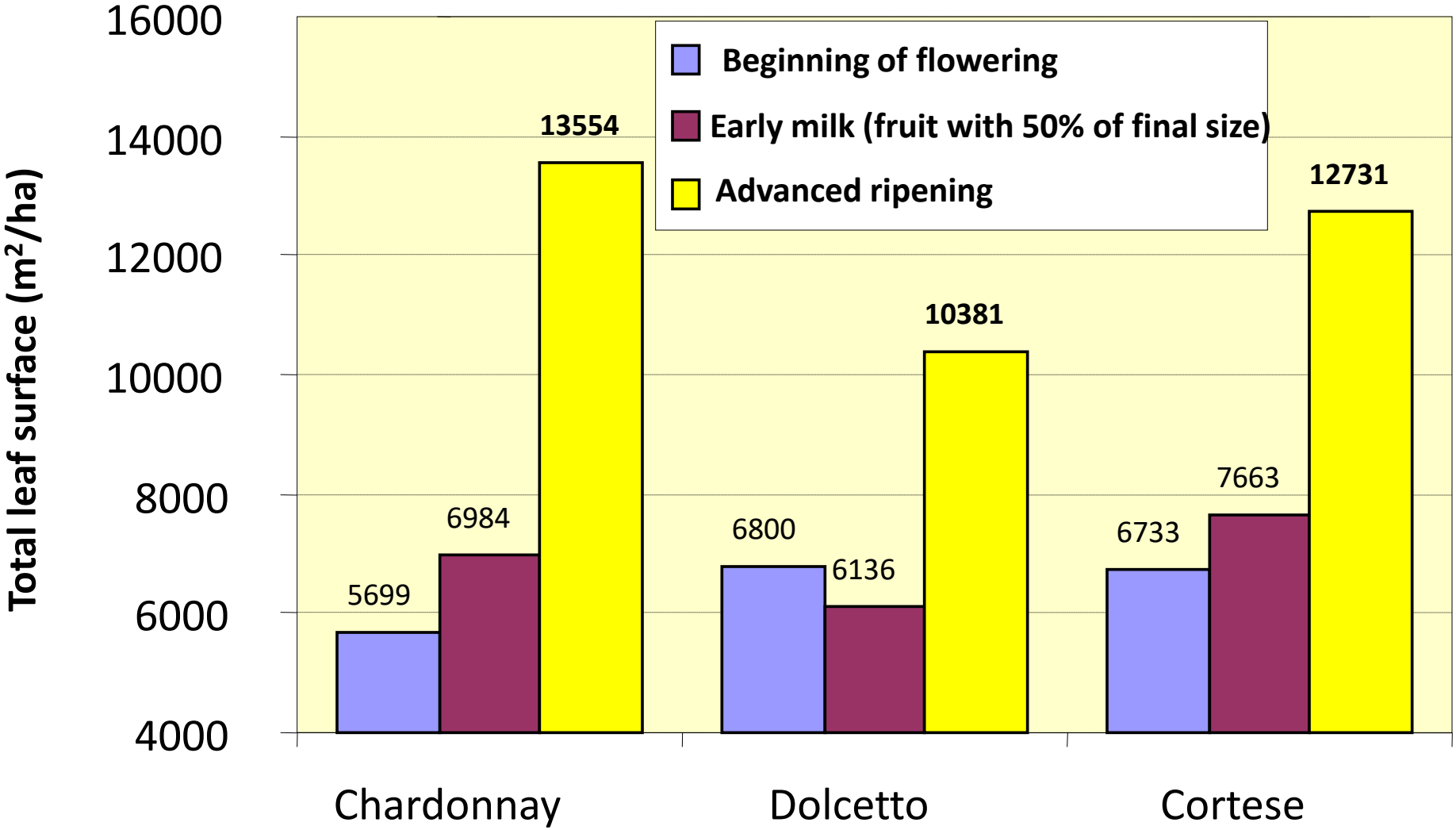


1. Background

LAI ACCORDING TO THE DIFFERENT TRAINING SYSTEMS



Total leaf surface according to the variety and the evaluation period

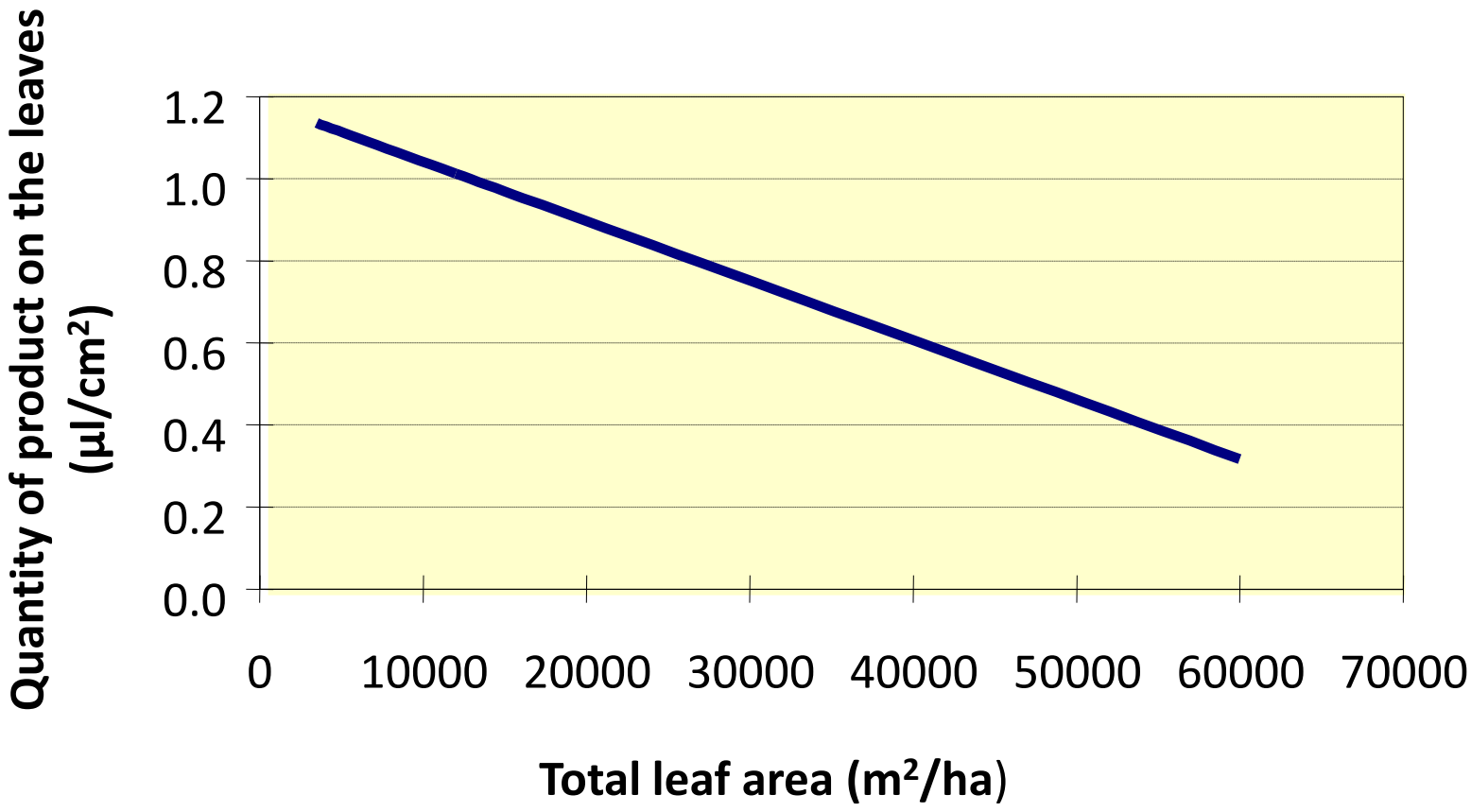


PIEMONTE - GUYOT
layout 2.8 X 1.0
3571 plants /ha

Results of tests made by DISAFA Univ.Torino

1. Background

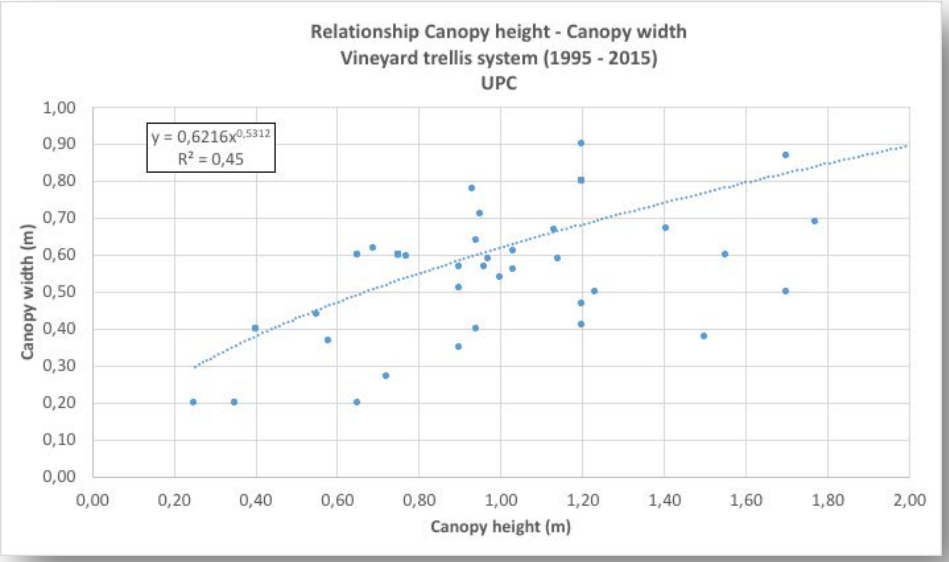
Amount of product on the leaves according to the leaf surface of the vineyard **distributing the same volume of water**
(Dose if the concentration is constant**)**

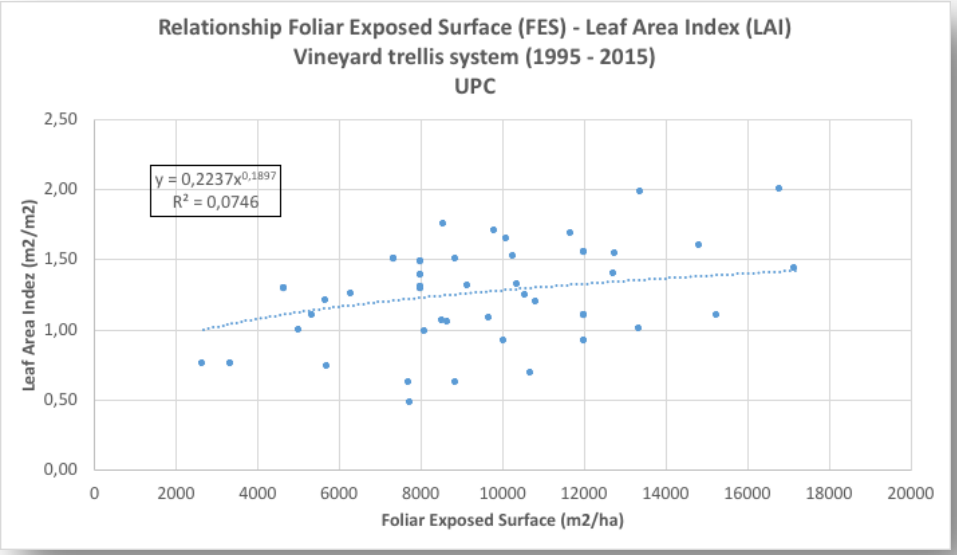


Results of the tests made by DISAFA Univ.Torino

Leaf Wall Area (LWA) for vineyard trellis systems.

(20 years of experience at Universitat Politècnica de Catalunya)





2. Current dose rate expression for 3D crops

Main current dose expression unit

Concentration of pesticide in water

(L or kg/hL)

High differences in specific unit of dose applied between EU *due to the different reference volume and for the same crop due to the differences in training system and layout*

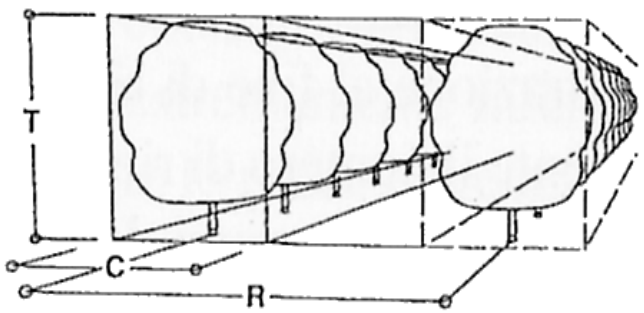
Generally ***not related to the crop target surface*** *and its seasonal development*

Target surface

(Kg or L / - m of canopy height – LWA - Row Length)

Target volume

(Kg/m³ TRV)



volume della vegetazione [Vv] = _____ *(m³/ha)*

$$Vv = \frac{T \times C \times 10000}{R}$$

Consider the target surface/volume

2. Current dose rate expression for 3D crops

Main current dose expression unit

Concentration of pesticide in water

(L or kg/hL)

easy to adopt

Mostly used in southern EU

Poor target addressed

High risk of over or under dosage

Target surface

(Kg or L / - m of canopy height – LWA - Row Length)

Target volume

(Kg/m³ TRV)

Not always easy to adopt

Mostly used in central – northern EU

Target addressed

Lower risk of over or under dosage

Volume rate
(Present situation in South EU)

Dose expression = concentration (Kg or L/hL)

↓

Reference volume (L/ha) could vary considerably also in the same country for different crops

(e.g.: Italy- 1000 L/ha for vineyard – 1500 L/ha for orchard)

↓

These volume rates are generally not more used

↓

Concentration values are consequentely increased

↓

E.g.: - Reference volume 1000 L/ha concentration = **X**

- Real volume 200 L/ha concentration = **5 X**

The contradiction of the dose expression based on [x]
The Spain example

CULTIVO	ENFERMEDAD
Cebolla	Mildiu
Lechuga	Mildiu
Pepino	Mildiu
Patata	Alternariosis y Mildiu
Tabaco	Moho azul
Tomate	Alternariosis, Mildiu y Septoriosis
Viña	Mildiu

TIPO DE APLICACIÓN	DOSIS RECOMENDADA
Aplicar en pulverización foliar normal, mojando uniformemente la parte aérea del cultivo	200-300 g por 100 l de agua. Max. 2,5 kg/ha

The contradiction of the dose expression based on [x]
The Spain Example

Anti mildiu product

CULTIVO	ENFERMEDAD	TIPO DE APLICACIÓN	DOSIS RECOMENDADA
Cebolla	Mildiu	Aplicar en pulverización foliar normal, mojando uniformemente la parte aérea del cultivo	200-300 g por 100 l de agua. Max. 2,5 kg/ha
Lechuga	Mildiu		
Pepino	Mildiu		
Patata	Alternariosis y Mildiu		
Tabaco	Moho azul		
Tomate	Alternariosis, Mildiu y Septoriosis		
Viña	Mildiu		

El número máximo de tratamientos por campaña será de 4 en viña y 3 en el resto de cultivos.
Los tratamientos deberán iniciarse al comienzo del periodo de crecimiento, de forma preventiva, antes del establecimiento de la enfermedad. Para ello se pueden seguir las recomendaciones de las Estaciones de Avisos. El intervalo máximo entre las aplicaciones será de 14 días. En condiciones muy favorables al desarrollo del mildiu, reducir el intervalo a 10 días, especialmente en las fases de mayor crecimiento del cultivo. En viña el último tratamiento se realizará, como muy tarde, 14 días después del final de la floración.

