Dose expression in “3D” crops
Point of view of PPP manufacturers

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representing ECPA Efficacy Expert Group

AAB Workshop
Barcelona, November 2018

Definition

European Crop Protection

- **Dose expression:**

A Dose Expression puts a quantity of product (dose rate) in relation to:

- an area (e.g. ground or treated leaf wall area (tLWA))

- a volume (e.g. spray volume or treated crop volume)

- **What is the purpose of a dose expression?**

It gives guidance on the proper use of a PPP

and allows transparency why a certain quantity of product was used

PPP Industry must deal with different dose expressions

- **Field trials to define the minimum effective dose and to confirm efficacy at target rate**
  - LWA rate (where applicable)
- **Studies to define the end points for national risk assessments**
  - Ha-rate (risk envelope approach)
- **National labels**
  - Multiple rates due to multiple dose expressions

Multiple dose expressions on different country labels

European Crop Protection

- Labels should be logical and practicable for farmers
- Labels should give clear guidance for an effective dosing
- and must indicate clearly the limits!
- For dose expressions on country labels specific national requirements must be followed
- The different rates expressed on the labels must be save

Maximum Ha-rate for endpoint definitions

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- Strict guidance documents require a ground based expression, thus Ha-rate
- Needed for E-fate, Ecotox, Consumer and Operator safety …
- The Ha-rate is the highest possible rate
- It must still allow a save use
- It may be limiting the use of a PPP
- Rates lower than the Ha-rate are covered in risk envelope
- Ha-rate may only be indirectly linked with efficacy data

Efficacy trials for BAD and dRR

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- **Zonal submission and evaluation system since 2011**
  (comparability and transparency of trial reports)
- **EPPO guidelines**
  - certain number of comparable trials must be conducted.
  - different conditions within a comparable area to be covered.
  - documentation of relevant information incl several crop parameter necessary incl clear dose expression (issue with data from the past)
- **Linking an acceptable level of efficacy with a minimum amount of product**

Dose Rate Expression in Pome fruit –

The Need for a Harmonized Approach from an Industry Perspective

An Industry Proposal of
Adama, BASF, Bayer CS, Dow AS, DuPont AS and Syngenta

R.-B. Toews [1]; J.-P. Huby [2]; B. Pollmann [3]; M. Teichmann [4]; P. Schlotter [5]; R. Wohlhauser [6]

[1]Bayer CropScience AG; [2]Du Pont de Nemours S.A.S.; [3]Adama Agriculture B.V.; [4]BASF SE; [5]Dow AgroSciences ; [6]Syngenta Crop Protection AG

Industry proposal for efficacy section: treated Leaf Wall Area (tLWA)

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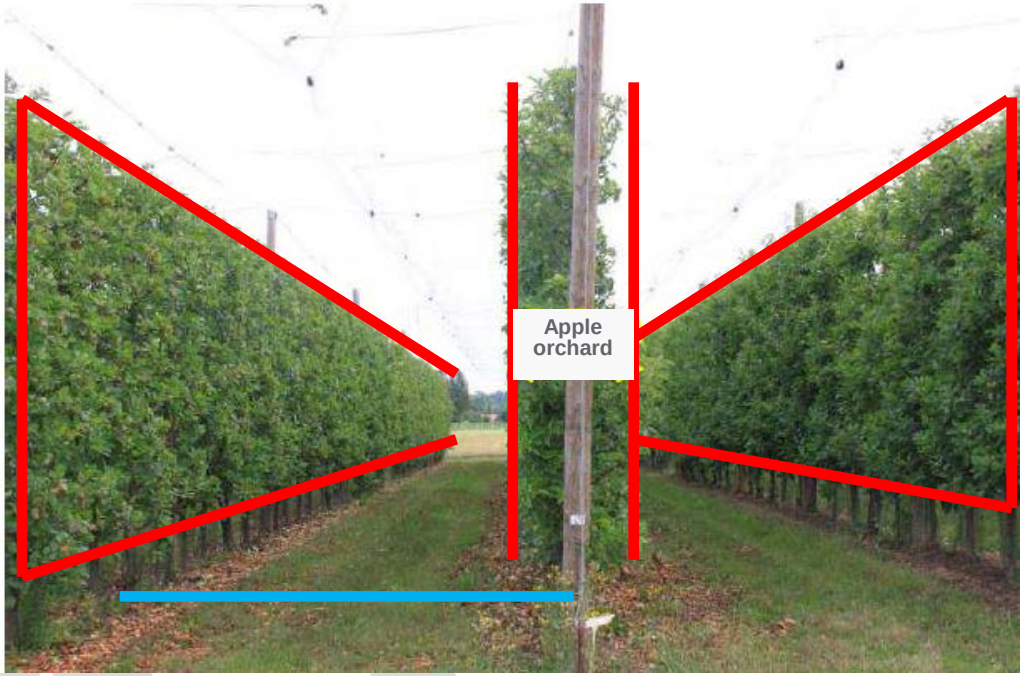
Sprayers deliver the spray liquid containing the product to a predominantly vertical area.

Consequently, the product quantity should not be related to ground area, but related to the treated leaf wall area.

tLWA = treated canopy height x 2 x 10‘000 / row spacing



ADAMA BASF We create chemistry BAYER Dow AgroSciences DUPONT syngenta

Why were other expressions not favoured for the efficacy section

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- **Ha-rate:** independent of crop parameters
- **Canopy height depending Ha-rate:**
  does not consider row spacing
- **Tree-row-volume model:** transfer to labels and farmers
  practice considered too complex
  crop thickness may be covered by dose adjustment measures
- **Concentration model:**
  no clear link between spray volumes and crop structures,
  spray volumes depend also on application devices

PPP Manufacturers agree

European Crop Protection

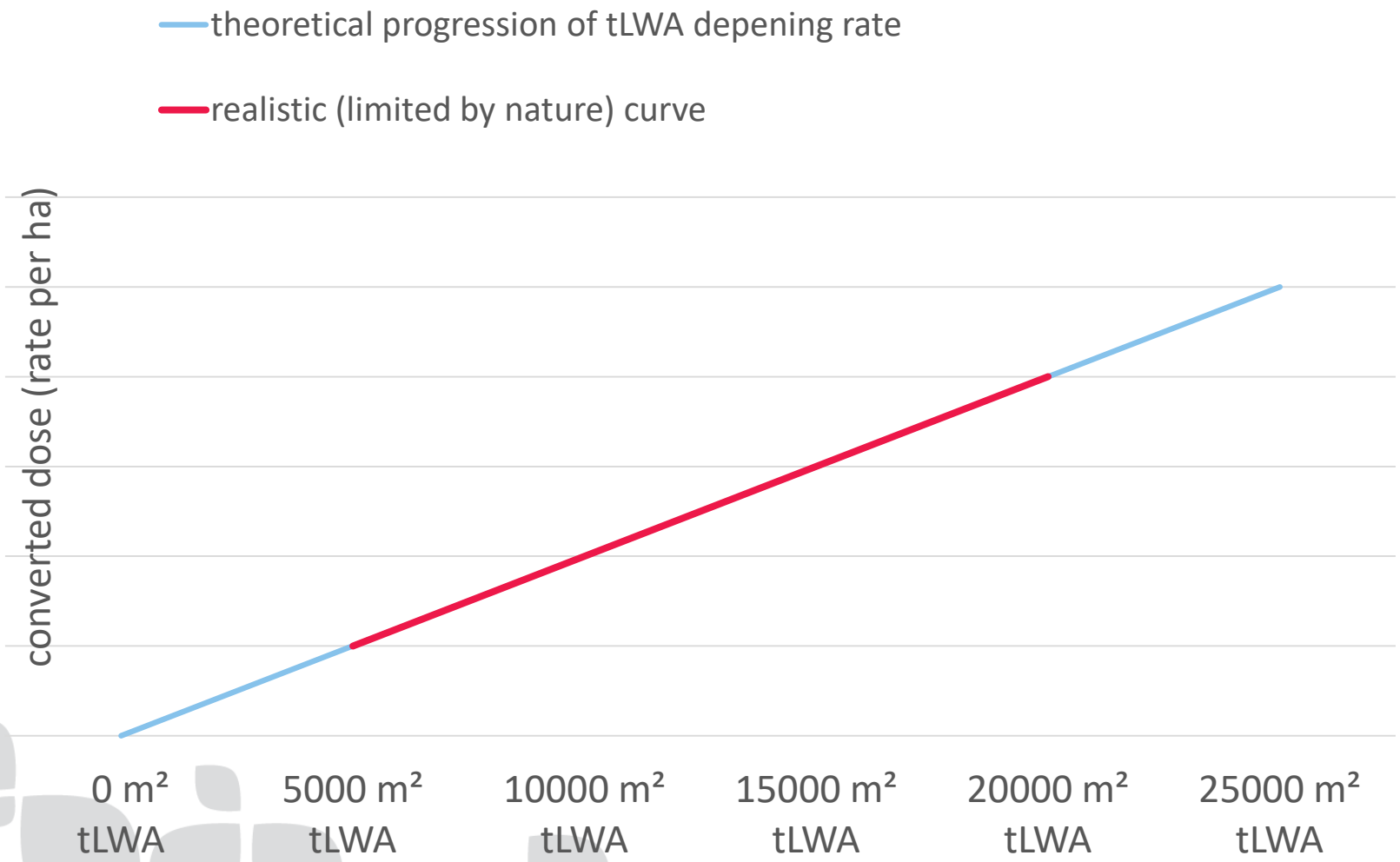
to use

- in line with the conclusions of the EPPO workshop in autumn 2016 in Vienna,
- in line with the agreement of C&S zone Steering Committee
- in registration trials
- for new products
- in pomefruits, grape vines and high growing vegetables

