Calibration and maintenance of pesticide application equipment

Key points for success

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European Commission
TAIEX
Technical Assistance Information Exchange Instrument (TAIEX), DG Enlargement

Workshop on Pesticide application equipment

Novi Sad (Serbia) June 2012

- Importance of calibration
- Calibration procedure
- Dose expresion alternatives
- Tools for an easy calibration
- Sprayer maintenance

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Importance of calibration

Calibration procedure

Dose expression alternatives

Tools for an easy calibration

Sprayer maintenance

Calibration procedure, whatever method is chosen represents great benefits when it is developed prior the application task

- Less pesticide use (according 128/2009/CE Directive)
- Increase of efficiency/efficacy of pesticide application process
- Less investment (pesticide, water, fuel, time,…)
- Less risk of contamination (TOPPS, TOPPS-PROWADIS,…)

Adequate calibration **optimal adjustment** **less drift losses**

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Interest and benefits of calibration / adjustment of pesticide application equipment

Official inspection of Sprayers
(acc. article 8) (Basis)

Procedure is obligate for MS
(128/2009/CE)

\+
1) Calibration
\+
2) Adjustment related to the canopy structure
\+
3) Drift reducing Technology

Tools are **voluntary**
Tools on which growers are manly interested
Tools can be implemented step by step

The supplementation of the official inspection by additional tools will lead to a win- win situation with benefits for public and growers / added values!

Calibration is also mentioned in EU Directive

CHAPTER II

TRAINING, SALES OF PESTICIDES, INFORMATION AND AWARENESS-RAISING

Article 5

Training

1. Member States shall ensure that all professional users, distributors and advisors have access to appropriate training by bodies designated by the competent authorities. This shall consist of both initial and additional training to acquire and update knowledge as appropriate.

The training shall be designed to ensure that such users, distributors and advisors acquire sufficient knowledge regarding the subjects listed in Annex I, taking account of their different roles and responsibilities.

Being not mandatory, is widely recommended and explicitly cited on the EU Directive. So…

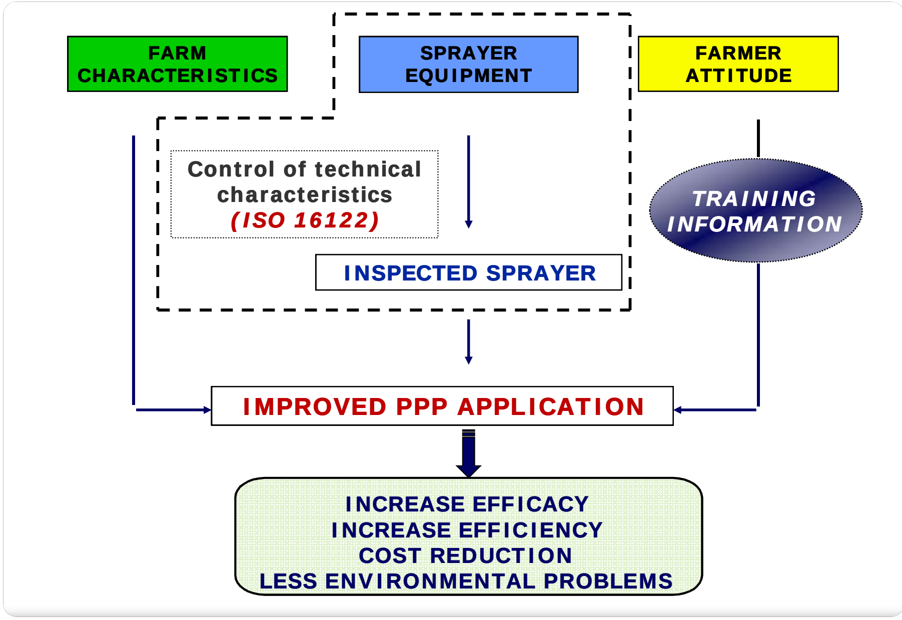
CHAPTER III

PESTICIDE APPLICATION EQUIPMENT

Article 8

Inspection of equipment in use

5. Professional users shall conduct regular calibrations and technical checks of the pesticide application equipment in accordance with the appropriate training received as provided for in Article 5.