250 g per 100 l
Max. 2,5 kg/ha

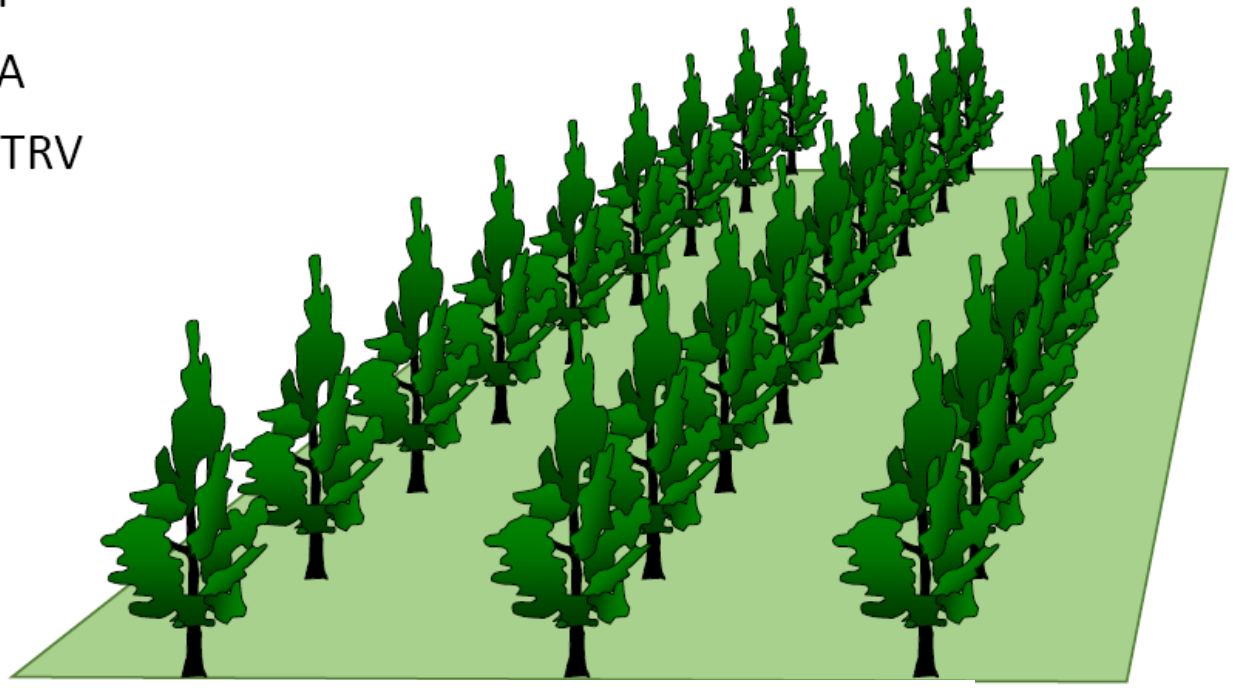
1000 L/ha

- **Who applies 1000 l/ha?**
- **[200 – 300 g/100 l] works properly?**
- **Only for 1000 l/ha?**
- **What happens if volume/ha is adjusted and spray coverage improved?**

2. Current dose rate expression for 3D crops in Europe

Reference units in the EU:

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



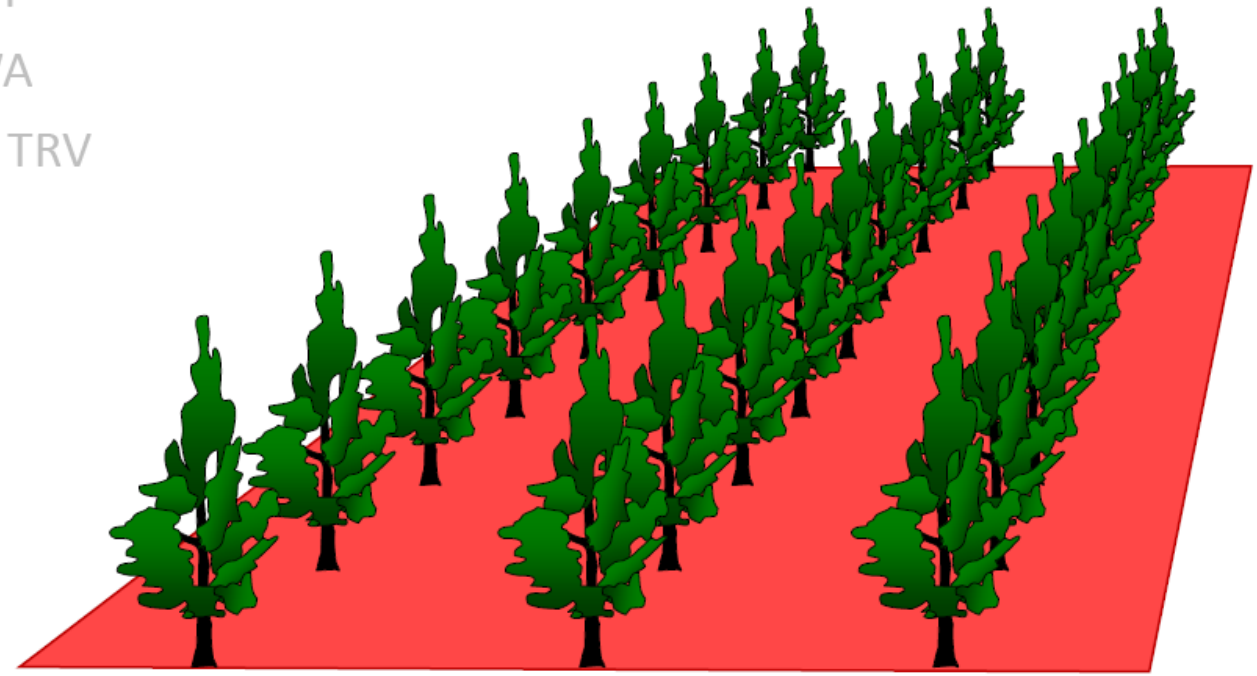
(Doruchowski 2017)

2. Current dose rate expression for 3D crops in Europe

Reference units in the EU: SE, 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



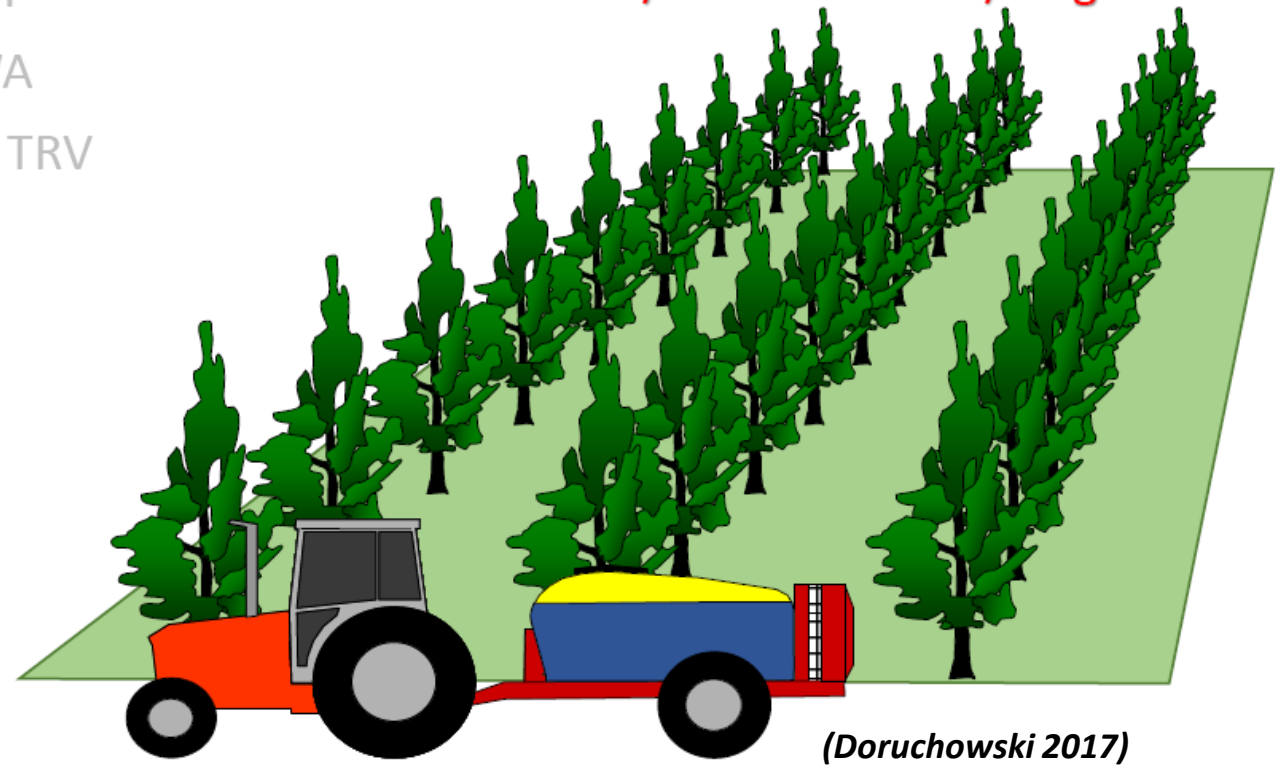
(Doruchowski 2017)

2. Current dose rate expression for 3D crops in Europe

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



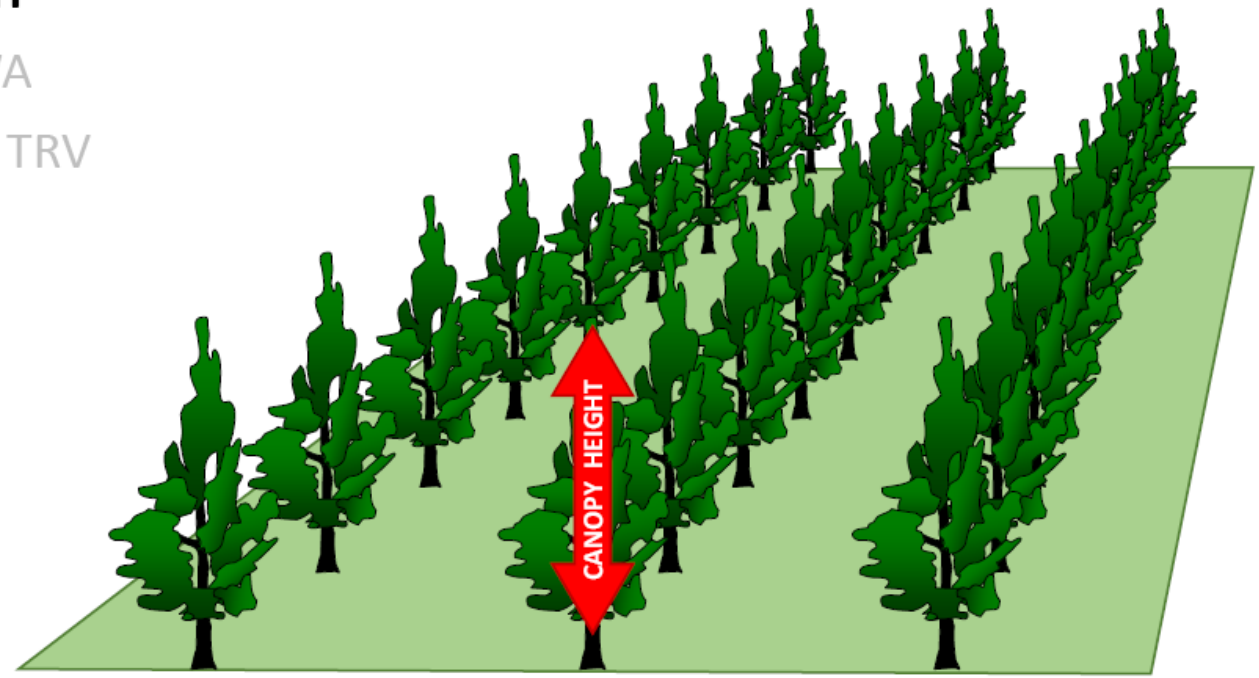
(Doruchowski 2017)

2. Current dose rate expression for 3D crops in Europe

Reference units in the EU: SE, ● 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**



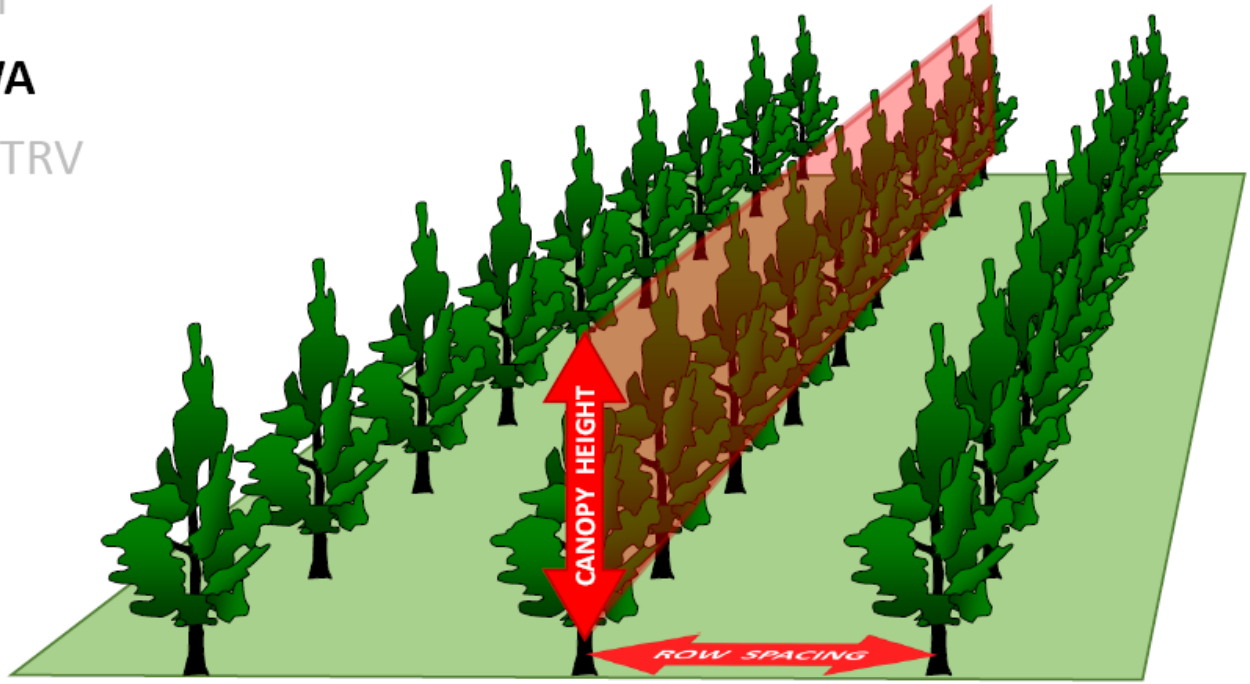
(Doruchowski 2017)