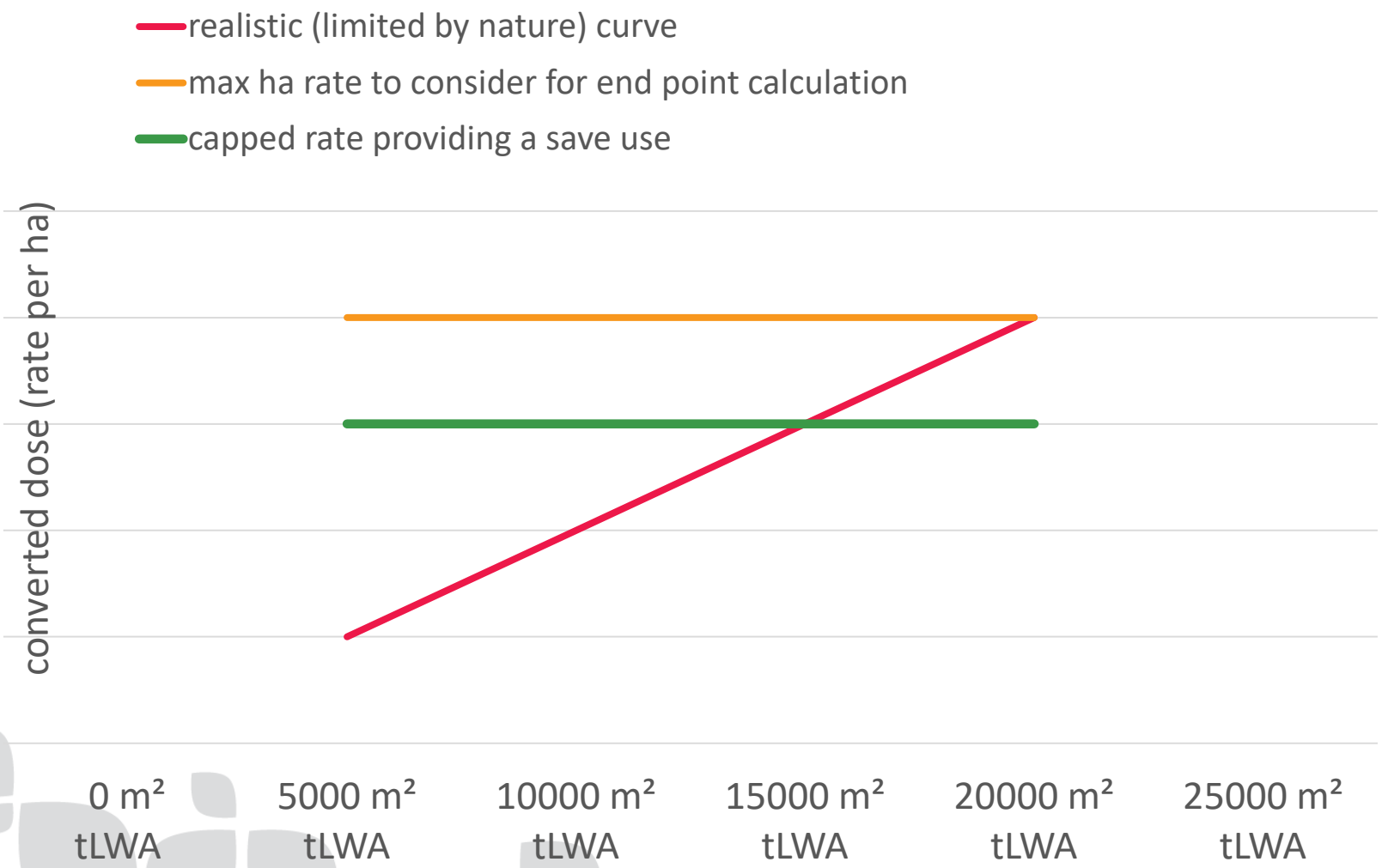
the dose expression „per 10.000 m² treated LWA“

and to improve the trial reporting quality

Process of GAP definition



aligning different expressions



- **Any national label needs to respect the upper limit (ha-rate)**

Open topics

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- How to apply reference products correctly while they are not registered with LWA expression in trials for new products?
- How to address situations (e.g. in grapes) when a higher tLWA rate is needed early in the season, when the tLWA is still small and later on, with decreasing susceptibility, a second, lower tLWA rate would be sufficient?
- Find agreement with concerned MS to translate BAD/dRR conclusions into label rates with other dose expressions.
- How can dose expression harmonization be fostered to other crops with single trees and globular canopy (olive, stone fruit, citrus) remaining practicability and being reasonable?
- Re-registrations
  How to manage heterogenous data packages (old/new)
  How to manage data when single authorities request expression changes on their labels?
  How to guide farmers in case of different dose expressions in a country?

Thanks for your attention

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BACKUP

Definition

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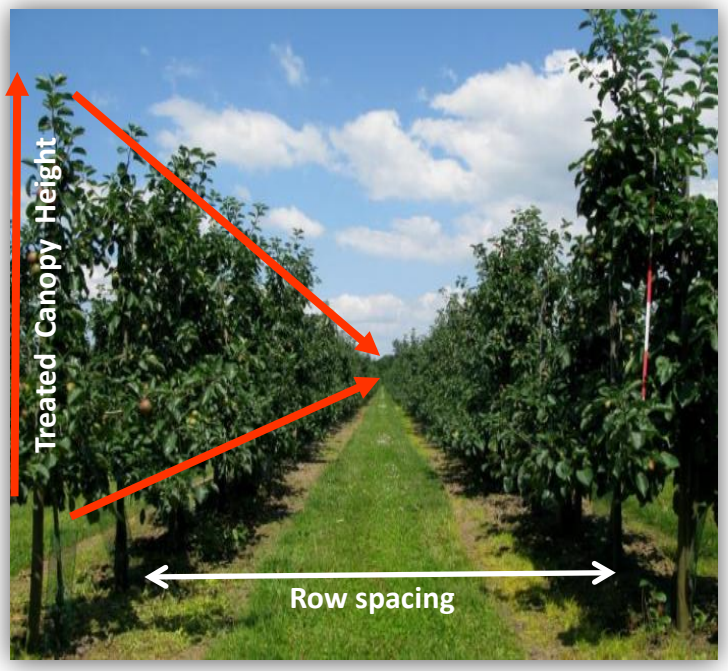
- The tLWA concept for expressing the dose of PPP in high growing crops is in principle not different to the ha-ground concept for any horizontally sprayed crop.
- The treated Leaf Wall Area (tLWA) of a high growing crop is a vertical area (2D) defined by the treated canopy height and the length of the row treated. The way of planting/cultivation (single row or multiple rows, row spacing) impacts the size of the tLWA.
- Further discussion still is needed on how to define the tLWA in high growing crops cultivated as single trees and with globular tree crowns.



Outcome of EPPO workshop

Vienna Oct 2016

Agreement reached on the **efficacy assessment** of **pome fruit, grapevine and high growing vegetables**

- **new registrations** efficacy trials and BAD / section 3 dRR with LWA dose expression
- **zonal or EU GAP** always expressed as **max rate per ha ground**
- All relevant **crop parameters** should be measured and available in BAD; crop LWA (LWA) and treated LWA (tLWA) to be clearly differentiated
- EPPO standard **PP1/ 239** revision to reflect outcome of workshop

- No agreement to use LWA on labels (National requirement).