*Farmers recalled that **incentives are preferred to penalties**, which are difficult to accept for farmers. They prefer voluntary approaches. Hence skill development and **knowledge/technology transfer are important elements** to be developed in the thematic strategy.*
(Hind, 2002)

*Use **inspections as a platform** to increase users' awareness*
(Stakeholder's Conference, 2004)

*The government (Belgium) always stressed that the mandatory **inspection of spraying** equipment **should** not **be** repressive but **educative** and beneficial for the user.*
(Braekman and Sonck, 2005)

*The farmers were more willing to "accept" information when given **personally and adjusted to site specific conditions** than when received through general letters and pamphlets.*
(Kreuger and Nilsson, 2001)

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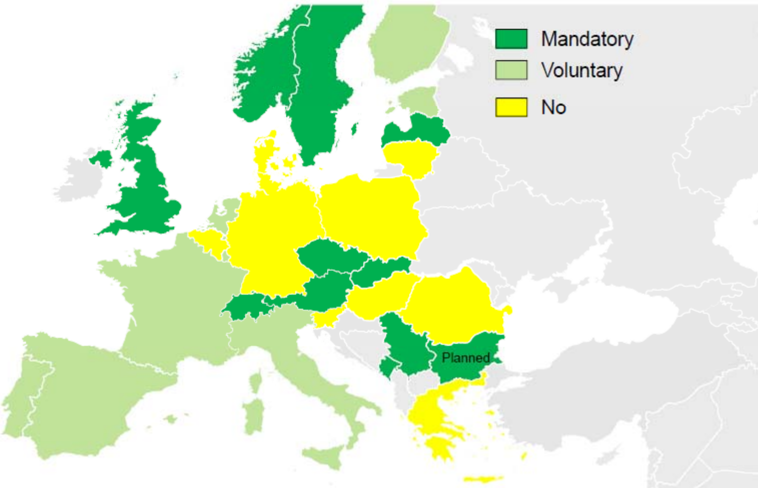
Calibration and training activities during inspection procedure



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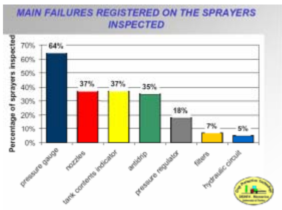
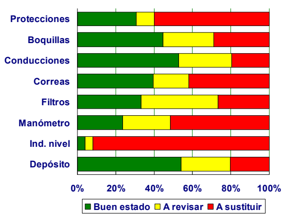
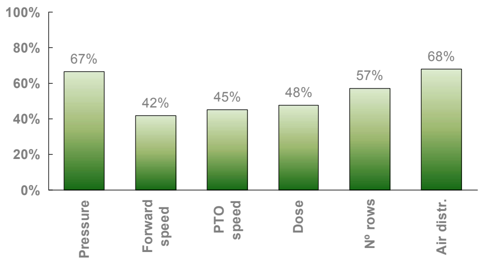
Defects solved with an adequate calibration process







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These sprayers have been **successfully inspected**

… but not calibrated !

Air flow volume / range – driving speed

Type / size / number of nozzles

Importance of calibration

Calibration procedure

Dose expression alternatives

Tools for an easy calibration

Sprayer maintenance

Calibration: the key point

Invest 15 min to adjust the sprayer for an optimal use according the particular conditions

Preconditions for a good calibration process

- ✓Simple … and yet effective
- ✓Not costly
- ✓verifiable

USER-FRIENDLY

UNIVERSALITY

LARGE SCALE PERFORMANCE

PERMANENT and FIRM PROGRESS

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Preconditions for a good calibration process

Whatever the selected process must be
SIMPLE and **PERFORMABLE**

✓By the grower himself

✓At the grower's site – field

✓In the interaction with the target

✓With simple tools

✓With options for inquiring-minded growers

Parameters for a good calibration process

Assumed

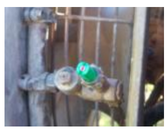
➢*Spray volume*
➢*PPP type and characteristics*
➢*Air flow volume*
➢*Air flow range/direction*


Measured

➢*Boom width*
➢*Boom height*
➢*Forward speed*
➢*Tree height and width*
➢*Row spacing*


Determined

➢*Nozzle flow rate*
➢*Nozzle size*
➢*Working pressure*
➢*Nozzle type*
➢*Number of nozzles*
➢*Nozzle orientation*