2. Current dose rate expression for 3D crops in Europe

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 m² LWA



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

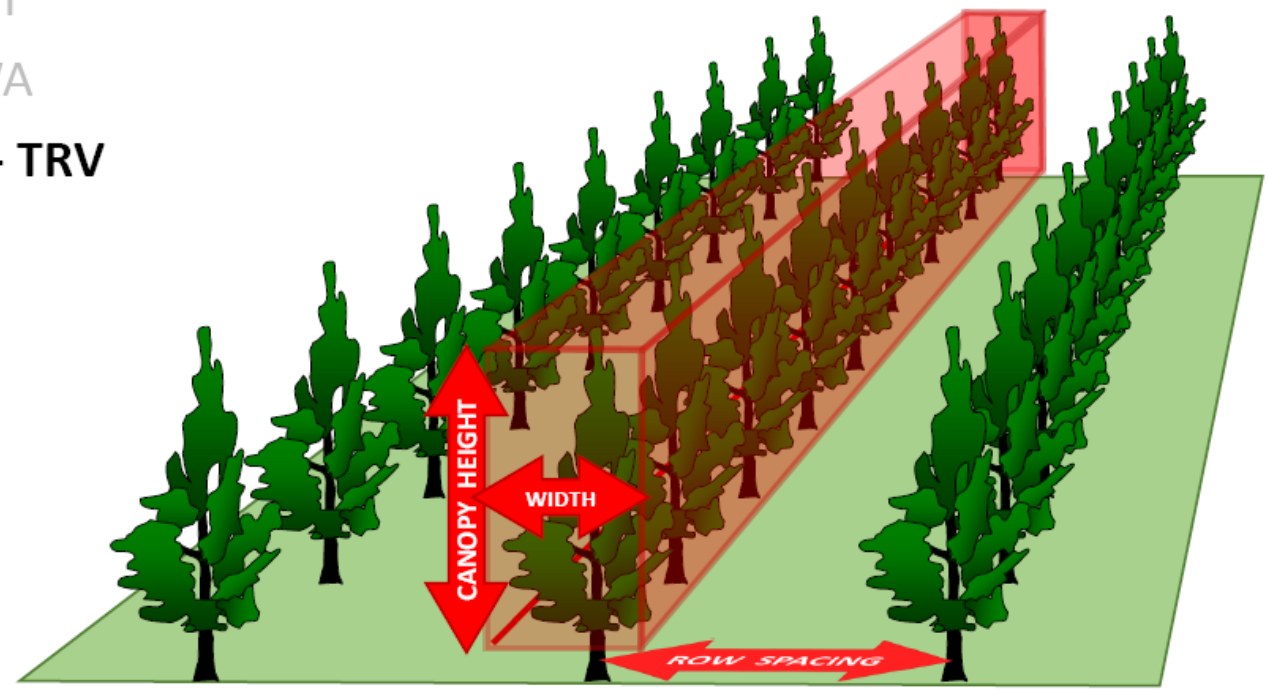
(Doruchowski 2017)

2. Current dose rate expression for 3D crops in Europe

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 m³ TRV



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

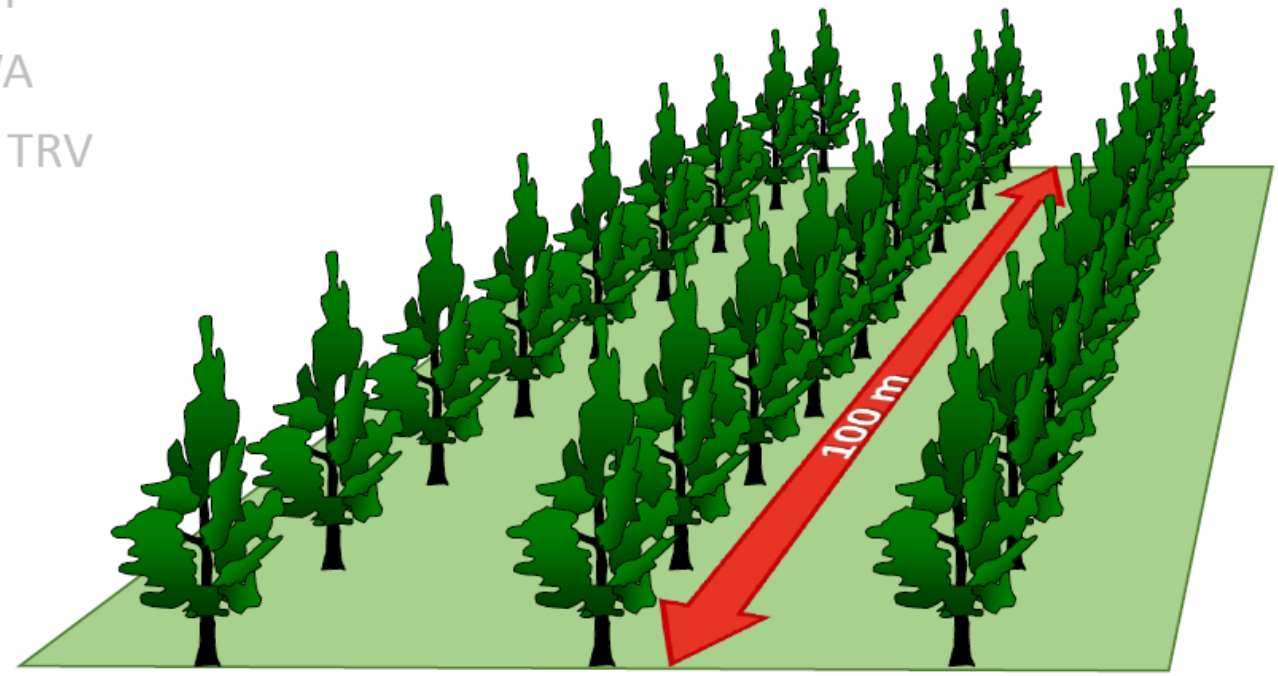
(Doruchowski 2017)

2. Current dose rate expression for 3D crops in Europe

Reference units in the EU: NO - ● -

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

kg or L/100 m di filare



(Doruchowski 2017)

2. Current dose rate expression for 3D crops in EU

The Problem

Dose expression and volume rate have been key factors widely discussed in the recent years, unfortunately without a clear and unique EU recommendation

2. Current dose rate expression in Europe

	Orchard	Vineyard	High-growing vegetables	Citrus / Olives
Austria and Germany	Kg/ha/m of canopy height (max kg/ha)	% accord. Eichhorn, max. kg/ha BBCH	Kg/ha/m of canopy height (max kg/ha)	---
Belgium	Kg or L /10'000m^2 LWA, max.kg or l /ha	---	Kg/ha	---
France	Kg/ha	Kg/ha	Kg/ha	---
Netherlands	(A) Concentration = L-kg/Hl) (Max vol/ha)	---	(A) Concentration = L-kg/Hl) (Max vol/ha)	---
Switzerland	Kg/10'000 m^3 TRV	%, max. spray vol / ha	(A) Concentration = L-kg/Hl) (Max vol/ha)	---
Norway	Kg/100m row length	(A) Concentration = L-kg/Hl) (Max vol/ha)	---	---
Greece	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)
Italy	(A) Concentration = L-kg/Hl) (min to max spray volume /ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)
Portugal	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)
Spain	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)	(A) Concentration = L-kg/Hl) (Max vol/ha)

6 different dose expression units for orchard

2. Current dose rate expression for 3D crops in EU

Need of Harmonisation of dose expression

EPPO General Standard PP 1/239(2)

Dose expression for crop protection products

- **"……. The dose should be expressed in a form easily understood by users of plant protection products"**
- **Reference units for crops (3D) listed and discussed (EPPO Vienna meeting 2017):**
  - ~~Ground area~~
  - ~~Spray volume (concentration %)~~
  - Canopy height – CH
  - **Leaf wall area (– LWA) x vineyard**
  - Tree row volume (–TRV)
  - Plant row

4. The Leaf Wall Area (LWA) dose expression system

The principle

To adapt the pesticide dose to the 'mass' of the target following the pharmaceuticals raccomandations dose principle

Pharmaceuticals: dose rate adapted to the body weight

15 kg
child

55 kg
lady - teacher

100 kg
worker

Dose

4. The Leaf Wall Area (LWA) dose expression system

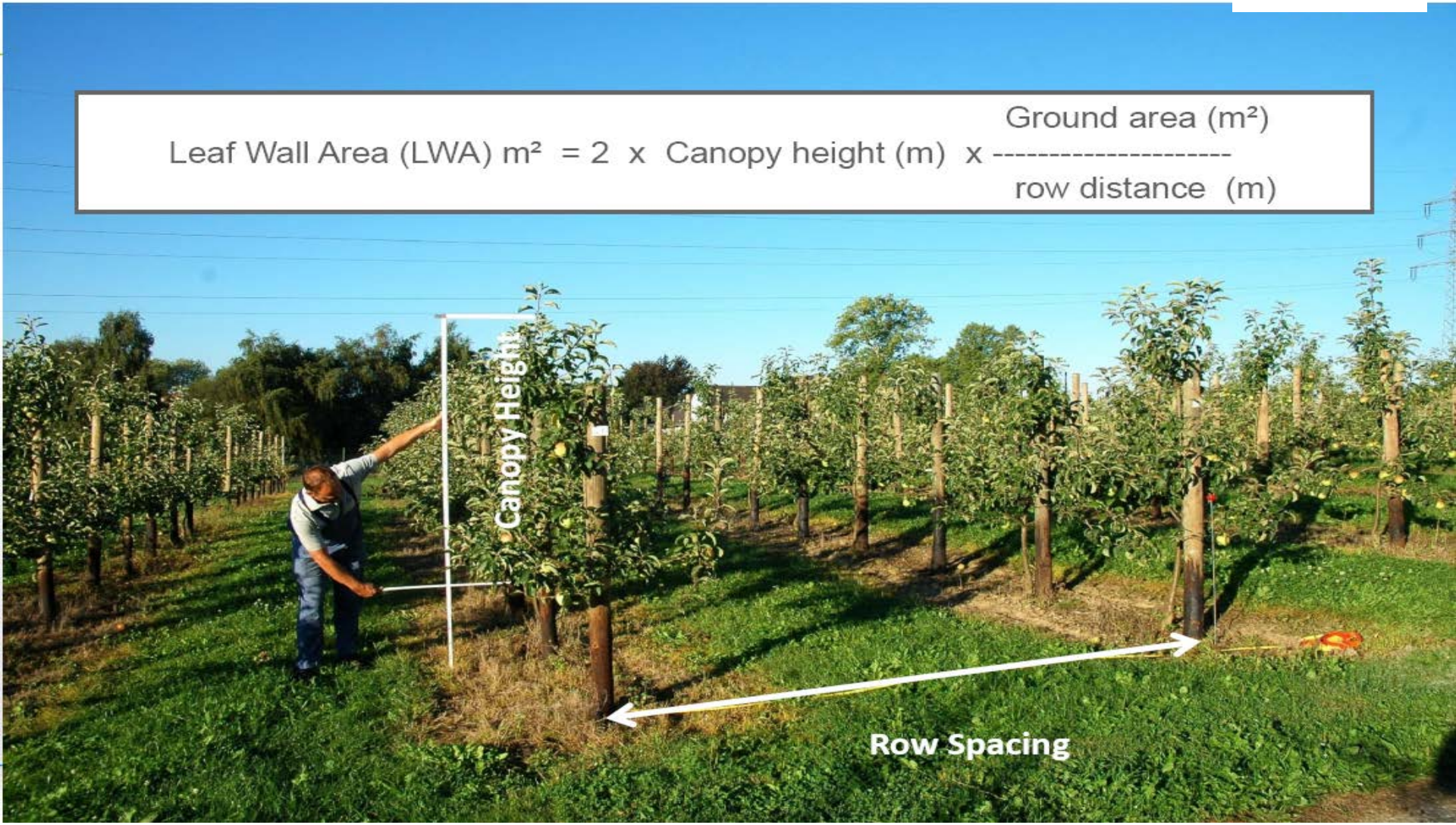
Agriculture: dose rate should be adapted to the size of the crop

(Principle: foliar applications should result in similar deposits per e.g. µl/cm^2 or ng/cm^2)

4. The Leaf Wall Area (LWA) dose expression system

Leaf Wall Area calculation

$$\text{Leaf Wall Area (LWA) m}^2 = 2 \times \text{Canopy height (m)} \times \frac{\text{Ground area (m}^2\text{)}}{\text{row distance (m)}}$$



4. The Leaf Wall Area (LWA) dose expression system

A possible future label

(Examples of LWA for pome fruit orchards)

	Canopy or foliage height (m)						
Row distance (m)	1.5	2.0	2.5	3.0	3.5	4.0	4.5
2.5	12'000	16'000	20'000	24'000	n.a.	n.a.	n.a.
3.0	10'000	13'333	16'666	20'000	23'333	n.a.	n.a
3.5	8'571	11'428	14'286	17'143	20'000	22'857	n.a.
4.0	7'500	10'000	12'500	15'000	17'500	20'000	22'500
4.5	6'666	8'888	11'111	13'333	15'555	17'777	20'000
5.0	6'000	8'000	10'000	12'000	14'000	16'000	18'000