Transition Phase agreed:

The leaf wall area (LWA) concept should first become effective in the efficacy evaluation in

- Pome fruit, grapevine and high growing vegetables; application dossiers for new products (under Article 33) will only be accepted when trials were planned and carried out based on LWA (effective from 01.01.2020);
- GEP Efficacy trials must be planned and carried out based on LWA (effective from 01.01.2018)
- The LWA dose rate shall be added in column 14 (remarks) or 10 - 12 (application rate) of the GAP table. It is restricted by the maximum rate per ha ground area and the range of possible concentrations resulting from columns 10 – 12 of the GAP table

GAP and inclusion of tLWA in remarks section

- The GAP is set and max dose/ha of ground area reported in GAP table
- Biology conduct efficacy trials with tLWA rate expression (rate given in remarks of GAP table) which is within the agreed risk envelop.
- All Risk assessment / other section work according to the worst case scenario max dose/ha of ground area

				Application				Application rate					
M.S	Crop	F G or I	Pests controlled	Method	Timing / Growth stage	Max. Nr a) per use b) per crop/ season	Min interval between applics (days)	**L <Prod X> /ha a) max. rate per appl. b) max. rate per crop/season**	g <Comp 1>/ ha a) max. rate per appl.	g <comp 2>/ ha a) max. rate per appl.	Water L/ha min/max	PHI (days)	**Remarks:**
Latvia	Pome /Pear	F	Venturia Inequalis	F	BBCH 57 -74 (Mar -July)	3	7	**a) 3.5 b) 10.5**	a) 275.0	a) 450.0	400-1500	35	**Target rate 2 kg per 10.000 m² LWA**

It may be necessary to cap / limit the tLWA to remain within critical GAP.

EPPO Workshop – follow up actions

European Crop Protection

Glossary of terms (crop and application related terms)

European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

18-23714
WP PPP point 6.1

Dose Expression of Plant Protection Products in high growing crops

Glossary of Terms

Version 21st February 2018

Terms	Definitions
Crop related terms	
High growing crops	Term for crops such as pome fruit & stone fruit ("top fruit"), small fruit and cane fruit crops (e.g. raspberry, blackberry, currants, etc.), grapevine, hop, citrus fruit, nut fruit, olives, but also some vegetables (i.e. tomato, pepper, aubergine, cucumber) and ornamentals (e.g. roses, alley trees) grown vertically in open field or in green houses. The foliar PPP applications (other than herbicides) in high growing crops are normally not sprayed towards the ground as is the case for other field crops, but sidewise and/or upwards.
Wall forming crops or **Wall crops**	Terms for high growing crops with a linear ground projected area without significant gaps along the row. E.g. super intensive crops of olives, apple, pear, grapevine.
Globular crops	Terms for high growing crops with elliptical or round ground projected area, with or without gaps in the row between the single plants resp. canopies. E.g. citrus, olives, stone fruits, nut fruits, persimmon, pomegranate.
Foliage height (FH) Unit: m	Distance from the lowest leaves / fruits to the plant top, excluding the stem area.
Canopy Height (particularly used for trees) (CH) Unit: m	Distance from the lowest leaves / fruits to the tree top, excluding the trunk area (synonymous with crown height).
Crop Height Unit: m	Total height of the aerial part of the plant from the ground.
Canopy or Foliage shape	Term to differentiate between spindle trees, globular tree shape, plants in goblet pruning system, tendone and pergola.

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Terms	Definitions
Width at the middle of the foliage height (= mid width of the crown) Unit: m	Average maximum distance between outer leaves of the foliage measured at the middle of the foliage height/canopy height.
Globular diameter Unit: m	Globular crops: Average distance between outer leaves of the tree/plant measured at the middle of the foliage height/canopy height (minimum + maximum width/ 2).
Ground area Unit: ha or m²	Ground surface area of the site/plot.
Rows per plot	Number of (treated) rows per plot. Double or multiple rows are considered as one, as long as they are in-between only two spray bands.
Row length per plot Unit: m	Sum of length of all rows of a plot. In case of double or multiple rows: also double/multiple rows are considered as a single row.
Row sides applied	Number of row sides applied. Usually two sides a row are applied, but in specific cases e.g. only one side per row may be applied.
Spacing between rows or Row Spacing Unit: m	In case of single rows: Distance from the centre of one row to the next row. In case of double or multiple rows: Distance from the middle of one double/multiple row to the middle of the next double/multiple row, only treated from the outer side.
Spacing within row Unit: m	Distance from centre of a tree/plant to the centre of the next tree/plant within a row.
Leaf Wall Area (LWA) Unit: m²/ha	The **Leaf Wall Area** is the area of the foliage or canopy surface per ha ground area. It is calculated using canopy or foliage height, and spacing between rows: **LWA (m²/ ground area)** = canopy or foliage height x row sides applied x (10.000 m²/spacing between rows m).
Tree Row Volume (TRV) Unit: m³/ha	The **Tree Row Volume** is the cubic volume of the rows. It is calculated using canopy or foliage height, mid-width of the crown, and spacing between rows: **TRV (m³/ha ground area)** = (canopy or foliage height) x (mid-width of the crown) x (10.000 m²/spacing between rows).

2

Application related terms	
Vertical spray band height Unit: m	The height of the sprayed band, usually indicating the height of the treated leaf wall/crop.
treated Leaf Wall Area (tLWA) Unit: m²/ha or m²/plot ('Spray band area' may be used as a synonym)	The **treated Leaf Wall Area** is the area of the leaf wall area actually treated with the plant protection product. It can be calculated for trial plots or for registration purposes. The tLWA may also be smaller than the actual LWA, if calculated from a spray band height lower than the actual foliage/canopy//crop height; e.g. bunch applications on grapevine.
tLWA per plot (m² per plot) (for trials)	row sides applied x vertical spray band height x row length
tLWA per ha (m²/per ha ground area) (for registration purposes)	row sides applied x vertical spray band height x (10.000 m²/ spacing between rows).
Treated Tree Row Volume (tTRV) Unit: m³/ha	The treated Tree Row Volume is the volume of the canopy/crop actually treated with the plant protection product. **tTRV (m³/ per ha ground area)** = (spray band height) x (mid-width of the crown) x (10.000 m²/spacing between rows).
Dose adjustment	Adjustment of the authorised doses to a specific situation (e.g. growth stage, width, pest pressure)

3

EPPO workshop – follow action

- LWA Standard operating procedure

=> 1st version (Feb 2018) published

18-23715
WP PPP Point 6.2

Standard Measurement Procedure in 3-D crop trials

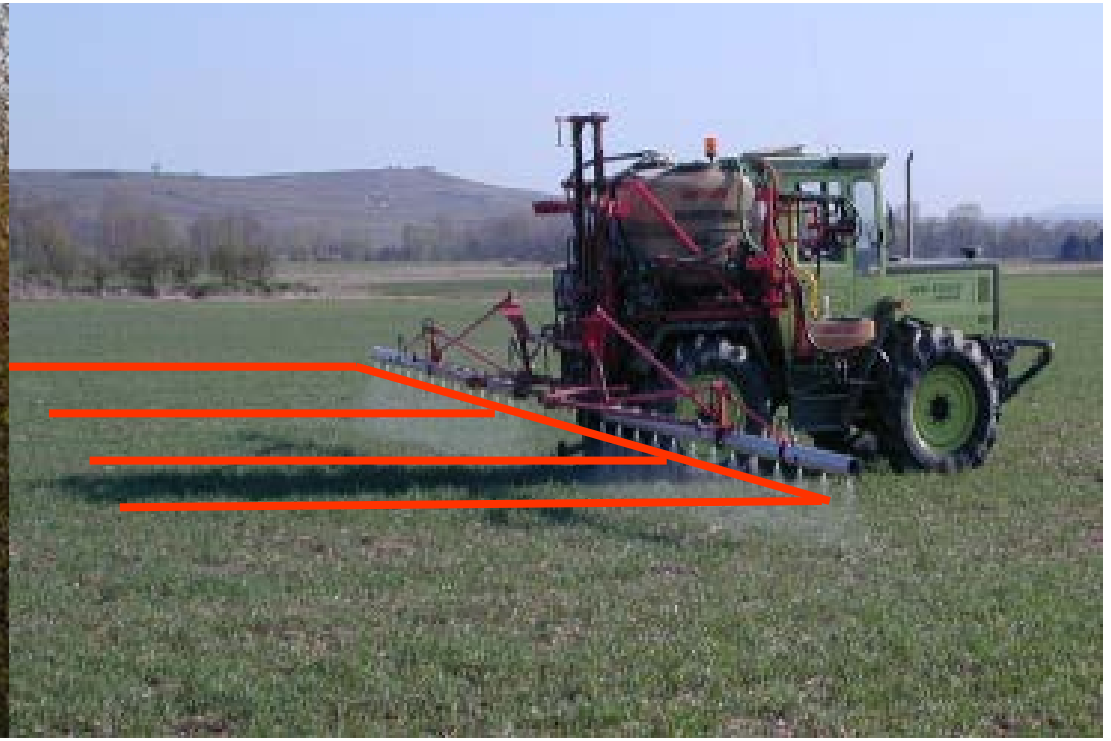
Crop Parameters recorded in trial reports

Version February, 21th 2018

Application volume expression
Basic Formula

$$\text{water volume (L/10 000m}^2\text{)} = \frac{\text{nozzle flow rate(L/min) * number of nozzles * 600}}{\text{working width (m) * travel speed (km/h)}}$$