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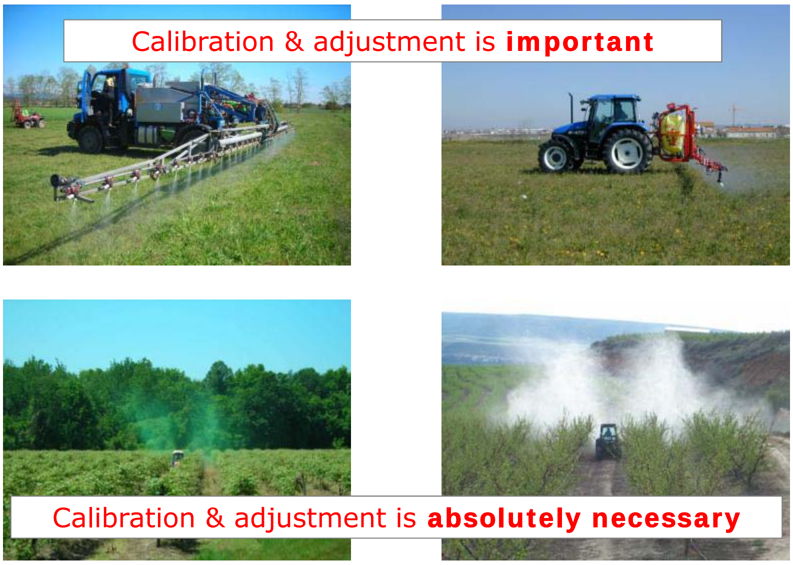

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Calibration procedure

Objective

Select the most adequate working parameters to obtain an uniform and precise distribution of the intended amount of pesticide over the target

Uniform target
"2D"
Liquid
Evenness
Low risk

Easy

No Uniform target
"3D"
Liquid + air
Heterogeneity
High risk

Difficult

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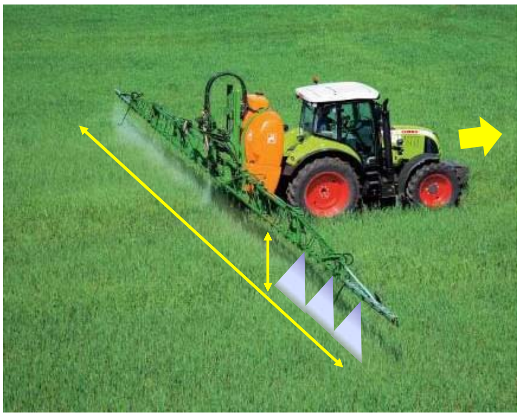
Field boom sprayer calibration process



Objective V (l/ha)
Even distribution over the field

Parameters (measured)

- *Boom width* **[a]** *(m)*
- *Boom height* **[h]** *(m)*
- *Forward speed* **[v]***(km/h)*

Parameters (calculated)

- *Nozzle type*
- *Flow rate* **[q]***(l/min)*
- *Working pressure (bar)*

$$q\ (l/min) = \frac{V\ (l/ha) \times a\ (m) \times v\ (km/h)}{600}$$

Example:
Calibration of a field boom sprayer for **200 l/ha**

1. Determine nozzle flow rate and working pressure

Boom width: 24 m

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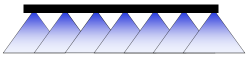
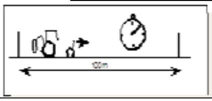


Volume: 200 l/ha

Recommended volume
200 l/ha



Fwd. Speed (km/h) $= \frac{3,6 \times 100}{\text{time (s)}}$

Fwd. speed table

t (s/100m)	45	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	85	90	95
v (km/h)	8,0	7,5	7,2	6,9	6,7	6,4	6,2	6,0	5,8	5,6	5,5	5,3	5,1	5,0	4,9	4,7	4,5	4,4	4,2	4,0	3,8

NOZZLE FLOW RATE CALCULATION

1,15 l/min

$$\frac{\overset{200}{\text{volume (l/ha)}} \times \overset{6,9}{\text{Fwd. speed (km/h)}} \times \overset{0,5}{\text{Nozzle distance (m)}}}{600}$$

DROPLET SIZE
Product characteristics and environment conditions)

WORKING PRESSURE
Select according droplets characteristics

CHECK
Us a graduate recipient to check the real flow rate of the nozzles and compare with catalogue information

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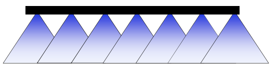

Volume: 200 l/ha

3 bar

Search the intended flow rate on the adequate nozzle catalogue. In this case ISO nozzles

Intended flow rate – ***1,15 l/min***
Closest flow rate on table – ***1,18 l/min***