= most common sizes for modern pome fuit orchards

Source: Bayer CropScience – Pflanzenschutz Nachrichten, Special Edition, 2007

4. The Leaf Wall Area (LWA) dose expression system

LWA expression way

Product: Kg, L / 10.000 m^2 LWA

Volume: L / 10.000 m^2 LWA

LWA expression: still several main aspectes need to be defined

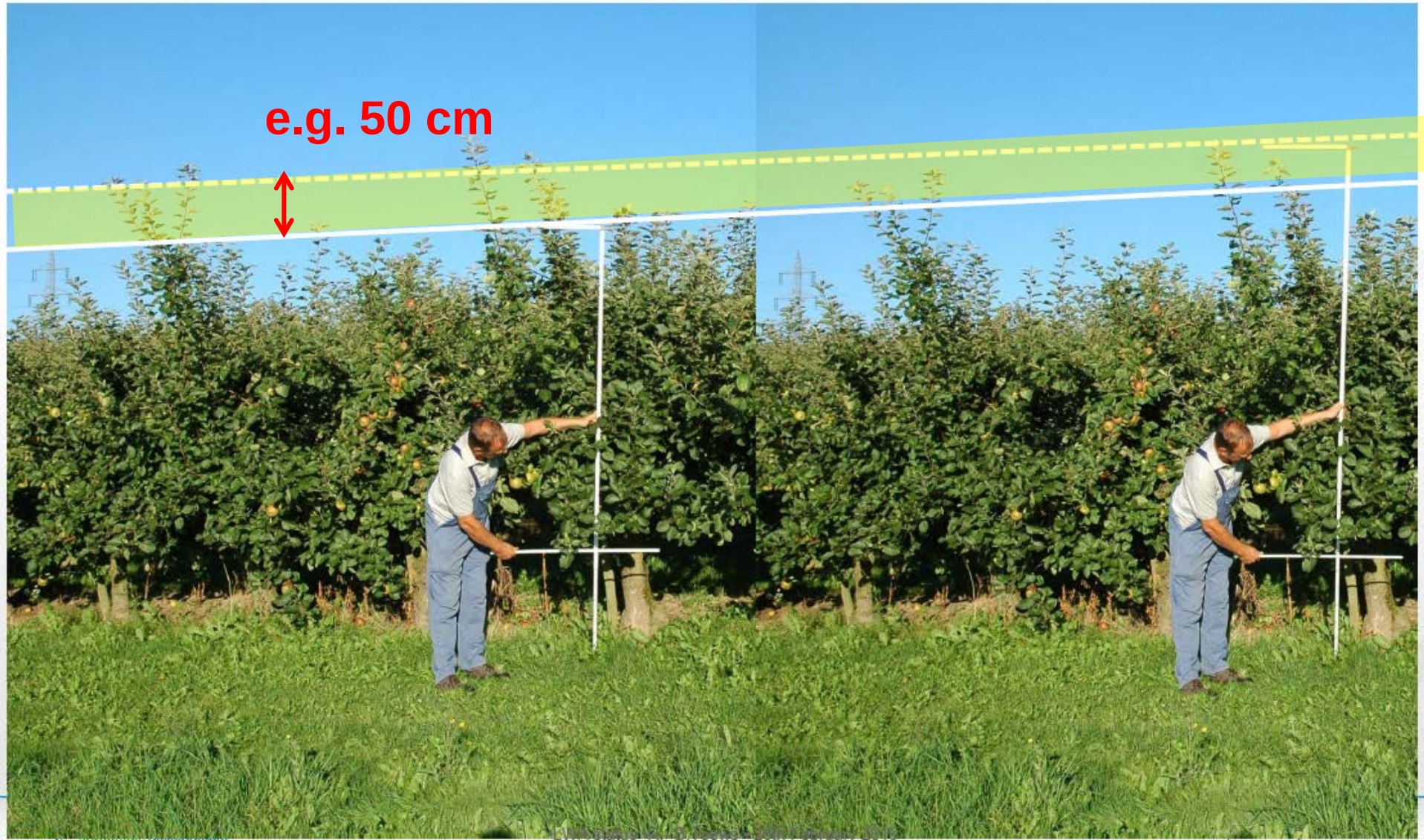
How to appropriate determine LWA

How to determine the VOLUME related to LWA

How to convert «old» dose expression systems to LWA

4. The Leaf Wall Area (LWA) dose expression system

Measurement of the Canopy Height



4. The Leaf Wall Area (LWA) dose expression system

Definition of the Treated Canopy Height

4. The Leaf Wall Area (LWA) dose expression system

Leaf Wall Area (measured)

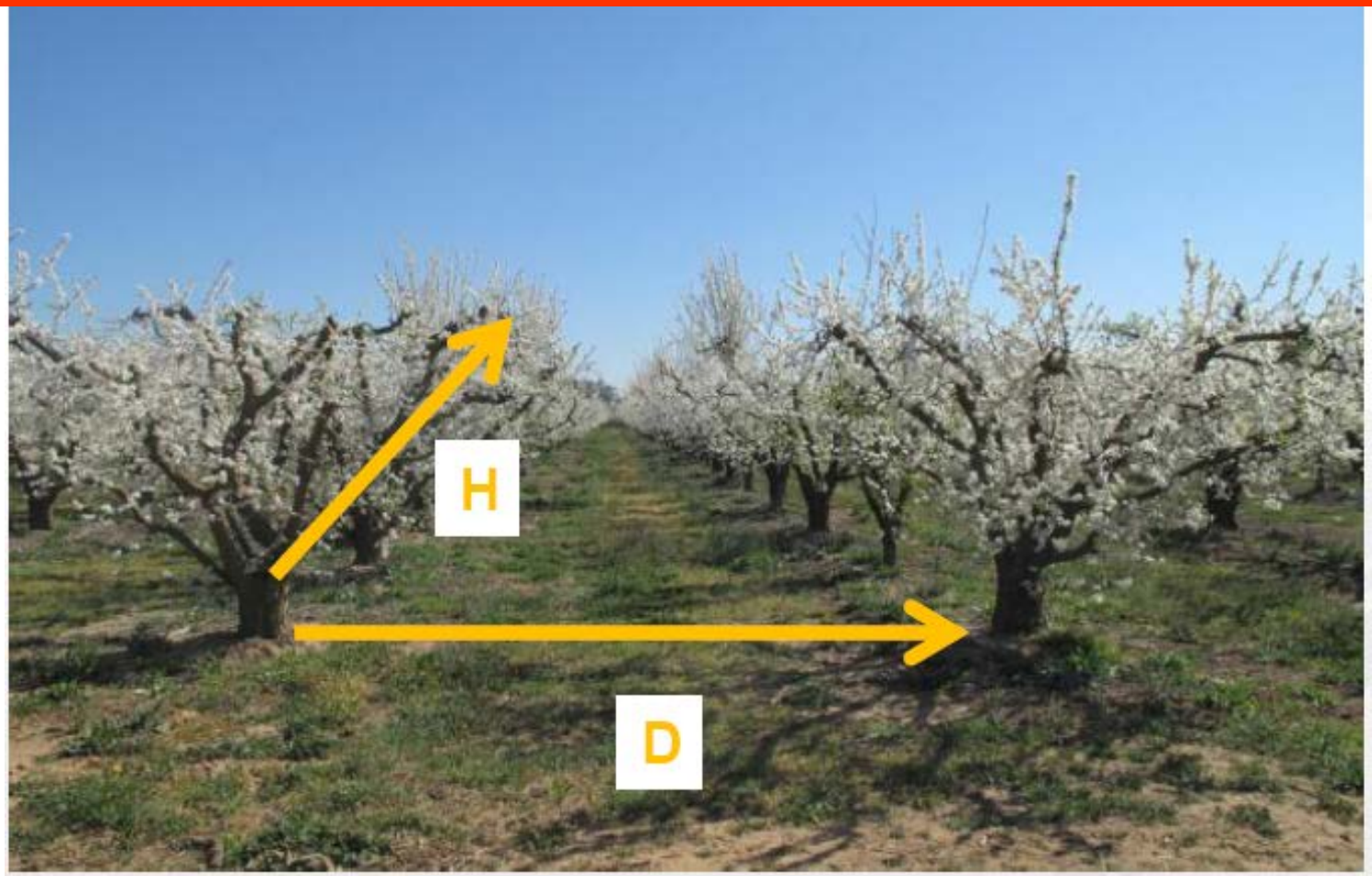
=

Leaf Wall Area treated ??

4. The Leaf Wall Area (LWA) dose expression system

4. The Leaf Wall Area (LWA) dose expression system

Example: Pome fruit orchard trained at «Vaso» system

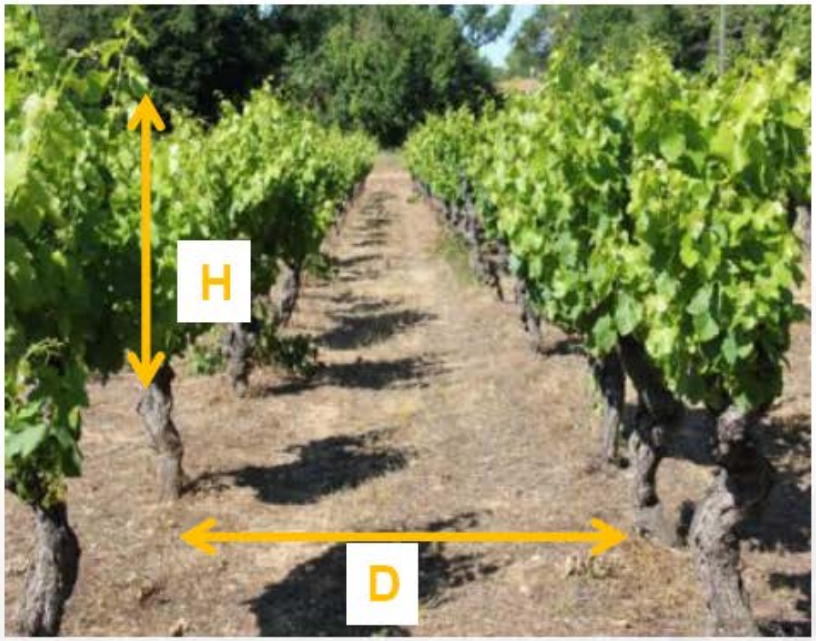


H = Treated Canopy Height

D = Row spacing

4. The Leaf Wall Area (LWA) dose expression system

Example: Vineyard trained at trellis system



H =Treated Canopy Height

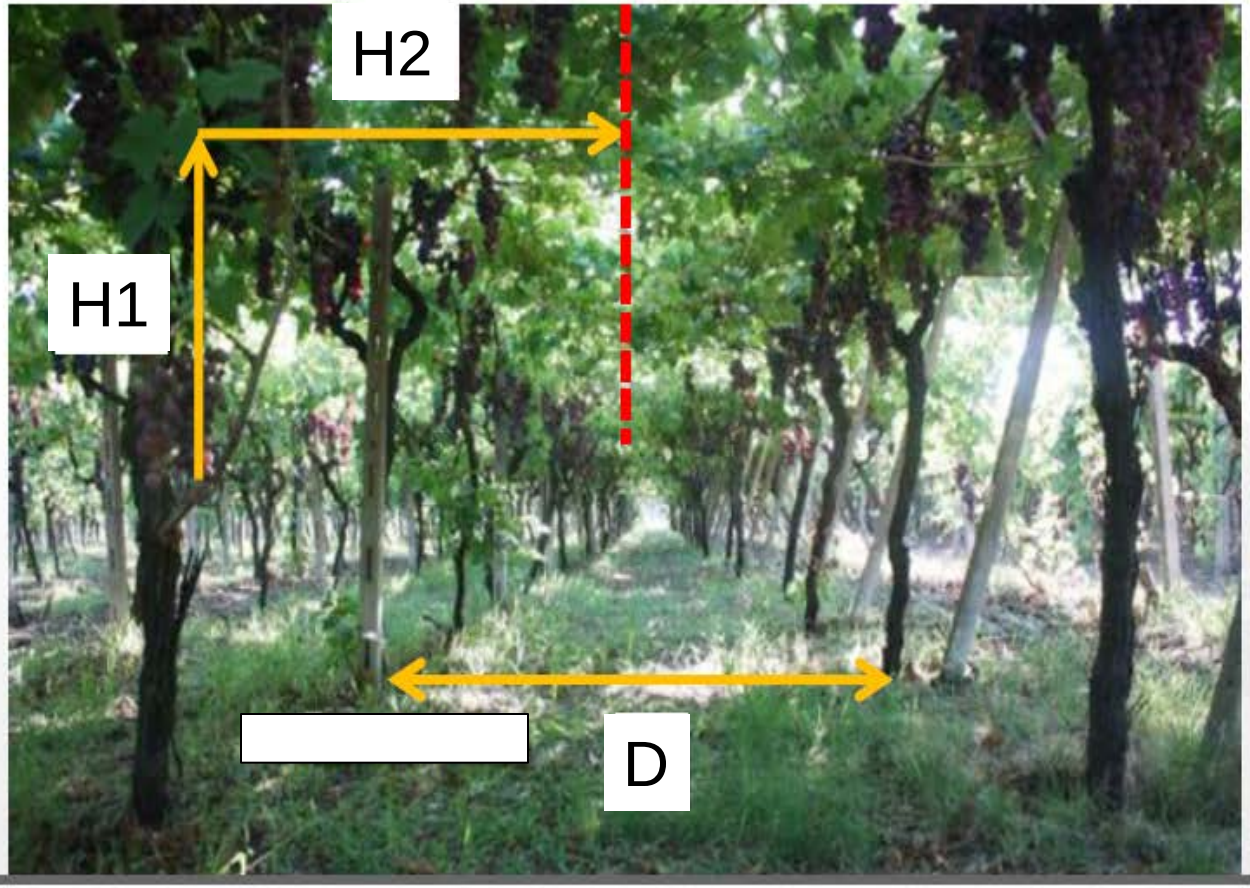
Only sprayed canopy height is relevant
should reflect the height of treated area(trunk to be disregarded)
Average on 10 most representative grapevines of the trial is recorded

D = Row Spacing

photo: Agroscope viti 2005/6

4. The Leaf Wall Area (LWA) dose expression system

Example: Vineyard trained at «Pergola» system



H1+H2 =Treated Canopy Height

Only sprayed canopy height is relevant
should reflect the height of treated area(trunk to be disregarded)
Average on 10 most representative grapevines of the trial is recorded

4. The Leaf Wall Area (LWA) dose expression system

Moving from

↓

Leaf Wall Area (LWA)

↓

TO

↓

Leaf Treated Wall Area (LTWA)??

↓

Standardized methods of LWA measurements are necessary !!