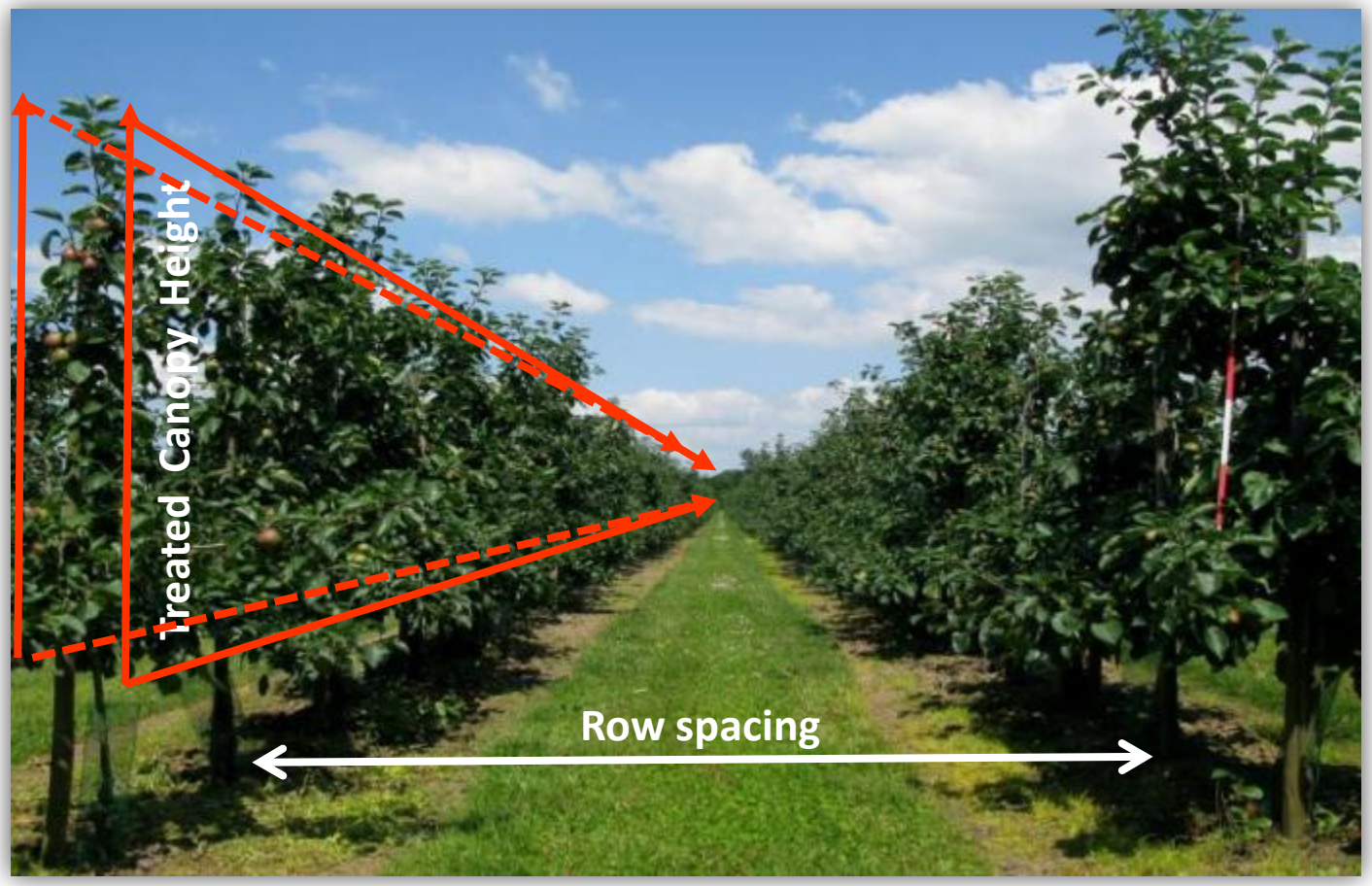
Treated area is the oversprayed plane between working nozzles and targets



Treated Leaf Wall Area

Basic Formula for Orchard or Vineyard

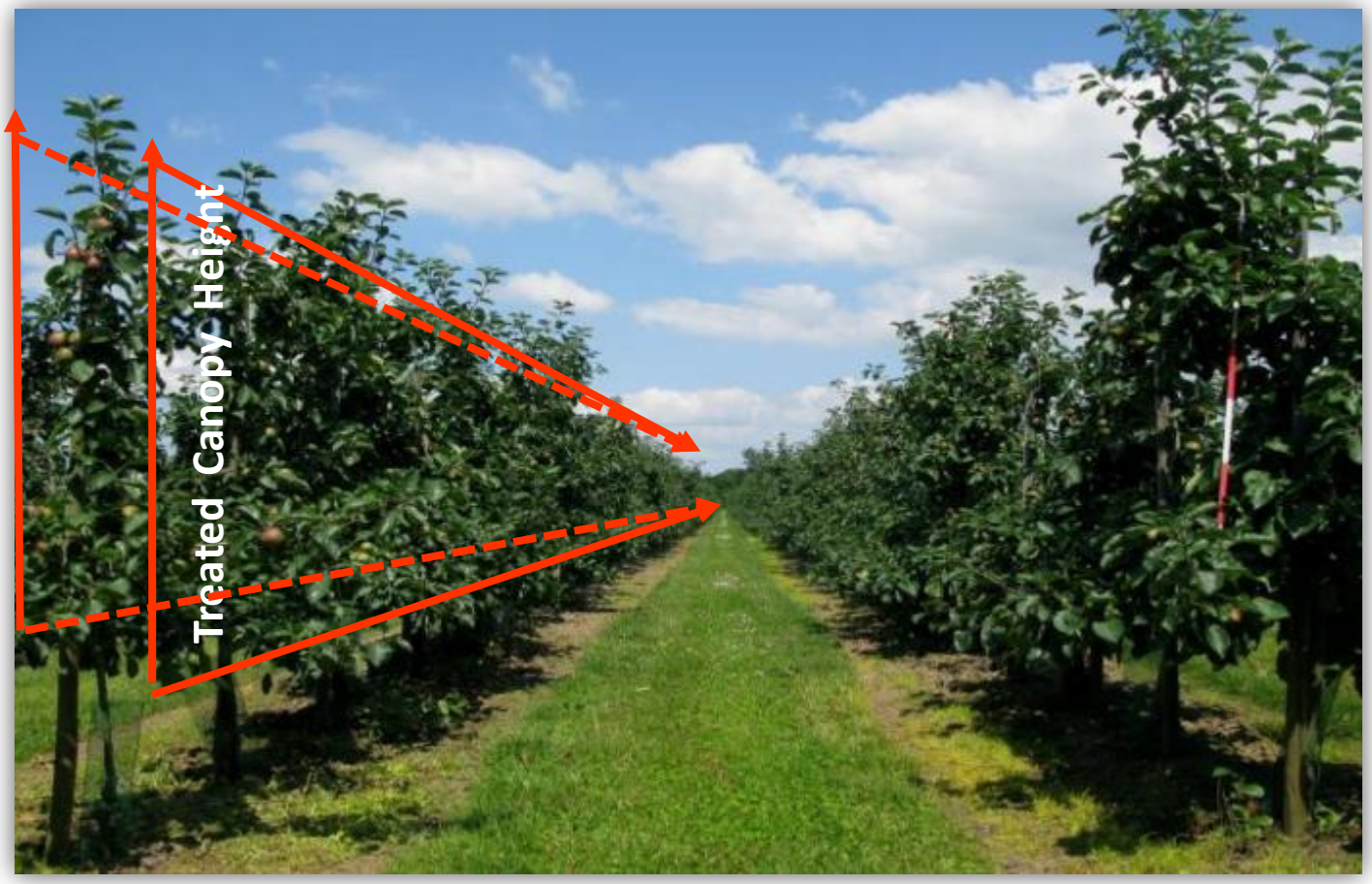
$$tLWA\ (m^2/ha\ ground\ area) = row\ sides\ applied \times Treated\ Canopy\ Height\ (m) \times \frac{ground\ area\ (m^2)}{Row\ Spacing\ (m)}$$



Treated Leaf Wall Area

Basic Formula for trial plots

tLWA (m^2/plot) = 2 x Treated Canopy Height (m) x length of treated rows per plot(m)



Important crop parameters for any trial in high growing crops

For orchard or vineyard characterization:

- Rows per plot
- Plant Shape
- Training system, Pruning System (Pergola, Goblet, Cordon, Spindel, isolated trees)
- Row Spacing
- Spacing within Row
- Plant /Row Diameter
- Plant Height
- Water Volume

Important crop parameters additionally to be given for tLWA calculation in trial plots

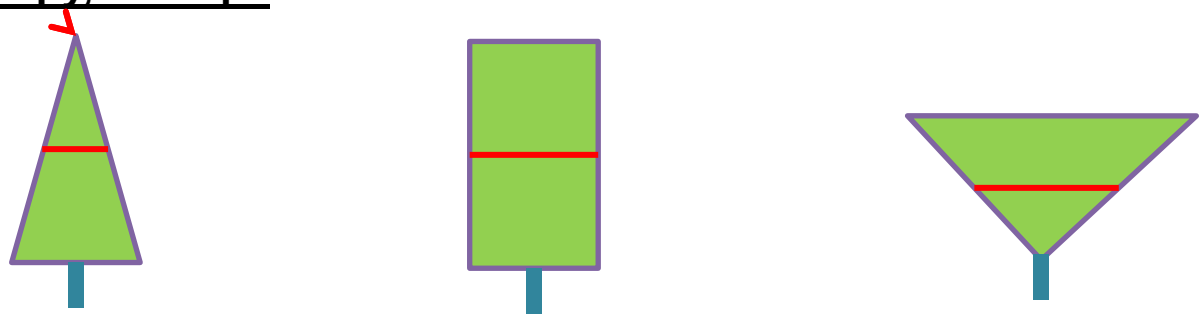
- Plot Length
- Treated Canopy Height
- Row sides applied (= 2)
- Treated Rows per plot

Measurement of **mid width of the canopy**

(Characterization of the Orchard or Vineyard)

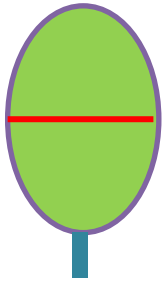
Average on 10 most representative plants of the trial randomly distributed has to be recorded

- **Vertical canopy, V-shape**:



Average **Plant Diameter** should be taken at mid-height of the canopy height (do not take into account extreme shoots in height and in width which could impact the total canopy height).