Pressure [bar]	*Flow rate [l/min]* 01	015	02	025	03	04	05	06	08
1	0,23	0,34	0,46	0,57	0,68	0,91	1,14	1,37	1,82
2	0,32	0,48	0,65	0,81	0,96	1,29	1,61	1,94	2,58
3	0,39	0,59	0,79	0,99	1,18	1,58	1,97	2,37	3,16
4	0,45	0,68	0,91	1,14	1,36	1,82	2,27	2,74	3,63
5	0,50	0,76	1,02	1,28	1,52	2,04	2,54	3,06	4,08

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Factors for a correct calibration

$$Q = k \times \sqrt{P}$$

To increase flow rate x2 working pressure must be increased x4

$$2 \times Q = k \times \sqrt{4 \times P}$$

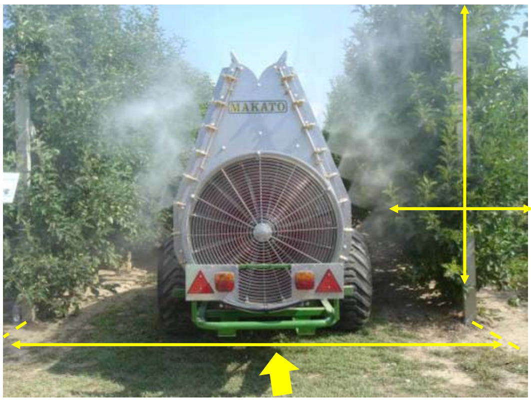
Best option to modify flow rate is to select the adequate nozzle size according the droplet spectrum desired

X 4

bar	Débit en l/mn									
	BLANCHE	LILAS	MARRON	JAUNE	ORANGE	ROUGE	GRISE	VERTE	NOIRE	BLEU
3	0,21	0,28	0,38	0,57	0,77	1,08	1,18	1,40	1,57	1,92
4	0,24	0,32	0,43	0,65	0,89	1,24	1,35	1,60	1,80	2,20
5	0,27	0,36	0,48	0,73	0,99	1,38	1,50	1,78	2,00	2,45
6	0,29	0,39	0,52	0,80	1,08	1,51	1,63	1,94	2,18	2,67
7	0,32	0,42	0,56	0,86	1,17	1,62	1,76	2,09	2,35	2,87
8	0,34	0,45	0,60	0,92	1,24	1,73	1,87	2,22	2,50	3,06
9	0,36	0,48	0,64	0,97	1,32	1,83	1,98	2,35	2,64	3,24
10	0,38	0,50	0,67	1,03	1,39	1,92	2,08	2,47	2,78	3,40
11	0,39	0,52	0,70	1,07	1,45	2,01	2,17	2,58	2,90	3,56
12	0,41	0,55	0,73	1,12	1,51	2,09	2,26	2,69	3,03	3,71
13	0,43	0,57	0,76	1,17	1,57	2,17	2,35	2,79	3,14	3,85
14	0,44	0,59	0,79	1,21	1,63	2,25	2,43	2,89	3,26	3,99
15	0,46	0,61	0,81	1,25	1,69	2,33	2,51	2,99	3,36	4,12
16	0,47	0,63	0,84	1,29	1,74	2,40	2,59	3,08	3,47	4,25
17	0,48	0,64	0,86	1,33	1,79	2,47	2,67	3,17	3,57	4,37
18	0,50	0,66	0,89	1,37	1,84	2,54	2,74	3,25	3,67	4,49
19	0,51	0,68	0,91	1,40	1,89	2,60	2,81	3,34	3,76	4,61
20	0,52	0,70	0,93	1,44	1,94	2,67	2,88	3,42	3,85	4,72
21	0,54	0,71	0,95	1,48	1,99	2,73	2,95	3,50	3,94	4,84
22	0,55	0,73	0,98	1,51	2,03	2,79	3,01	3,57	4,03	4,94
23	0,56	0,74	1,00	1,54	2,07	2,85	3,07	3,65	4,12	5,05
24	0,57	0,76	1,02	1,58	2,12	2,91	3,14	3,72	4,20	5,15
25	0,58	0,77	1,04	1,61	2,16	2,97	3,20	3,80	4,28	5,25

Orchard sprayer calibration process

Objective **V (l/ha)** *Distribution according canopy*



Parameters (measured)

- *Row spacing* **[r]** *(m)*
- *Forward speed* **[v]** *(km/h)*
- *Tree height* **[h]** *(m)*
- *Tree width* **[w]** *(m)*

Parameters (calculated)