4. The Leaf Wall Area (LWA) dose expression system

Main aspects still to be defined/achieved

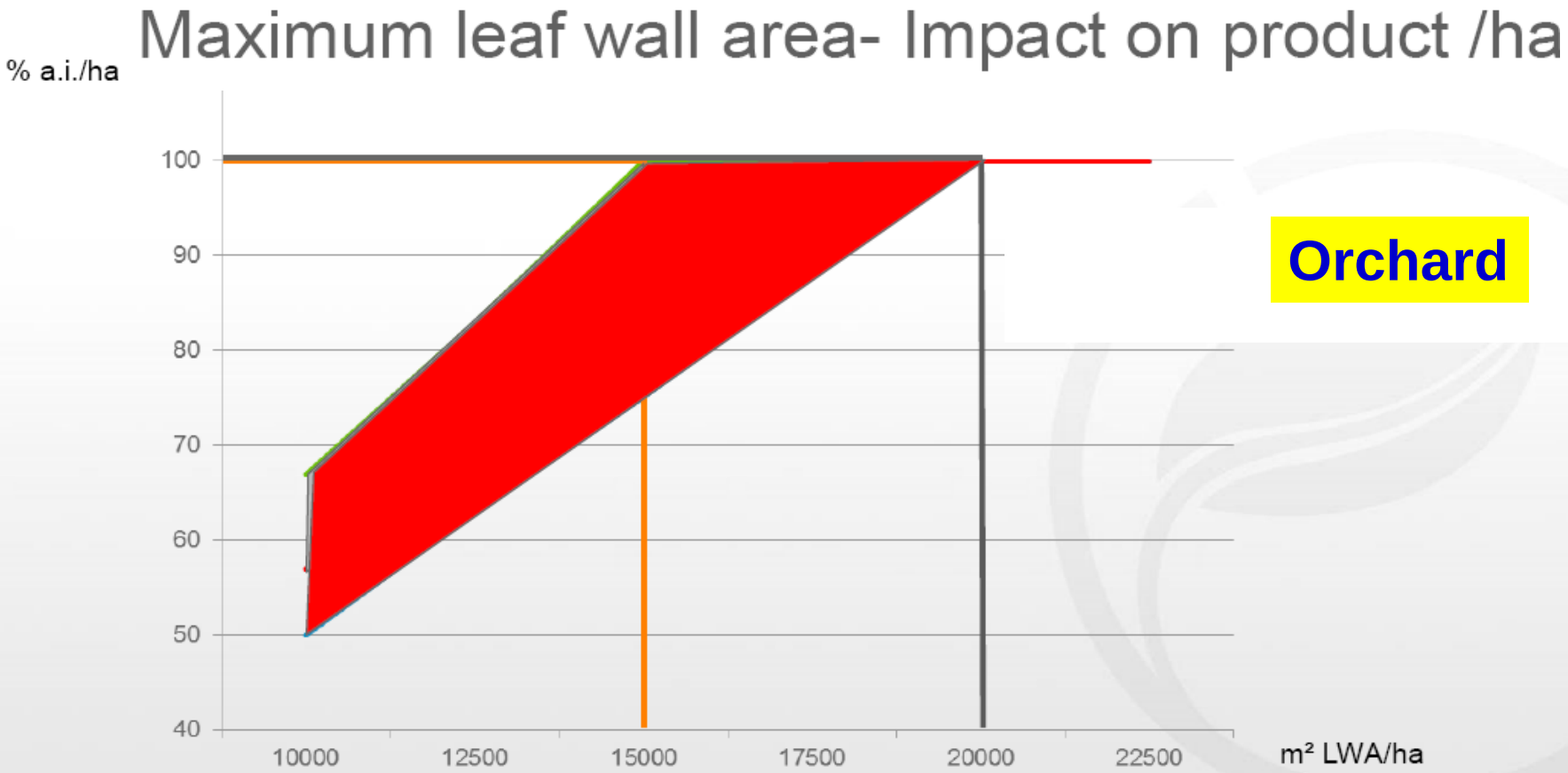
MAX Leaf Wall Area (LWA) value

Reference Volume rate x LWA

Conversion formula from the current used dose expression units to LWA and viceversa

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved)

Max LWA value

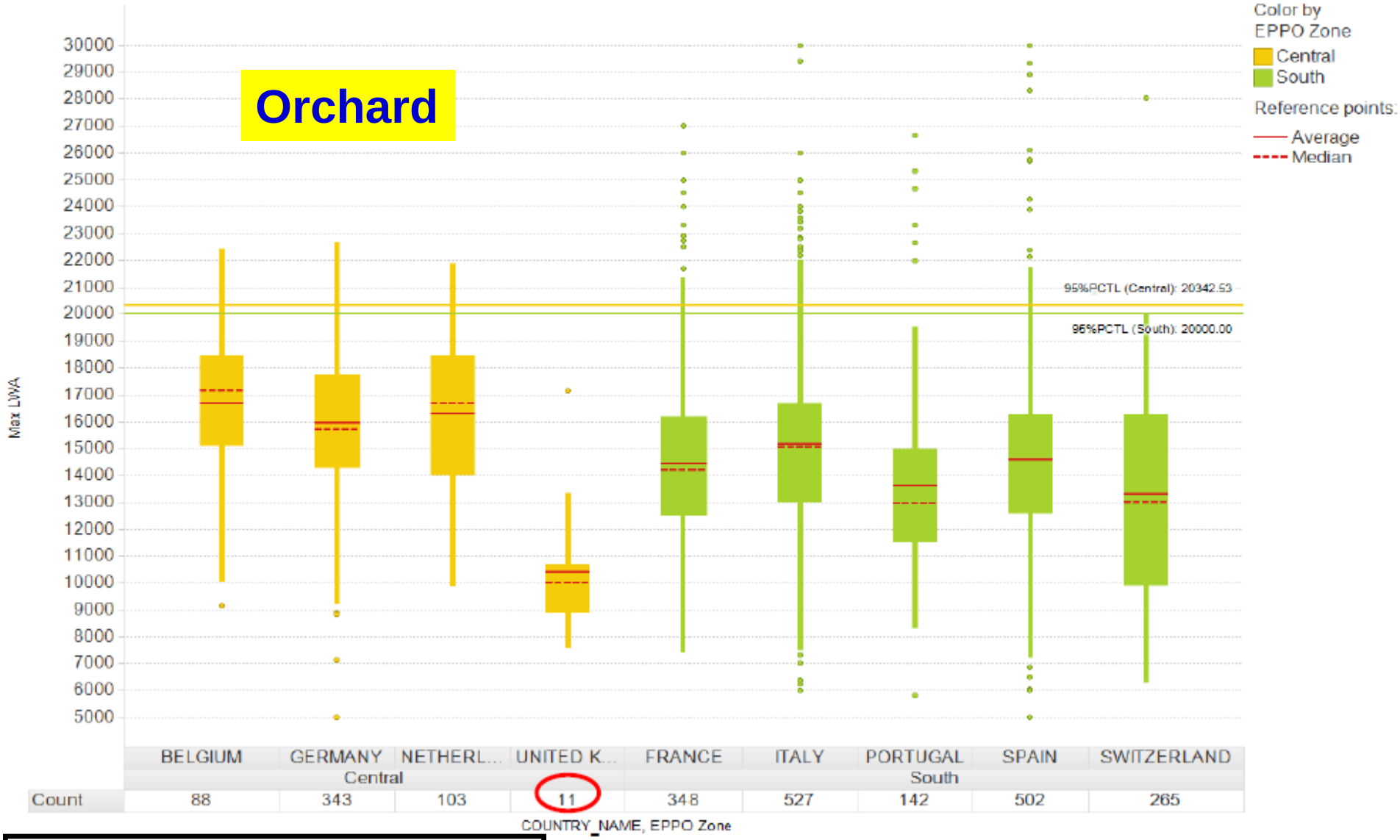


Orchard

From R.D. Toews – Bayer Application Technology Group

4. The Leaf Wall Area (LWA) dose expression system

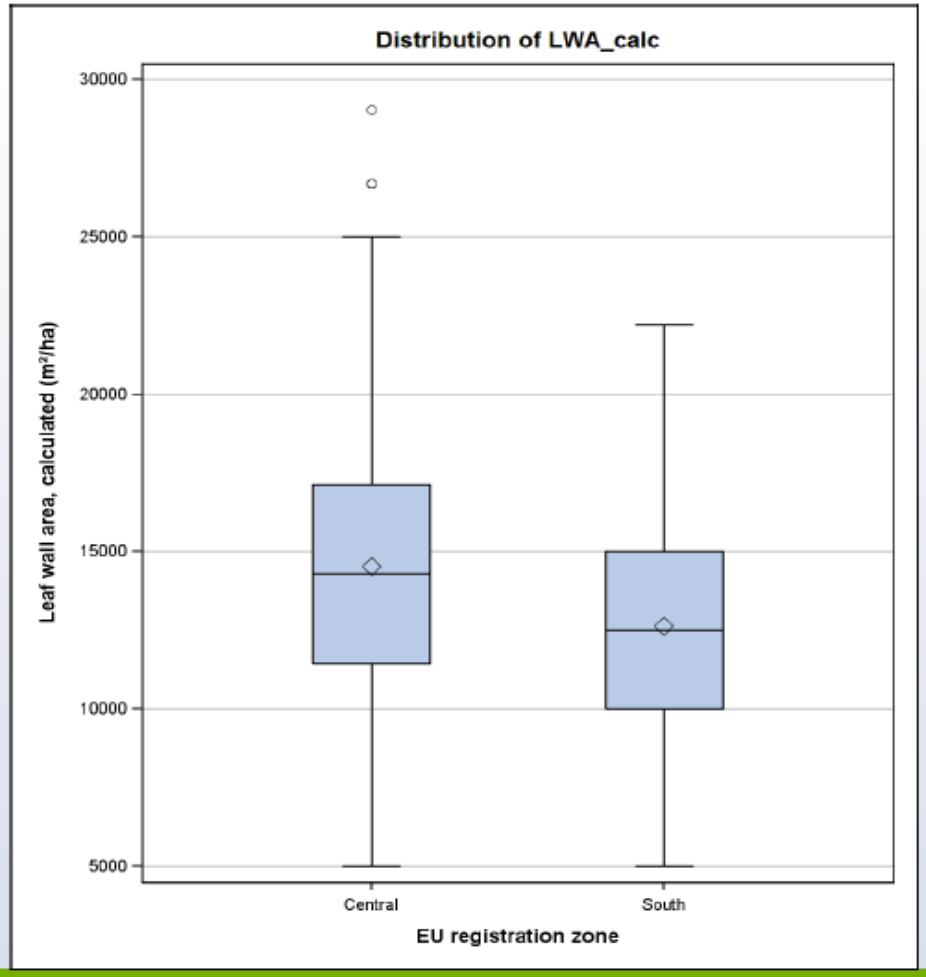
LWA per country & zone (Chemical industry Data)



- Max LWA: (5000.00 <= Max LWA <= 30000.00) and empty values

4. The Leaf Wall Area (LWA) dose expression system

Apple + pear: distribution of LWA in regulatory zones



Analysis by Peter Lancashire (SAS 9.2 on 14OCT2011 at 10:15) . . . © Bayer CropScience AG

The source data come from efficacy and residue trials in Europe from 2003-2011.

Key: line=median, diamond=mean, box=half data, whisker=box±1.5, points=outliers.

Bayer CropScience

4. The Leaf Wall Area (LWA) dose expression system

Distribution of LWA by Fruit Trees groups (all countries together)

Crop name	N Obs	Mean	90th Pctl	95th Pctl
Apple	900	13462	18462	20000
Pear	321	13465	18400	20000
Apricot	39	9200	12000	12941
Nectarine	59	8770	13333	15000
Peach	238	9565	12500	14222
Cherry	149	11353	15429	17143
Plum	134	11614	15556	17143

Crop group	N Obs	Mean	Lower 95% CL for Mean	Upper 95% CL for Mean	25th Pctl	50th Pctl	75th Pctl	90th Pctl	95th Pctl
Pome	1221	13463	13254	13671	10667	13333	15152	18462	20000
Stone	619	10340	10079	10601	8000	10000	12500	15000	15556

Analysis by Peter Lancashire (SAS 9.2 on 14OCT2011 at 10:15) . . . © Bayer CropScience AG

The source data come from efficacy and residue trials in Europe from 2003-2011.

Key: line=median, diamond=mean, box=half data, whisker=box±1.5, points=outliers.

Bayer CropScience

4. The Leaf Wall Area (LWA) dose expression system

Max LWA value

- Germany Authorities & Advisory service proposal:
  18000 m² /ha (worst case scenario)
- Bayer proposal: ***15000 m²/ha or country specific***
- Chemical Industries proposal*: ***20000 m²/ha***

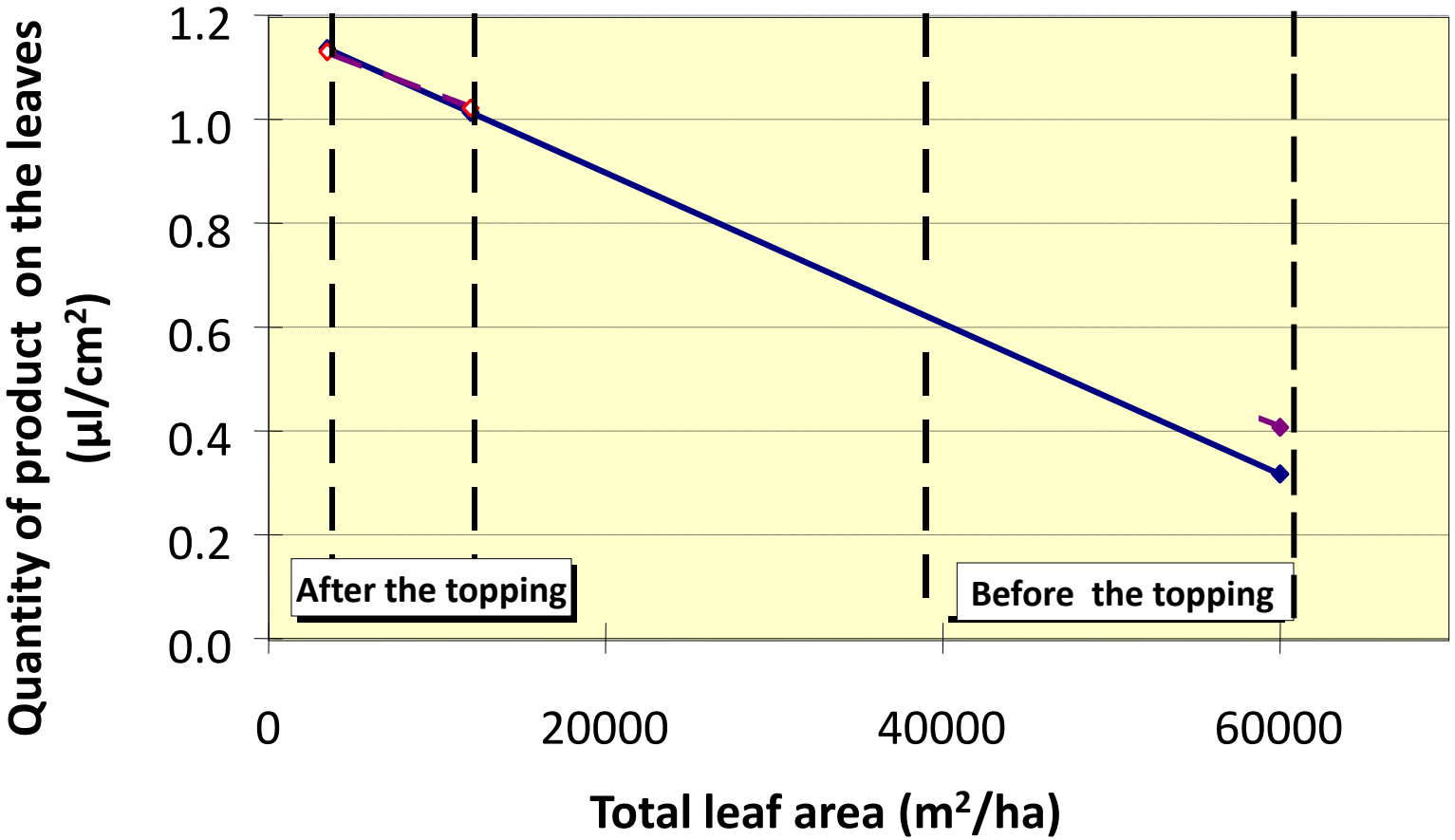
*** Dummersdorf, June 2012**

Necessity to find an harmonized value

NOTE: For small 3D canopy e.g. 'Alberello' trained vineyard need to define also a **'minimum LWA value'** (e.g. 2000-3000 m²/ha) **to avoid under dosage**

4. The Leaf Wall Area (LWA) dose expression system

Vine plant: HOW TO CONSIDER THE EFFECT OF THE TOPPING / LEAF STRIPPING ON THE DEPOSITS AND THEREFORE TO DETERMINE THE DOSE USING LWA ??