- **Globular shape**:

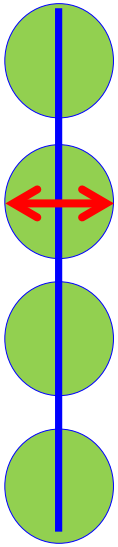


Average distance between outer leaves of the tree/plant at the middle of the canopy height (minimum + maximum width/ 2).

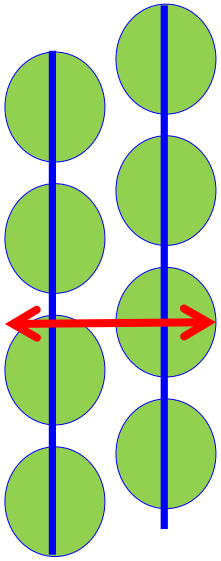
Width at the middle of the foliage height = mid width of the crown Unit: m	Average maximum distance between outer leaves of the foliage at the middle of the foliage height/crown height.

Definition of **mid width of the canopy**

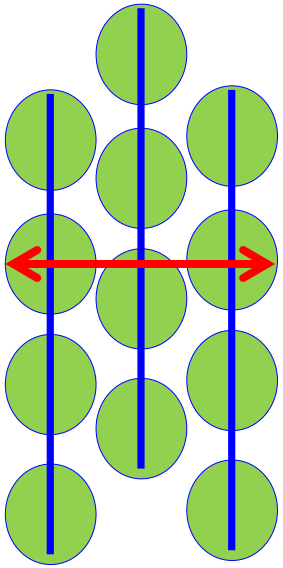
Single Row



Double Row



Multiple Row



Average **Plant Diameter** should be taken at mid-height of the canopy height (do not take into account extreme shoots in height and in width which could impact the total canopy height).

Width at the middle of the foliage height = mid width of the crown Unit: m	Average maximum distance between outer leaves of the foliage at the middle of the foliage height/crown height.

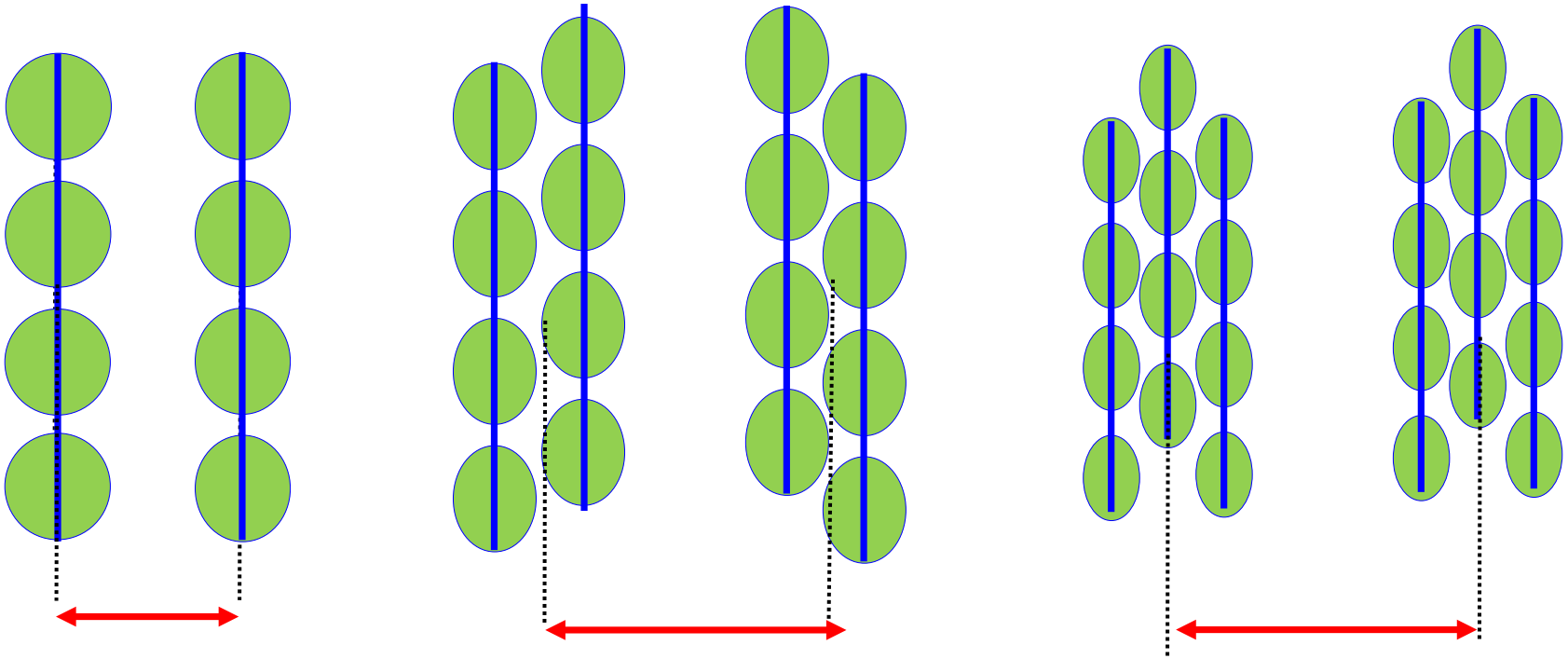
Measurement of the **Row Spacing**

(Characterization of the Orchard or Vineyard)