- *Nozzle type*
- *Nozzle number* **[n]**
- *Nozzle orientation*
- *Nozzle flow rate* **[q]** *(l/min)*
- *Total flow rate* **[Q]** *(l/min)*
- *Working pressure (bar)*
- *Air flow rate* **[A]** *(m^3/h)*

$$Q\ (l/min) = \frac{V\ (l/ha) \times a\ (m) \times v\ (km/h)}{600}$$

$$A\ (m^3/h) = \frac{h\ (m) \times r\ (m) \times v\ (km/h) \times 1000}{K \approx (2\text{-}3)}$$

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Example for uniform orchard calibration

Volume 600 l/ha – 4 km/h – 4 m – 16 nozzles

$$\text{Flow rate (l/min)} = \frac{\text{Volume (l/ha)} \times \text{w (m)} \times \text{Fwd. speed (km/h)}}{600}$$

$$\text{Flow rate (l/min)} = \frac{600\ l/ha \times 4\ m \times 4\ km/h}{600} = 16\ l/min$$

$$\frac{16\ l/min}{16\ nozzles} = 1\ l/min$$

Nozzle selection on catalogue

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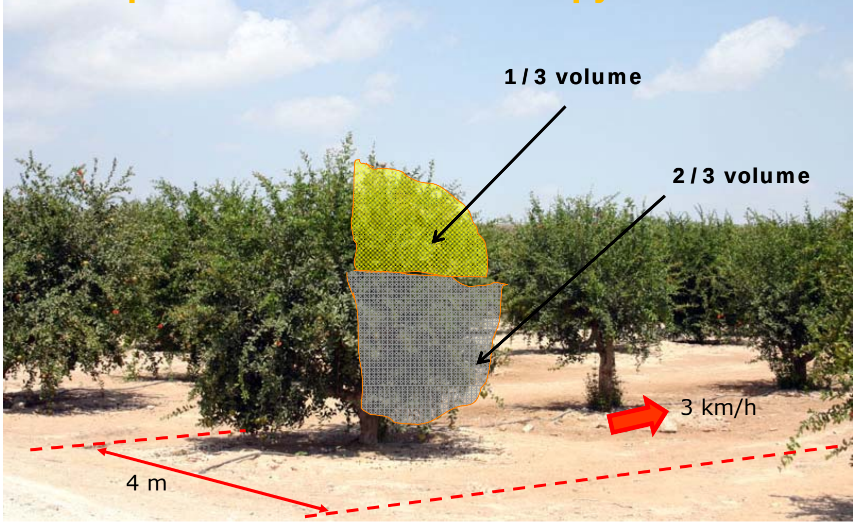
Results

Caudal (litros por minuto)											
Boquilla	Presión de trabajo (bar)										
	5	6	7	8	9	10	11	12	13	14	15
lila	0.37	0.40	0.43	0.45	0.48	0.50	0.53	0.55	0.57	0.59	0.61
marrón	0.48	0.52	0.56	0.59	0.62	0.66	0.69	0.71	0.74	0.77	0.78
amarilla	0.74	0.81	0.87	0.92	0.97	1.02	1.07	1.11	1.15	1.19	1.23
naranja	0.98	1.06	1.14	1.21	1.28	1.34	1.40	1.46	1.51	1.57	1.62
roja	1.39	1.51	1.62	1.72	1.82	1.91	1.99	2.07	2.15	2.22	2.30

- ✓*600 l/ha*
- ✓*4 km/h*
- ✓*4 m (working width)*
- ✓*16 nozzles ATR yellow*
- ✓*10 bar*

Example for non uniform canopy distribution



Example for non uniform canopy distribution

Application rate 800 l/ha – 4 km/h – 4 m – 16 nozzles

1/3 volume with 3 nozzles

2/3 volume with 5 nozzles

16 nozzles (8 + 8)

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$$\text{Flow rate (l/min)} = \frac{800\ \text{l/ha} \times 4\ \text{m} \times 4\ \text{km/h}}{600} = 21.3\ \text{l/min}$$

10.6 l/min x 1/3 = 3.5 l/min
3.5/3 nozzles = **1.18 l/min**

10.6 l/min x 2/3 = 7 l/min

7/5 nozzles = **1.4 l/min**

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Boquilla	Caudal (litros por minuto)										
	Presión de trabajo (bar)										
	5	6	7	8	9	10	11	12	13	14	15
lila	0.37	0.40	0.43	0.45	0.48	0.50	0.53	0.55	0.57	0.59	0.61
marrón	0.48	0.52	0.56	0.59	0.62	0.66	0.69	0.71	0.74	0.77	0.78
amarilla	0.74	0.81	0.87	0.92	0.97	1.02	1.07	1.11	1.15	1.19	1.23
naranja	0.98	1.06	1.14	1.21	1.28	1.34	1.40	1.46	1.51	1.57	1.62
roja	1.39	1.51	1.62	1.72	1.82	1.91	1.99	2.07	2.15	2.22	2.30