Quantity of product on the leaves (µl/cm²) before and after the topping

Results of the tests made by DISAFA Univ.Torino

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved)

Reference Volume rate x LWA

Essential parameter

IMPORTANCE OF SOME PARAMETERS IN FUNCTION OF THE TARGET TYPE

Results of test made by DISAFA Univ.Turin

	Leaves	Bunches	Grape-stalk
Sprayer type	n.s.	***	n.s.
Volume applied	***	***	***
Air flow rate	n.s.	n.s.	n.s.
Training system	n.s	-	-
Growth stage	***	-	-
Leaf position	***	-	-
Time of topping off	n.s.	-	-

Key: *** = very significant, n.s. = not significant,
- = parameter not examined

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved)

Low Volume rates generally allow to obtain higher spray deposit on the target

VOLUME (l/ha)	Spray deposit leaves (µl/cm²)	Spray deposit bunches (µl/g)	Spray deposit grape-stalk (µl/g)
200	0.427a	0.903a	3.767a
400	0.347b	0.669b	2.437b
600	0.305c	0.534b	1.295c
SPRAYER TYPE			
Air-assisted	0.357ns	0.784a	2.604ns
Pneumatic	0.369ns	0.471b	2.190ns
AIR FLOW RATE			
Low	0.397ns	0.857a	2.420ns
Medium	0.360ns	0.818ab	2.660ns
High	0.313ns	0.657b	2.733ns

All values normalised to 400 l/ha – Tests made by DISAFA Univ Turin

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved – Reference Volume rate)

Volume rate refered to LWA

↓

Still few experimental data available !!

↓

First suggestion

↓

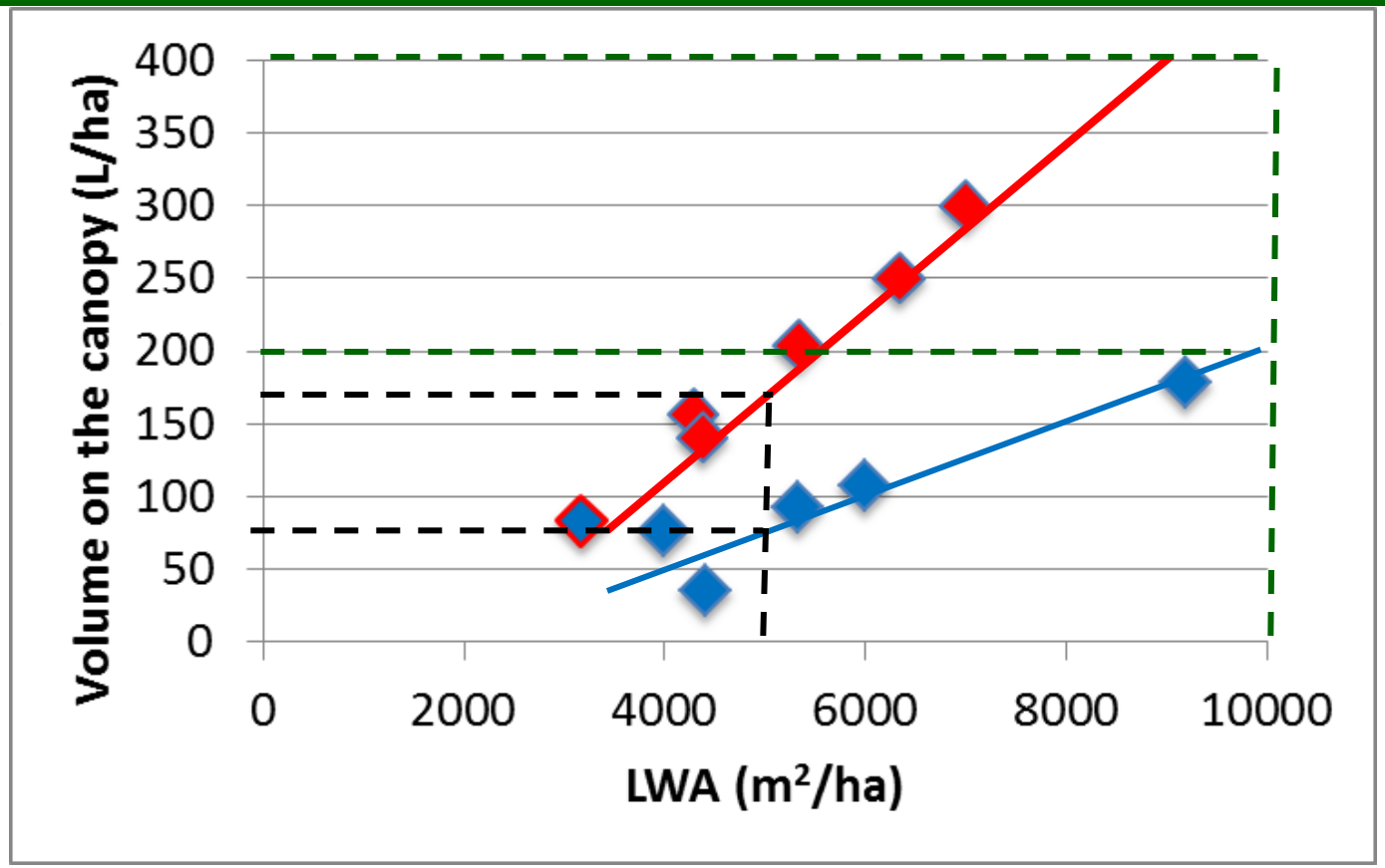
150 ÷ 400 L x 10.000 LWA/ha

AMOUNT OF LIQUID ABLE TO DEPOSIT ON THE CANOPY IN CORRESPONDENCE OF DIFFERENT LWA VALUES

(DISAFA TESTS IN NORTHERN ITALIAN VINEYARDS)

Red Dots : *Tunnel Sprayer*

Blue Dots: *Airblast Sprayer*



PROBABLY IT IS BETTER TO REFER THE VOLUME RATE (L/ha) TO AT LEAST 2 VINEYARD GROWTH STAGES:

< 5000 m²/ha LWA = 75 ÷ 175 L/ha

5000 ÷ 10000 m²/ha LWA = 200 ÷ 400 L/ha

REFERENCE VOLUME RATE x LWA.

20 years of experience at Universitat Politècnica de Catalunya

Which is the optimal volume rate?

0,037 l/m² LWA

- ✓ Optimal deposition
- ✓ Optimal coverage
- ✓ Optimal distribution
- ✓ Low drift losses

With a very well adjusted sprayer!!

Italian suggestion : 5000 LWA = **175L/ha**

10.000 LWA = **400 L/ha**

Spain suggestion : 5000 LWA x 0.037 = **185 L/ha**

10.000 LWA x 0,037 = **370 L/ha**

REFERENCE VOLUME RATE x LWA.

(20 years of experience at Universitat Politècnica de Catalunya)

Lechuga	Mildiu	Aplicar en pulverización foliar normal, mojando uniformemente la parte aérea del cultivo	200-300 g por 100 l de agua. Max. 2,5 kg/ha
Pepino	Mildiu		
Patata	Alternariosis y Mildiu		
Tabaco	Moho azul		
Tomate	Alternariosis, Mildiu y Septoriosis		
Viña	Mildiu		

El número máximo de tratamientos por campaña será de 4 en viña y 3 en el resto de cultivos.
Los tratamientos deberán iniciarse al comienzo del periodo de crecimiento, de forma preventiva, antes del establecimiento de la enfermedad. Para ello se pueden seguir las recomendaciones de las Estaciones de Avisos. El intervalo máximo entre las aplicaciones será de 14 días. En condiciones muy favorables al desarrollo del mildiu, reducir el intervalo a 10 días, especialmente en las fases de mayor crecimiento del cultivo. En viña el último tratamiento se realizará, como muy tarde, 14 días después del final de la floración.

250 g per 100 l
Max. 2,5 kg/ha

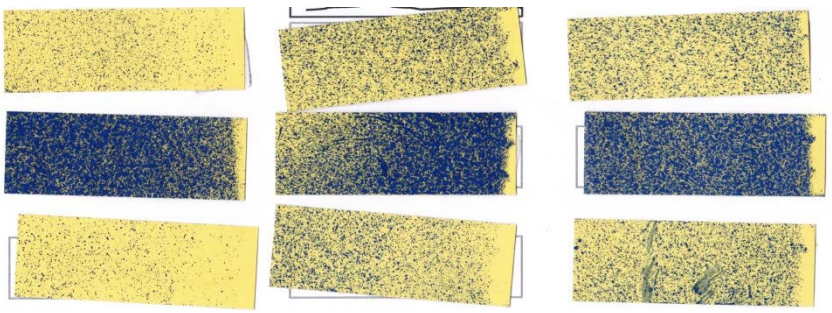
1000 L/ha

5000 m²LWA/ha

5000x0,037 = **185 L/ha**

REFERENCE VOLUME RATE x LWA.

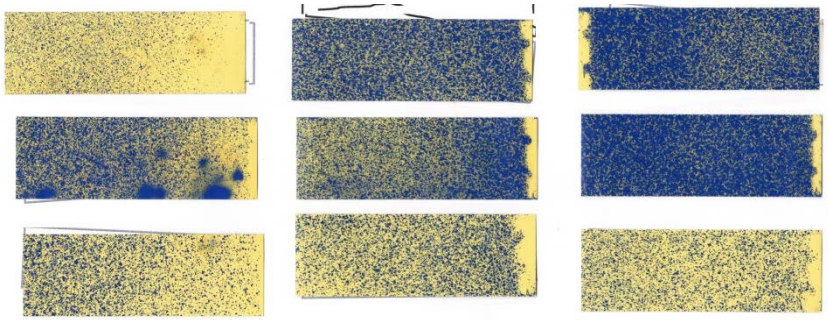
(20 years of experience at Universitat Politècnica de Catalunya)



% of Max. Dose

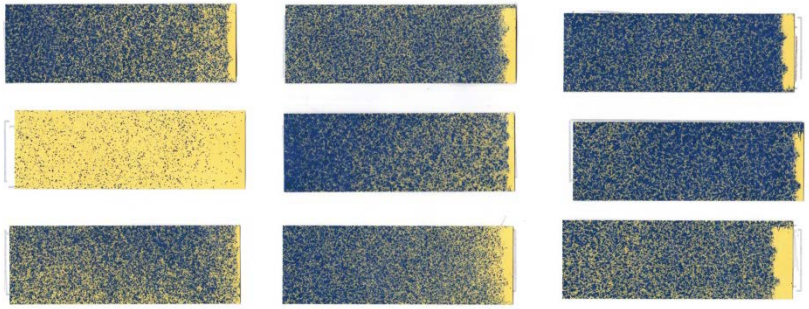
312 g → 12.5 %

350 L/ha



437 g → 17.5 %

500 L/ha

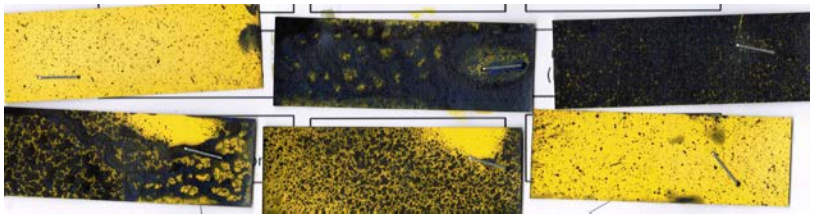


625 g → 25.0 %

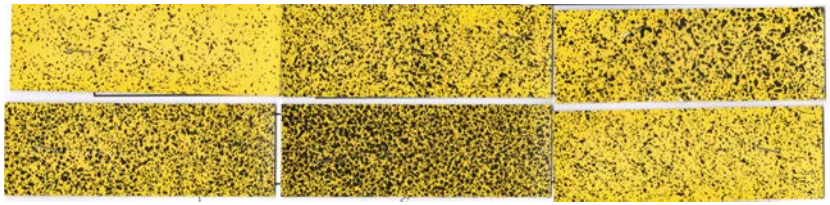
Gil et al., 2014. Spray adjustments based on LWA concept in vineyard. Relationship between canopy and coverage for different application settings*Aspects of Applied Biology* ***122****, 2014 , 25-32*

REFERENCE VOLUME RATE x LWA.