Single Row

Double Row

Multiple Row

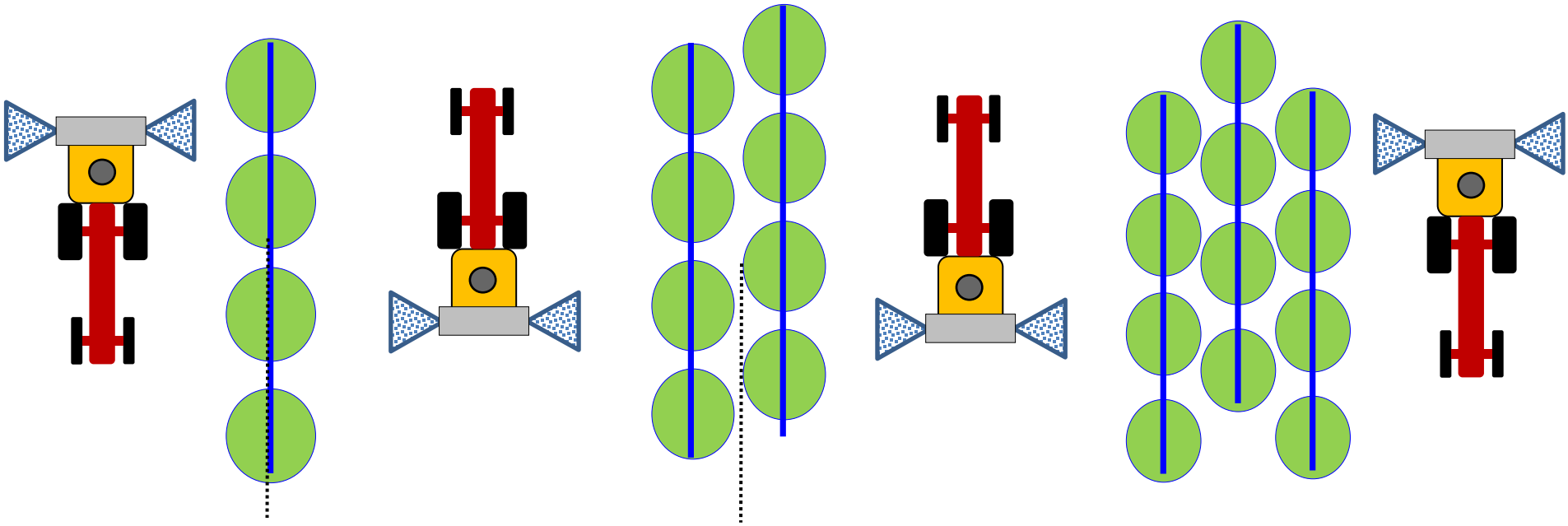


Definition of **Row sides applied**

Single Row

Double Row

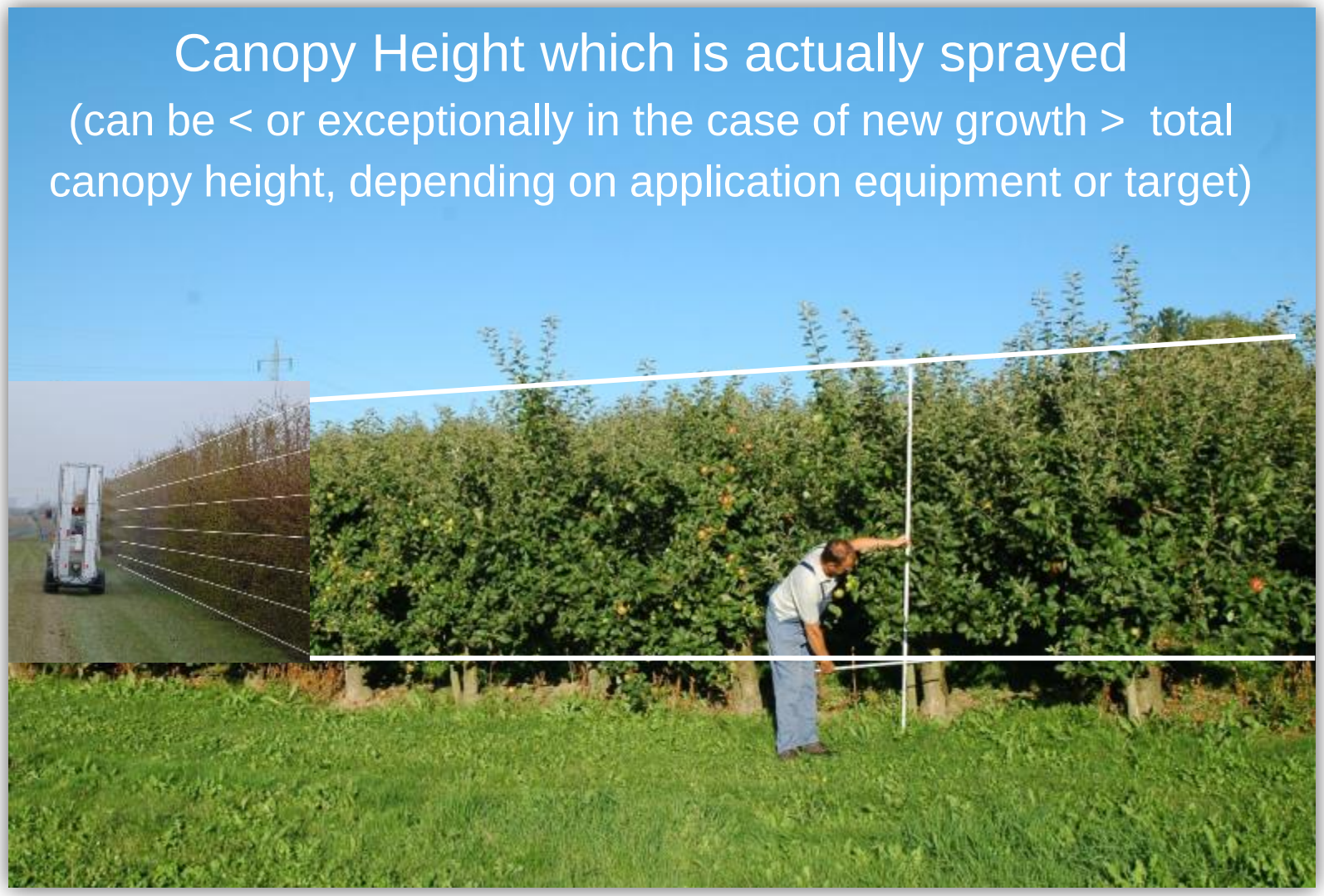
Multiple Row



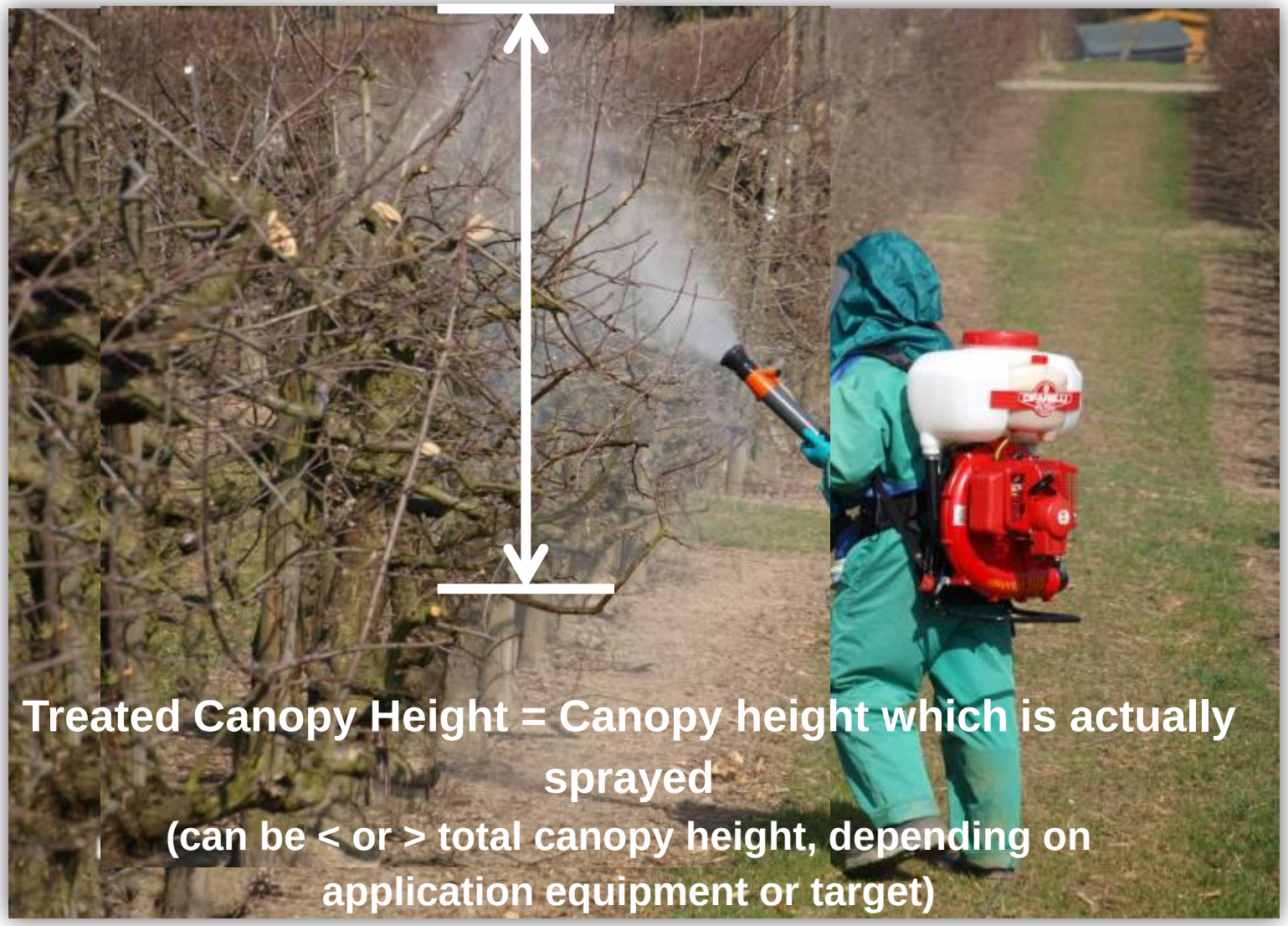
In all cases: Row sides applied = 2

The number of row sides applied corresponds to the number of sides which are applied

Definition of the Treated Canopy Height



Definition of the Treated Canopy Height



Treated Canopy Height = Canopy height which is actually sprayed

(can be < or > total canopy height, depending on application equipment or target)