1.11 x 3 = 3.33 l/min

1.46 x 5 = 7.30 l/min

10.63 l/min → **797 l/ha**

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Air flow adjustment: objective the canopy

TRACTOR

- *RPM*
- *Tractor gear*

SPRAYER

- *Transmision gear*
- *Propeller blade setting*
- *Section air outlets*

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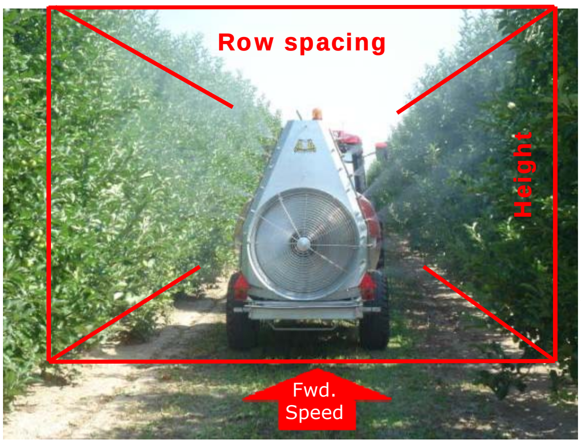
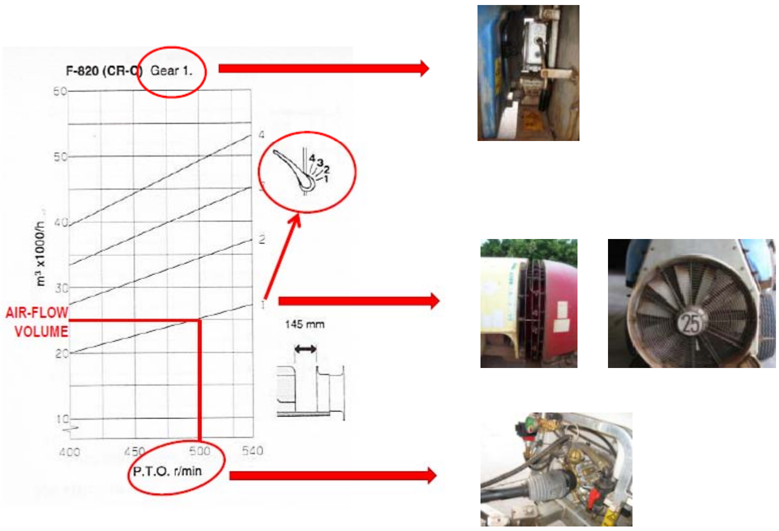
How to calculate the air needs

$$\textbf{Air Volume}\ [m^3/h] = \frac{\text{Tree height [m] x Row spacing [m] x Fwd. Speed [km/h]}}{K \approx (2\text{-}3)} \times 1000$$



Adjustment of air settings



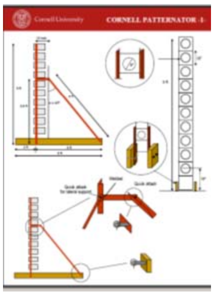
Adjustment according canopy structure implies:

Adequate selection of air flow characteristics (velocity, air flow rate,…)
Precise orientation of air outlets






The user's opinion… the most important "impact factor"



Using Simple Technology To Improve Spray Deposition and Reduce Drift at Dalrymple Vineyards

Bill Dalrymple
Dalrymple Farms, Ovid, NY

Reprinted from Sustainable Viticulture in the Northeast, Issue 5

I first saw Andrew Landers demonstrate his spray patternator at a field day demonstration in 2004. It inspired me to build my own. The unit I built cost me less than $50, and as you can see is made mostly out of old window screens I had laying around. Each screen has a channel in the bottom that funnels the water into the seven gallon-sized jugs, so I can run my sprayer for 15 minutes and find out how evenly the water is being distributed in the canopy.

When I first tried it out with my standard sprayer settings, it was throwing spray way up to the top, which obviously wasn't making it into the vine canopy. I was able to change the direction that nozzles were pointing to adjust for the direction of air coming out of the fan - downward canopy, instead of having half of it shoot into the air. It greatly reduced drift.