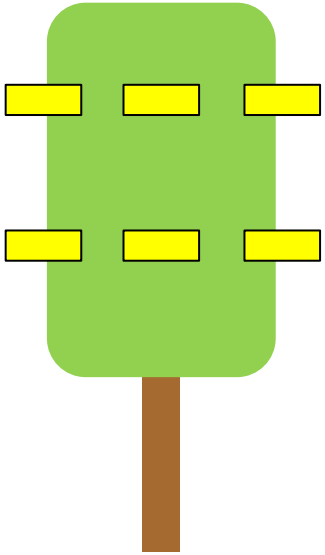
(20 years of experience at Universitat Politècnica de Catalunya)

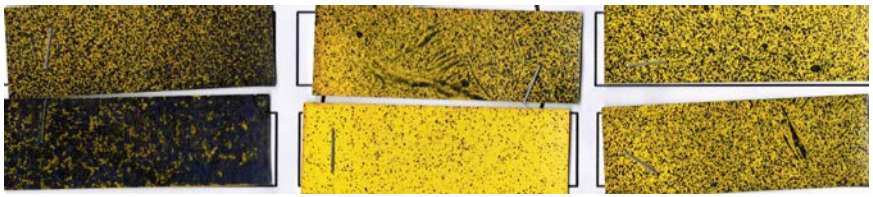


1000 l/ha (LWA)



370 l/ha (LWA)





370 l/ha (LWA)

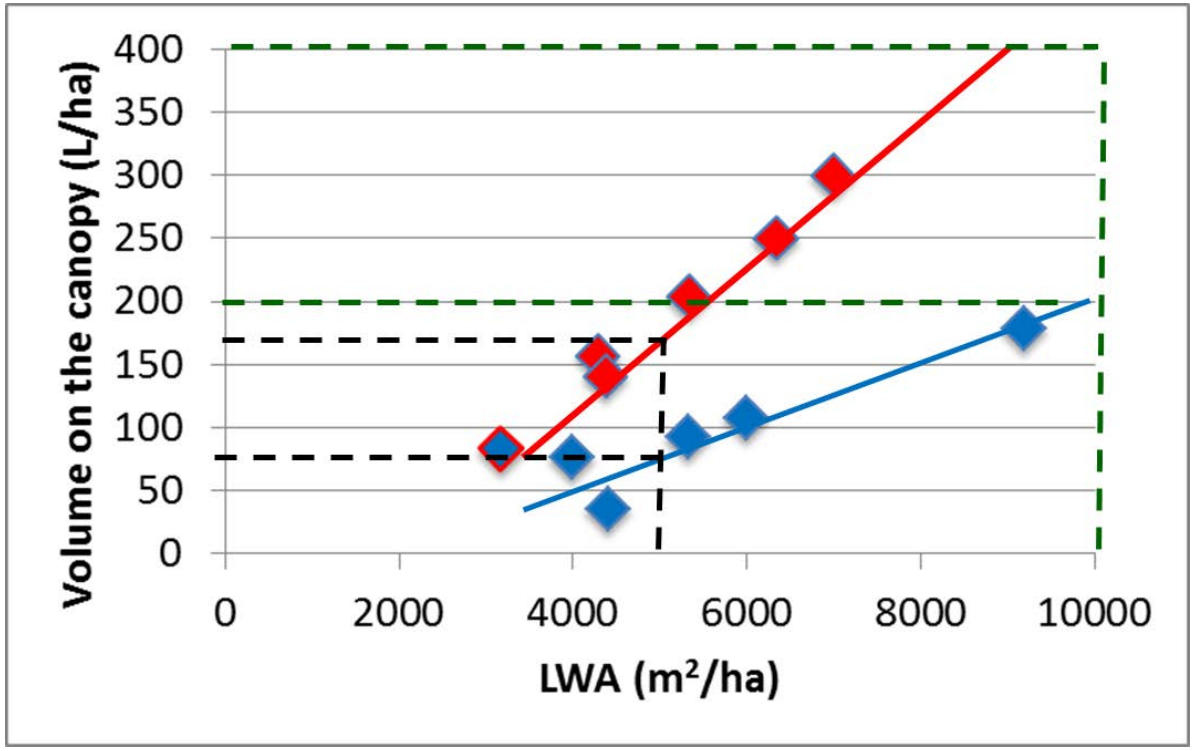
REFERENCE VOLUME RATE

EXAMPLES OF CALCULATION OF THE SPRAY VOLUME ACCORDING TO DIFFERENT PLANT PARAMETERS APPLIED TO:

Vineyard : ***Pinot Nero***
Training system: ***Casarsa***
Growth stage: ***ripening of berries (BBCH 81)***
Row size: ***1.5 m (height)***
1.5 m (width)
0.9 m (height of vegetation from the ground)
Inter row distance: ***3.0 m***

LWA = 4000 m^2/ha
LAI = 2.6
TRV = 7500 m3/ha
SU = 5.0
Total canopy Surface (TCS) = 26180 m^2/ha

CALCULATION OF THE SPRAY VOLUME CONSIDERING THE LEAF WALL AREA (LWA)



PROBABLY IT IS BETTER TO REFER THE VOLUME RATE (L/ha) TO AT LEAST 2 VINEYARD GROWTH STAGES:

< 5000 m2/ha LWA = 75 ÷175 L/ha

5000 ÷ 10000 m2/ha LWA = 200 ÷ 400 L/ha

LWA = 4000 m^2/ha = Volume 175 l/ha

CALCULATION OF THE SPRAY VOLUME CONSIDERING THE LEAF AREA INDEX (LAI)

$$V\ (l/ha) = \frac{2 \times LAI \times D_i \times \overbrace{4/3 \times \pi \times (VMD/2)^3}^{D_V} \times 10^{-7}}{R}$$

V = volume application rate

LAI = leaf area index

D_i = optimal density of droplet impacts (n/cm^2)

D_v = droplets volume

R = recovery factor on the target (70÷75%)

CALCULATION OF THE SPRAY VOLUME CONSIDERING THE LEAF AREA INDEX (LAI)

LAI = 2.6

VMD = 210 µm (medium droplet size)

D_i = 120 (contact insecticide)

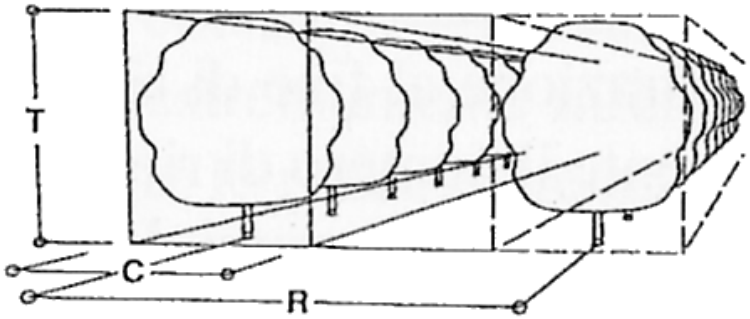
R = 70%

$$V\ (l/ha) = \frac{2 \times 2.6 \times 120 \times 4/3 \times \pi \times (210/2)^3 \times 10^{-7}}{0.7} = 430\ l/ha$$

CALCULATION OF THE SPRAY VOLUME CONSIDERING THE TREE ROW VOLUME (TRV)

Input:

Tree height	[T]	=	1,5 m
Canopy width	[C]	=	1,5 m
Inter-row width	[R]	=	3,0 m



Volume index (i)

(litres per 1000 m^3 of vegetation)

very high	120
high	100
medium	70
low	50
very low	30
ultra low	10

$$\text{Vegetation volume (Vv)} = \frac{T \times C \times 10000}{R} = \frac{1{,}5 \times 1{,}5 \times 10000}{3} = 7500 \text{ m}^3/\text{ha}$$

$$\text{Spray volume (Vt)} = \frac{Vv \times i}{1000} = \frac{7500 \times 70}{1000} = 525 \text{ l/ha}$$

CALCULATION OF THE SPRAY VOLUME CONSIDERING THE SURFACE UNIT (SU)

Reference volume (l/ha)	SU (m^2/m^2)
300	2.5

Actual SU = 5.0

Considering the experimental correlation between SU and volume rate, the spray volume should be equals to **370 l/ha**

CALCULATION OF THE SPRAY VOLUME CONSIDERING THE TOTAL CANOPY SURFACE (TCS)

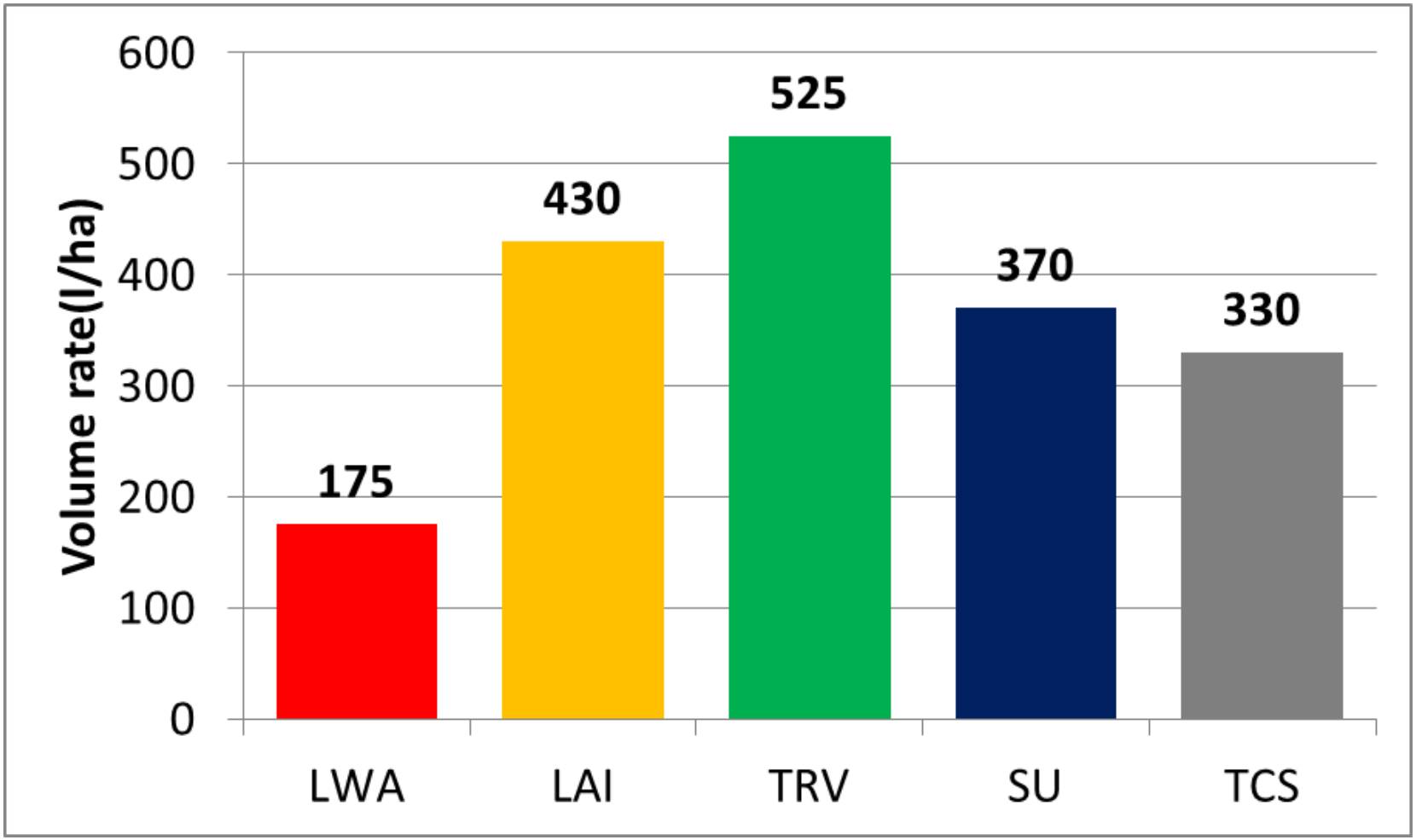
Reference spray deposit: 0.5 µl/cm^2

Total spray deposit on the canopy =
0.5 µl/cm^2 x 26180 m^2 (total canopy surface) =
130 litres

Percentage of spray volume recovered in correspondence of a total canopy surface of 25000 m^2/ha = 40%

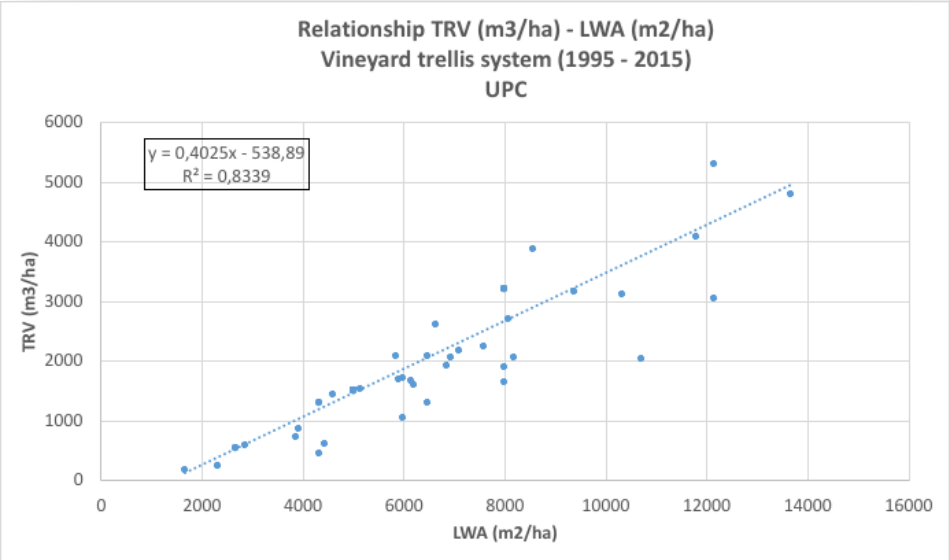
Spray volume = 330 l/ha

DIFFERENCES BETWEEN THE SPRAY VOLUMES CALCULATED

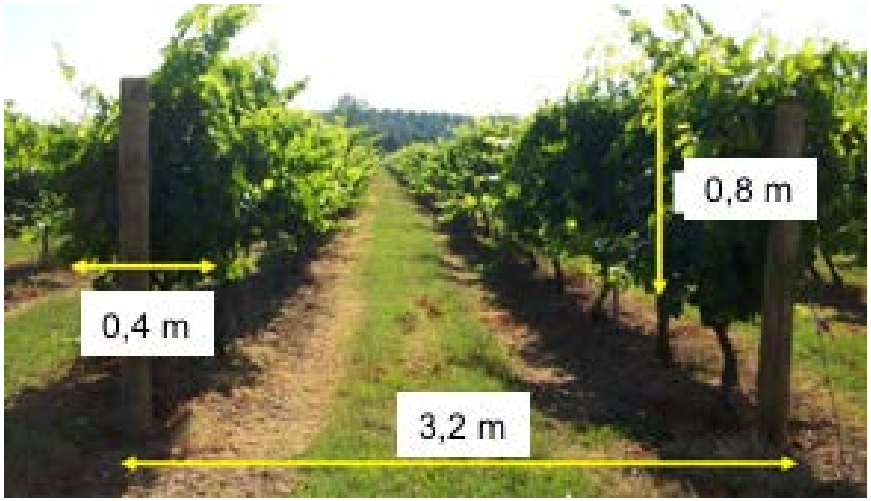


Volume rate : moving from TRV to LWA for vineyard

(20 years of experience at Universitat Politècnica de Catalunya)



Ex. 5000 m² LWA/ha



$Y = 0{,}042\ X - 538{,}89$

↓

TRV = 1473 m³/ha

↓

0,12 l/m³ TRV

↑

185 l/ha

↑

0,037 l/m² LWA

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved)

Conversion formula from the current used dose expression units to LWA & viceversa

Always possible ??