Measurement of crop parameters
Pome Fruits - Vertical Canopy

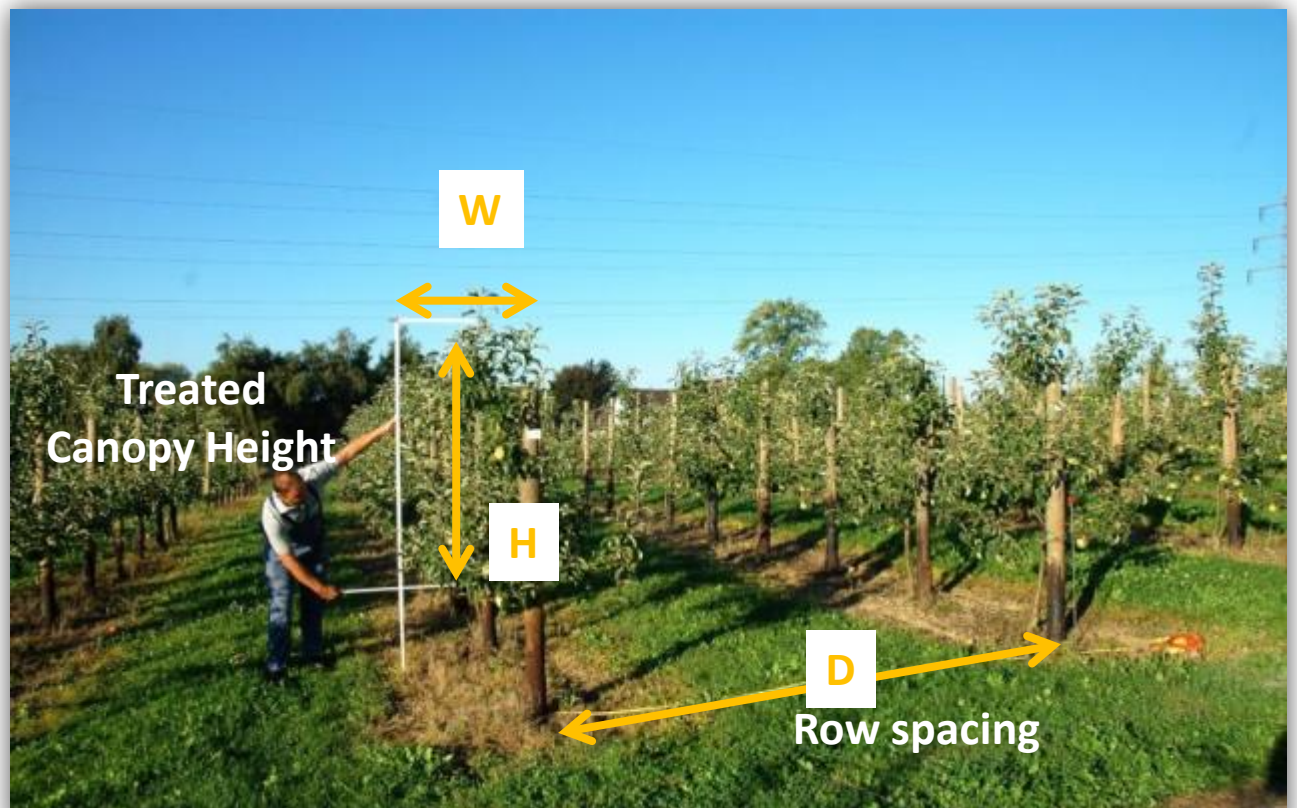


Photo:B.Toews

H =Treated Canopy Height

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

D = Row Spacing

W= Plant/Row Diameter

Measurement of crop parameters
Stone Fruits - V-shape

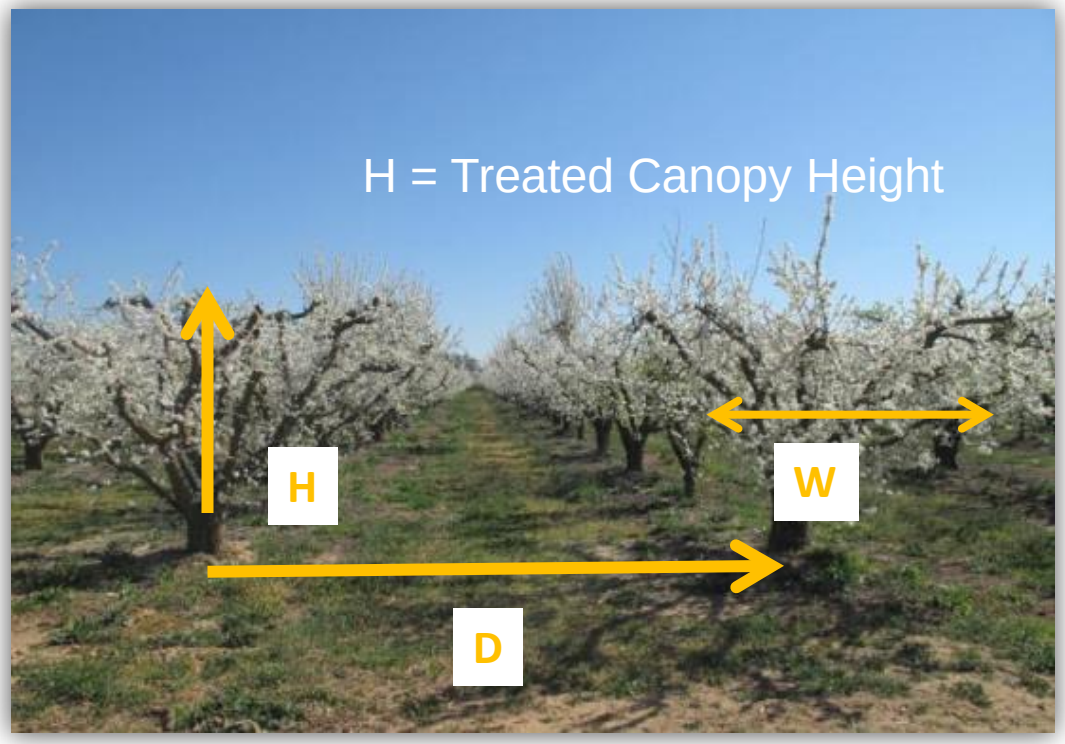
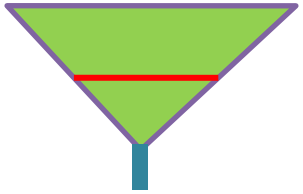


photo:Agroscope viti 2005/6

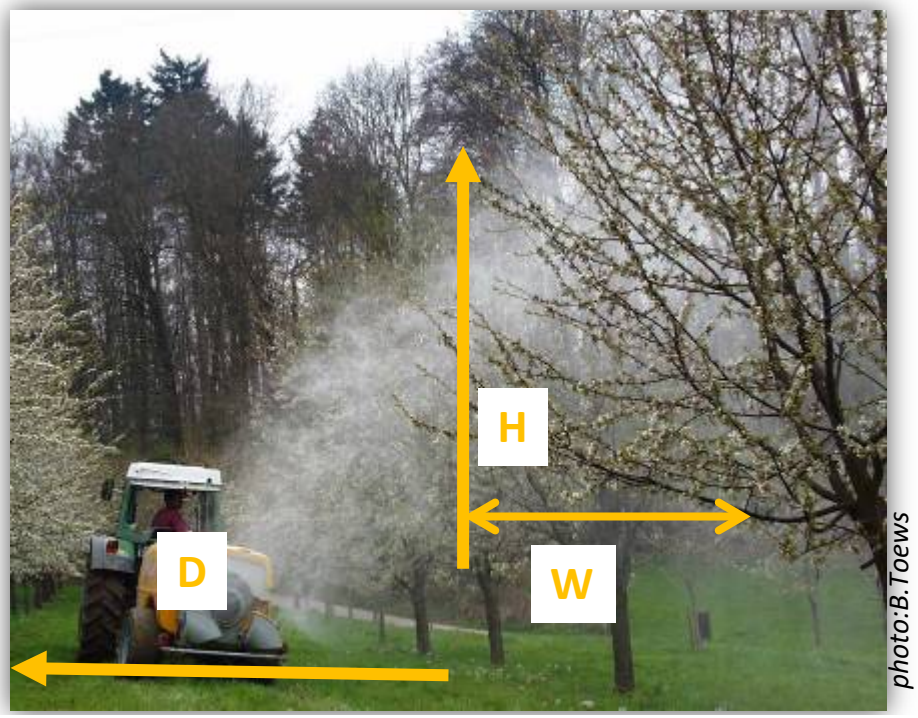


H =Treated Canopy Height

Only treated canopy height is relevant. It should reflect the height of treated area (trunk to be disregarded in most cases)
Average on 10 most representative trees of the trial is recorded

D = Row Spacing
W= Plant/Row Diameter

Measurement of crop parameter
Stone Fruits - Globular shape



H =Treated Canopy Height Only treated canopy height is relevant. It should reflect the height of treated area (trunk to be disregarded in most cases) Average on 10 most representative trees of the trial is recorded

D = Row Spacing

W= Plant Diameter Should be measured at the middle point of canopy height

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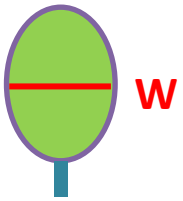


Measurement of crop parameter in Grapes “Trellised”