I worked with Andrew and Emilio Gil on using the "Dosavina" program on my farm. It uses vine dimensions, growth stage, spray material, variety, and spray conditions to calculate an optimum amount of water to deliver per acre. Early in the season, I was able to mix my fungicides in the appropriate concentration for 50 GPA, but actually apply much lower volume - down to as low as 17 GPA in some cases. I feel we got the same coverage while applying much less material per acre. We didn't need so much water to cover the relatively small leaf area present before bloom, and we figure we've saved around $2000 - $3000 on spray materials annually on our farm.

Importance of calibration

Calibration procedure

Dose expression alternatives

Tools for an easy calibration

Sprayer maintenance

Adapted dose (volume) to canopy characteristics
The challenge

The TRV concept

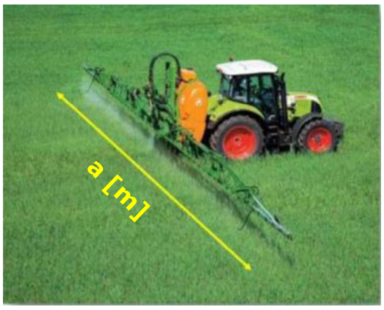
$$\text{TRV [m}^3\text{/ha]} = \frac{\text{Height [m]} \times \text{Width [m]} \times 10000}{\text{Row distance [m]}}$$

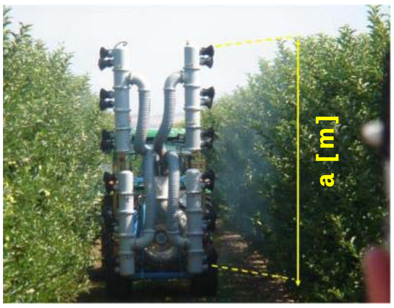
Volume [l/ha]=TRV [m³/ha] x *i* [l/m³]

Dosage des fongicides en fonction du volume de la vigne

www.agrometeo.ch

Leaf Wall Area (LWA) concept





$$\text{Volume [l/ha]} = \frac{\text{Flow rate [l/min]} \times 600}{\mathbf{a}\ \text{[m]} \times \text{Fwd. Speed [km/h]}}$$

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Leaf Wall Area (LWA) concept

Row distance (m)	Row length/ha (m)	Spray time/ha (min)	Spray volume (L/ha)	Leaf wall area, both sides (m²/ha)	Spray volume (L/10,000 m² LWA)ª
1.7	5.800	58	421	6.960	605
1.8	5.500	55	400	6.600	606
2.0	5.000	50	363	6.000	605
2.2	4.500	45	327	5.400	605
3.0	3.000	30	218	3.600	605

Tree Fruits Dose Adjustment Discussion Group Meeting

Wageningen, the Netherlands, September 29, 2009

OBJECTIVES

- recognition of the target
- overview of different pome fruit structures in Europe
  - depending on country
  - depending on orchard type
- evaluation of variability within the countries and across Europe
- considering possibility of harmonisation of dose rate expression and adjustment

Tree fruit dose adjustment group meeting Conclusions

1. Maximum **product amount per ha** ground surface per application (kg or l product/ha/spray) and **maximum total product amount per ha** ground surface **per season** (kg or l product/ha/season) should to be specified on the labels of all products.

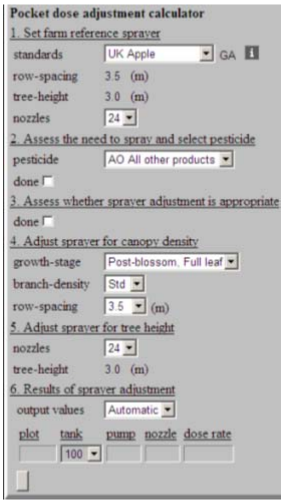
2. The need to move to **another expression method other than concentration**, (with or without a minimum or maximum water volume), given that growers do not generally apply PPP's as high volume applications was agreed. It was agreed that labels should advise on the range of water volumes to be used.