Model

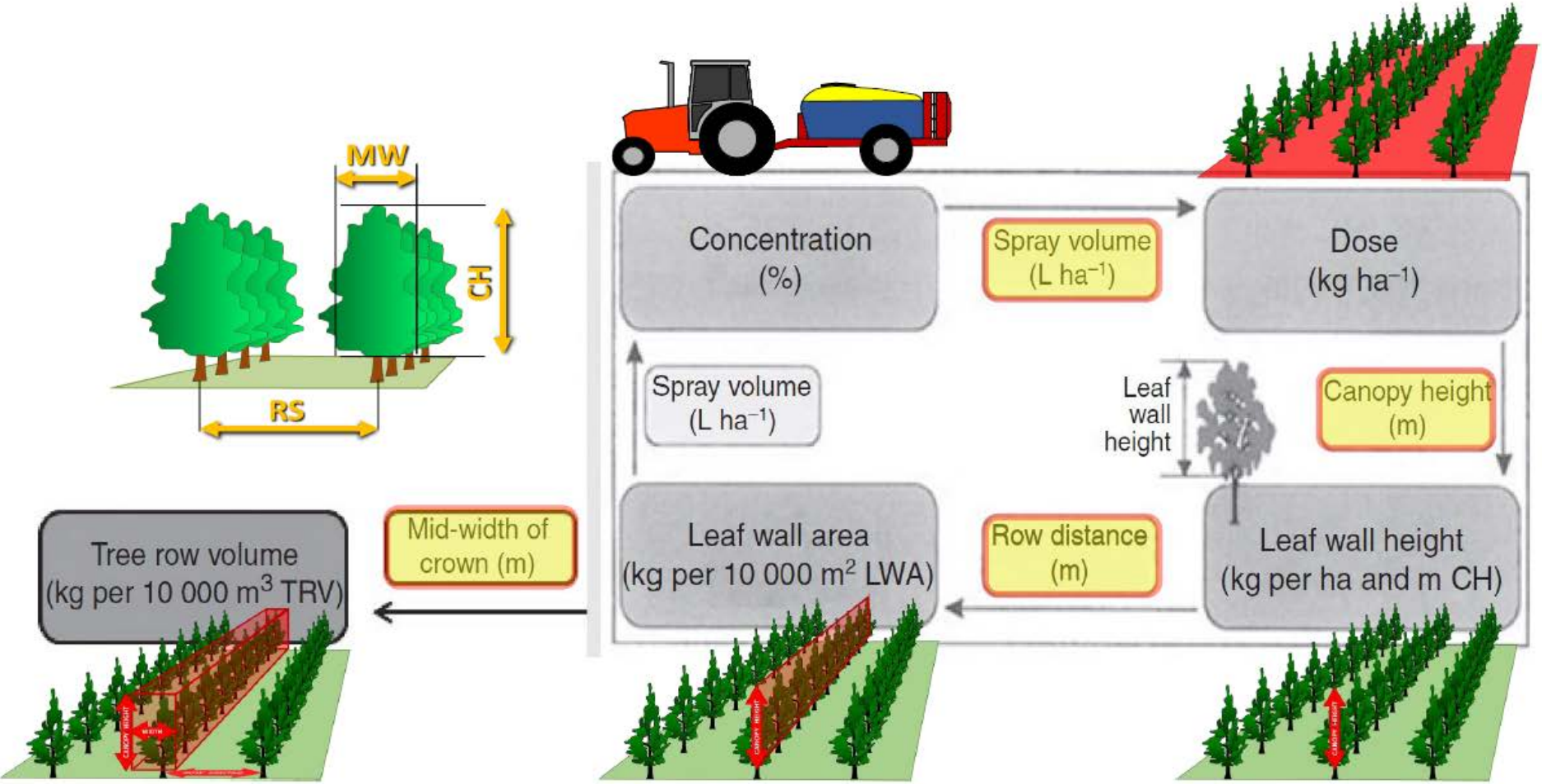
Simplified formula

ARM Syngenta

UPC Disc

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved)

Conversion formula from the current used dose expression units to LWA & viceversa

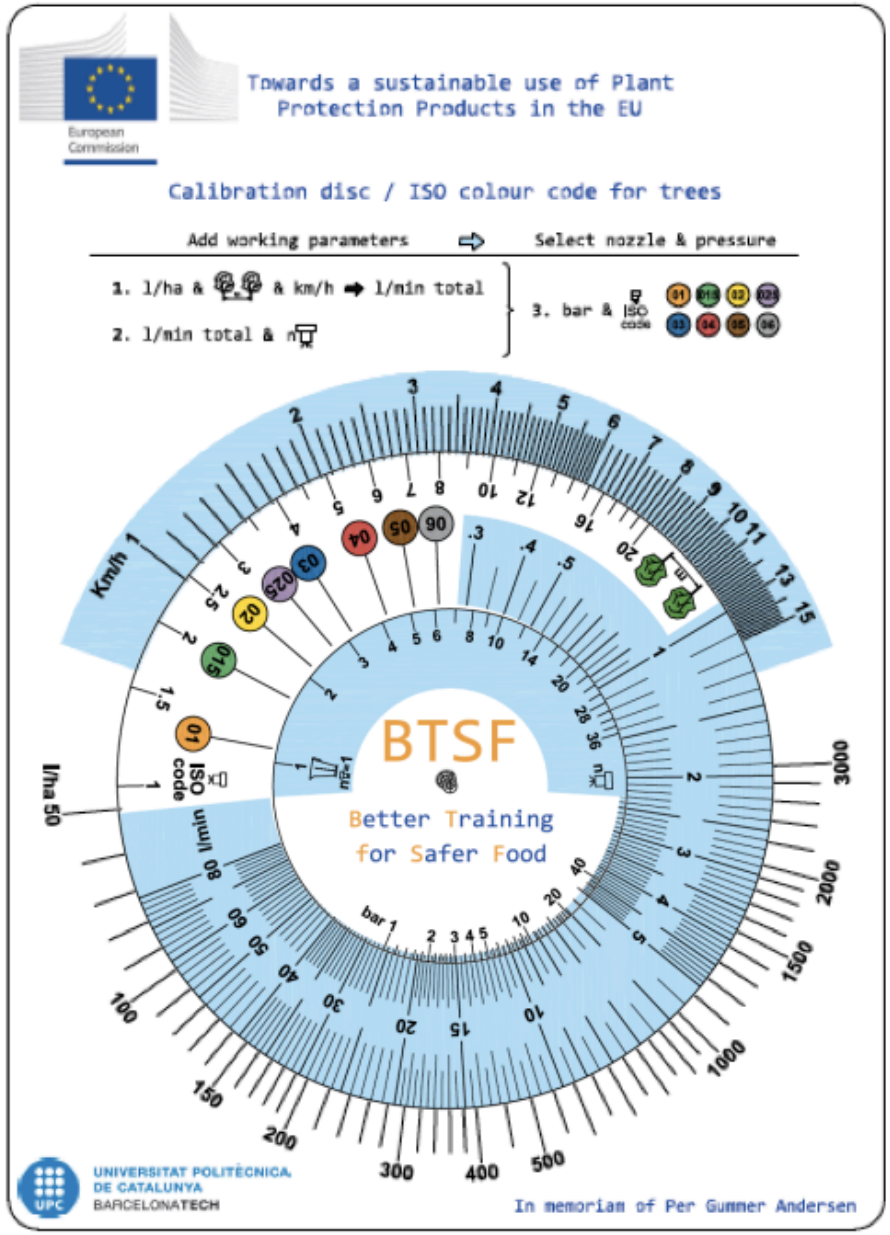


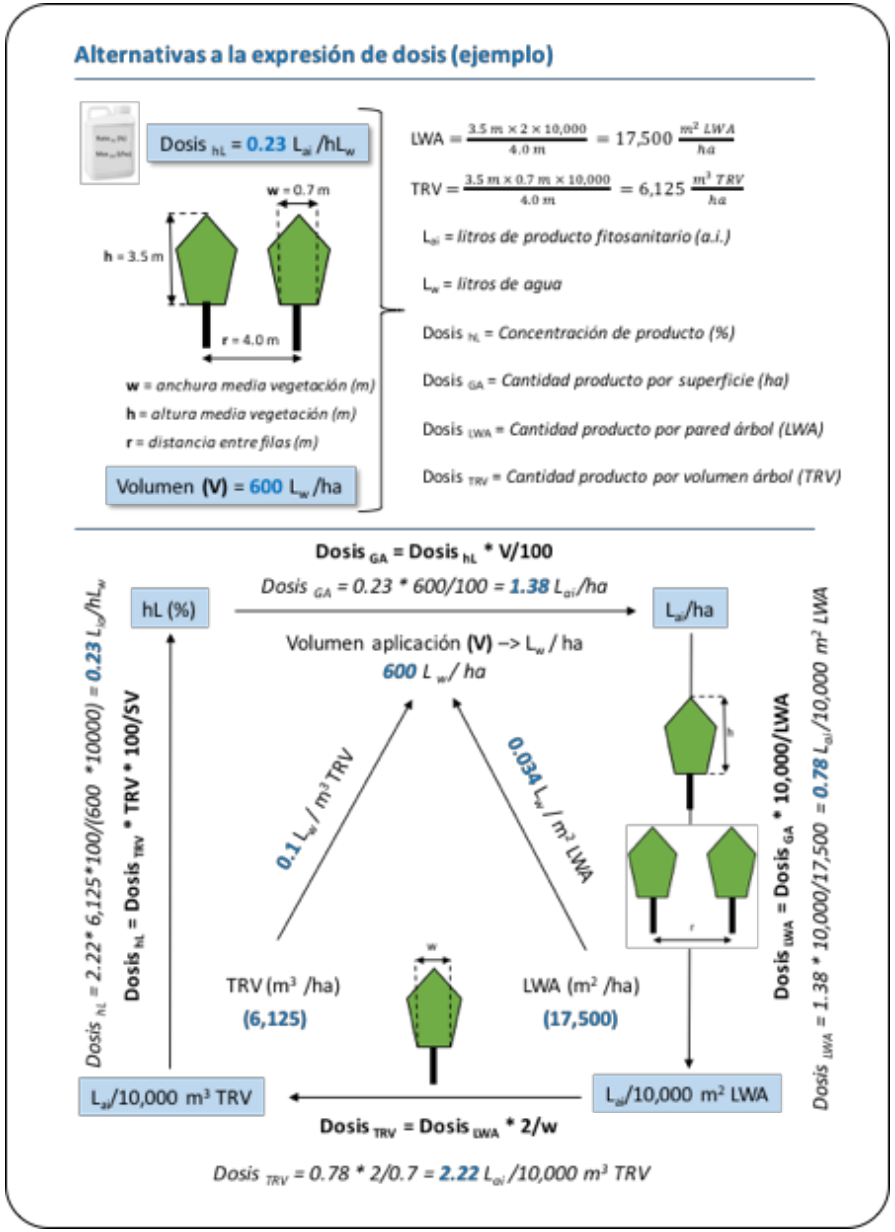
EPPO Standard PP1/239(2) after: Frießleben et al.,2007.

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved – Conversion formula)

	Conversion Formula	Example • Application rate X: 0.8 L /10000 m² LWA • Foliage height. 3.5 m • Row distance: 4.0 m • LWA: 17500 m² / ha ground area • Spray volume: 1500 L/ha ground area	
Conversion to rate per ha ground area	$\text{rate}_{\text{GA}} = \frac{X * LWA}{10000}$	$\text{rate}_{\text{GA}} = \frac{0.8 * 17500}{10000}$	$\text{rate}_{\text{GA}} = \sim 1.40$ l/ha
Conversion to rate per hl	$\text{rate}_{\text{HL}} = \frac{x * LWA}{SPV * 100}$	$\text{rate}_{\text{HL}} = \frac{0.8 * 17500}{1500 * 100}$	$\text{rate}_{\text{HL}} = \sim 0.09$ l/hl
Conversion to rate per ha ground area and per m foliage height	$\text{rate}_{\text{FH}} = \frac{x * 2}{row\ distance}$	$\text{rate}_{\text{FH}} = \frac{0.8 * 2}{4.0}$	$\text{rate}_{\text{FH}} = \sim 0.40$ l/ha/m FH

4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved – Conversion formula)





4. The Leaf Wall Area (LWA) dose expression system (main aspects to be defined/achieved - conversion formula)

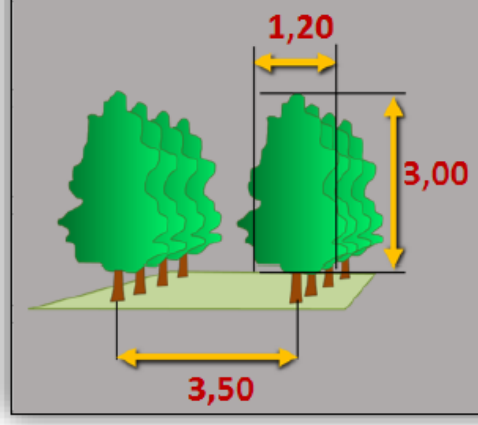
Conversion formula from the current used dose expression units to LWA & viceversa

Excel Tool for dose conversion

- request from Organising Committee of EPPO Workshop:

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

RESET

5. Some considerations

A common dose rate expression in 3D crops is essential due to the necessity to:

- *Consider the real target surface and its characteristic related to crops layout-variety-training system and growing season*
- *Avoid the present big difference between countries*
- *Allow better and faster comparison and understanding of expression data across EU*
- *Facilitate the comunication with or between regulatory bodies*
- *Fullfil the SUD and the NAP'S requirements of reducing the use of PPP thanks to a more precise application*

5. Some considerations (continue)

LWA dose rate expression it is <u>probably the more suitable system</u> but still several questions are open:

- ***<u>Is it useful for all 3D crops ??</u>*** (what about small – ornamental- and big crops : Citrus-Poplar)
- ***<u>How to transform dose rate from currently dose expression unit to LWA ??</u>***
- ***<u>How shall be changed the previuos PPP registration documents</u>*** (e.g.: residue and operator exposure) **when using LWA ??**
- ***<u>How to refer volume rate to LWA ??</u>***
- ***<u>How shall be make a PPP label with LWA ??</u>***
- ***<u>How and who will be in charge to train the farmer to appropiate use LWA ??</u>***

6. CONCLUSION

LWA – DOSE expression in 3D crops

Several «open points» still exists also for LWA adoption in Vineyards

More <u>coordinated</u> research activities are needed

Work in progress

/ha Leaf wall area LWA

THANKS FOR ATTENTION

/hl (%)

/ha and m of canopy height

/ha area

/10000 m3 rows volume TRV