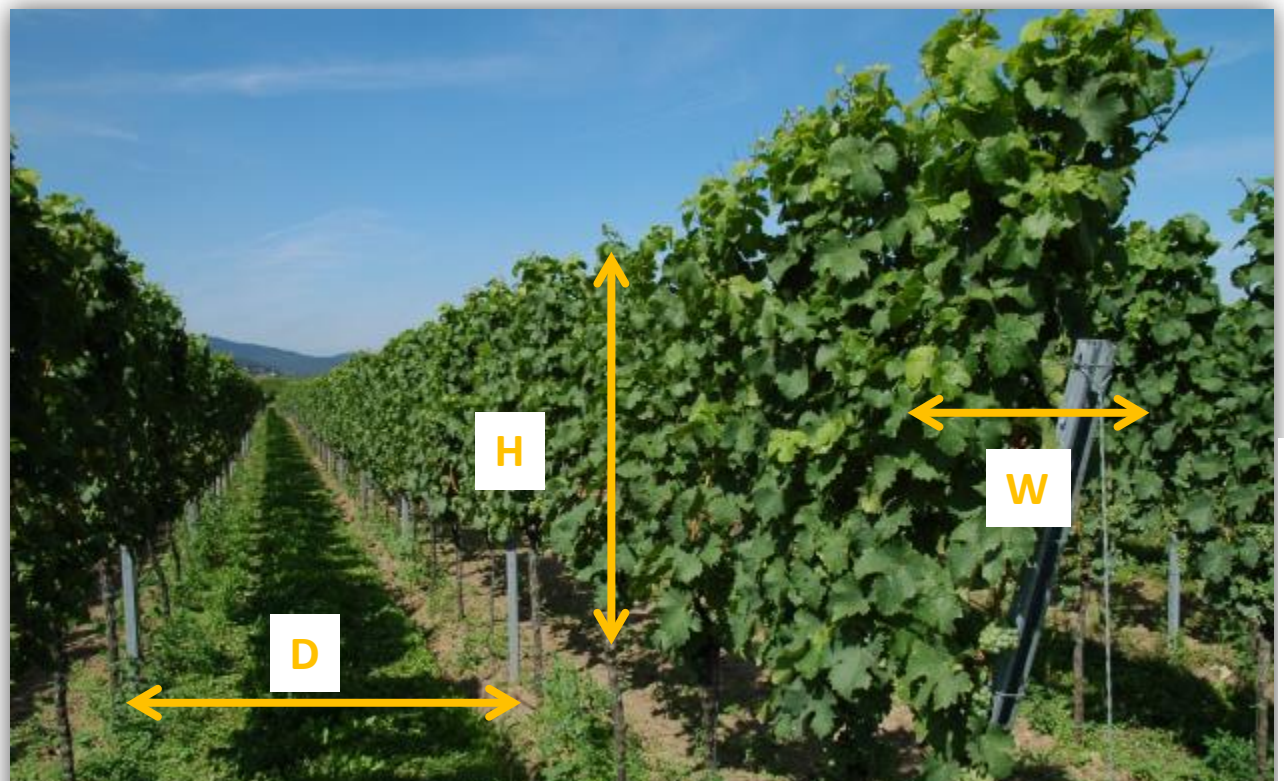


Photo: B.Toews

H =Treated Canopy Height

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

D = Row Spacing

W= Plant/Row Diameter

Dos and don‘ts for vertical band spraying

DO!

Measured Treated Canopy Height= 50 cm

-> Product calculated based on 50 cm

Product applied on 50 cm - correct (large) distance between nozzle and target area – straight movement

Dos and don‘ts

DON’T!
(doesn`t represent usual Practices)

Measured Treated Canopy Height = 20 cm

-> Product calculated based on 20 cm

Product applied on 20 cm

–small distance between nozzle and target area – curved movement

Dos and don‘ts

DON’T!

Recorded Treated Canopy Height = 20 cm

-> Product calculated based on 20 cm

But Product applied on 50 cm because of too large distance between nozzl

and target area

Measurement of crop parameter in Grapes “Goblet”

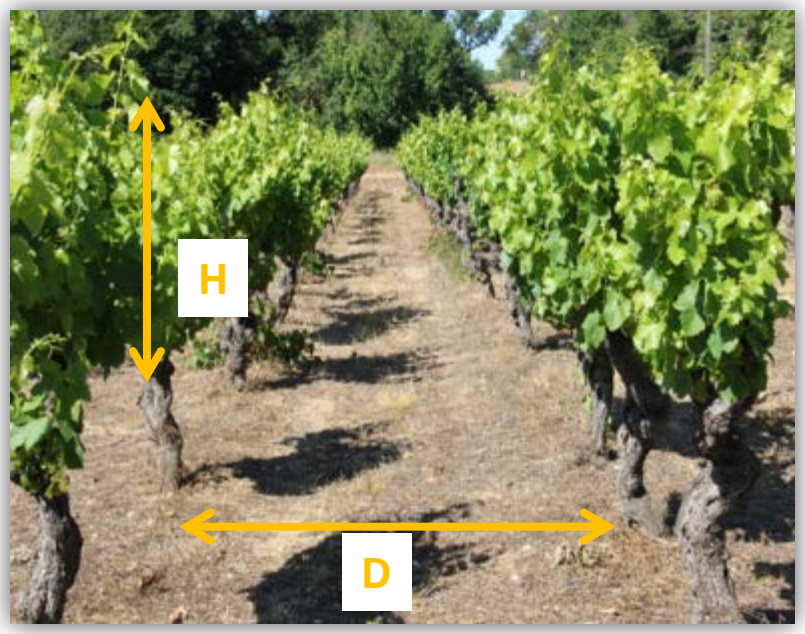
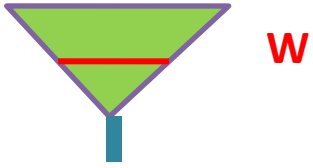


Photo: DuPont

H =Treated Canopy Height

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

D = Row Spacing
W = Plant Diameter



Measurement of crop parameter in Grapes “Pergola”

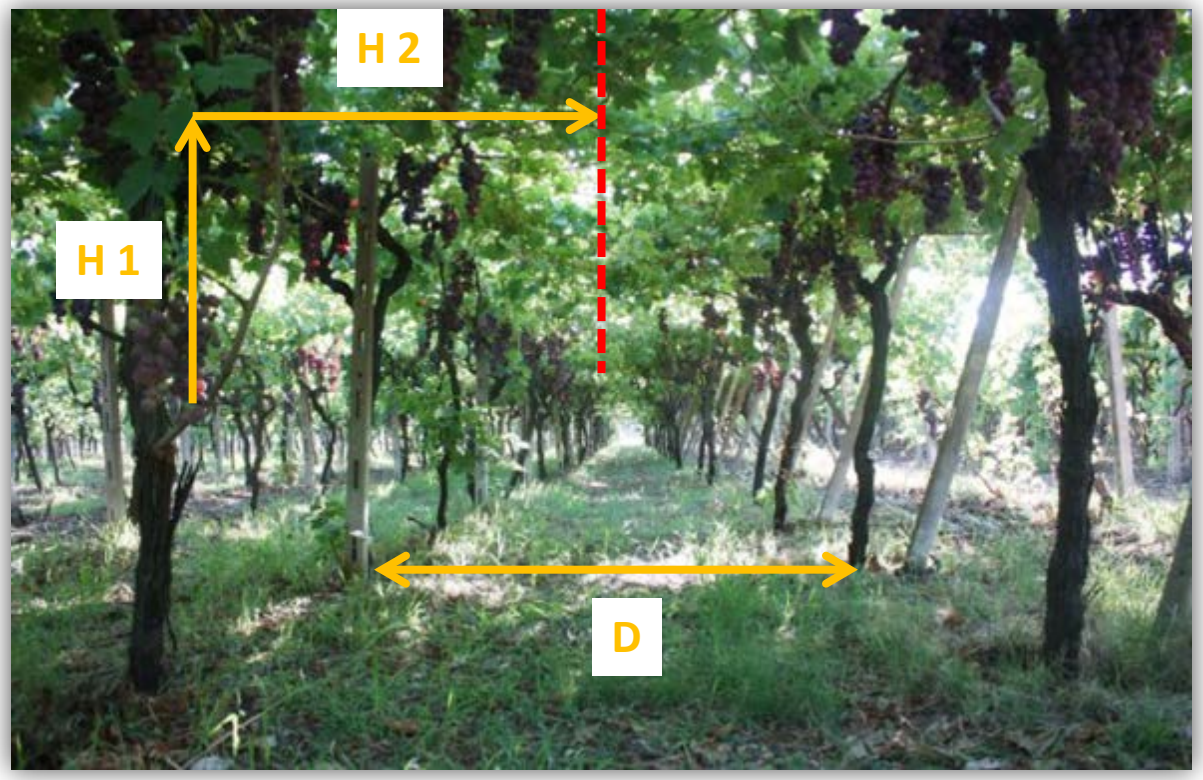


Photo: M. Troisi

H1+H2 =Treated Canopy Height Only treated canopy height is relevant
should reflect the height of treated area (trunk to be disregarded in most cases)
Average on 10 most representative grapevines of the trial is recorded

D = Row Spacing