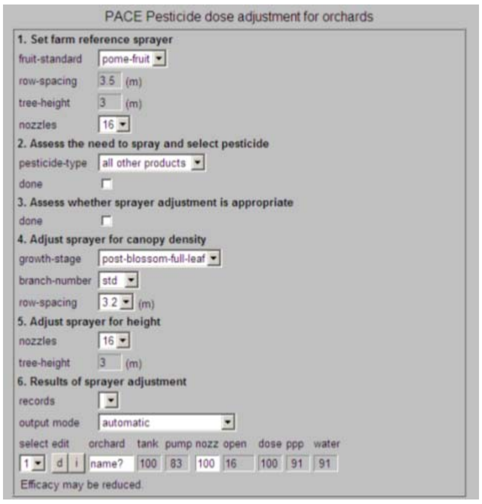
3. Need to gather and provide comprehensive **information of the structures** being treated in efficacy and residue trials, including growth stage, tree row height, crown height, tree row width, tree row spacing and canopy area density.

4. Three choices were therefore deemed suitable; **dose /ha** ground area, **dose / ha Leaf Wall Area** and **dose /ha at a given Tree Row Volume**. Industry unanimously preferred the **Leaf Wall Area** expression method.

Pesticide Adjustment to the Crop Environment (PACE)

http://pjwrc.co.uk/DoseAdjustmentOrig.htm





www.pace.pjwrc.co.uk/DoseAdjustment2.htm

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European Methods of Label Dose Rate Expression

Ground-Area (GA) Dose Rate

- *The amount of applied product per unit ground area*
- Liters/ha of ground area
- Parapet 75 WDG registered in the UK by Dow

Leaf-Wall-Area (LWA) Dose Rate

The amount of applied product per unit leaf-wall area
Liters/ha of leaf wall area
Steward registered in Belgium by DuPont

Canopy-Volume (CV) Dose Rate

The amount of applied product per unit canopy volume
Liters/ha of ground area and 1 meter crown height
Insegar registered in Germany by Syngenta

Tree-Row-Volume (TRV) Dose Rate

The amount of applied product per unit ground area of a given TRV
Liters/ha of ground area for a tree volume of 10,000 m^3/ha
Stroby registered in Switzerland by BASF

Row-Length (RL) Dose Rate

Amount of applied product per unit tree row length of canopy
Liters/100 meters row length
Calypso SC 480 registered in Norway by Bayer

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Importance of calibration

Calibration procedure

Dose expression alternatives

Tools for an easy calibration

Sprayer maintenance

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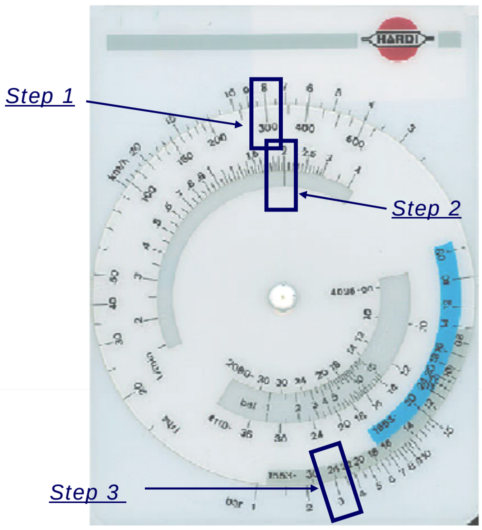
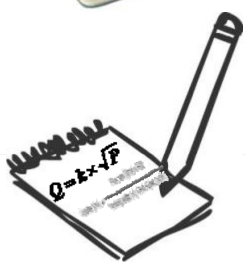
Calibration tools





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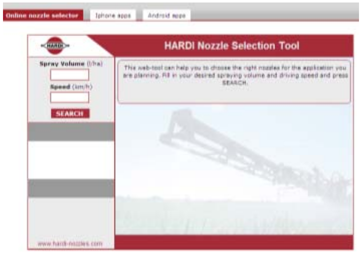
On-line tools for sprayer calibration

www.agrotop.com/en/nozzle-calculator



www.hardi-international.com

www.spray.com/services

www.albuz-spray.com

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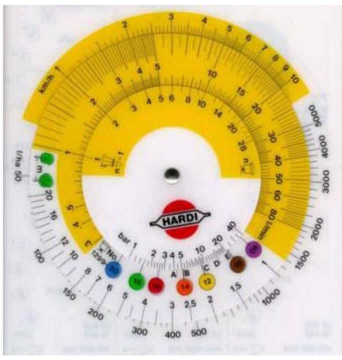
Calibration tools



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Manitenance of the sprayer

- ✓Damaged or wear nozzles
- ✓Losses on hoses/pipes
- ✓Correct functioning of the pump
- ✓Check nozzle flow rate
- ✓Filters
- ✓PTO and fan
- ✓General cleaning

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