Calibration and maintenance of pesticide application equipment

Key points for success

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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

- 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**
Interest and benefits of calibration/adjustment of pesticide application equipment

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

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

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

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

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. (Braeckman 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)
Calibration and training activities during inspection procedure

Defects solved with an adequate calibration process
These sprayers have been **successfully inspected**

... but not calibrated!

Air flow volume/range – driving speed
Type / size / number of nozzles

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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
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
Calibration & adjustment is **important**

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Calibration & adjustment is **absolutely necessary**

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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
**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
**Recommended volume**

Volume: 200 l/ha

**Fwd. Speed (km/h)**

volume (l/ha) x Fwd. speed (km/h) x Nozzle distance (m)

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>45</th>
<th>46</th>
<th>50</th>
<th>52</th>
<th>54</th>
<th>56</th>
<th>60</th>
<th>62</th>
<th>64</th>
<th>66</th>
<th>70</th>
<th>72</th>
<th>74</th>
<th>76</th>
<th>78</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (s/100m)</td>
<td>1,15 l/min</td>
<td>6,9</td>
<td>0,5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**DROPLET SIZE**

Product characteristics and environment conditions

**WORKING PRESSURE**

Select according droplets characteristics

**CHECK**

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

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

Volume: 200 l/ha

**Intended flow rate** ~ **1,15 l/min**

**Closest flow rate on table** ~ **1,18 l/min**

**Pressure [bar]**

<table>
<thead>
<tr>
<th>Flow rate [l/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>
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
Orchard sprayer calibration process

Objectives: 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] (m³/h)

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

\[
A \text{ (m³/h)} = \frac{h \text{ (m)} \times r \text{ (m)} \times v \text{ (km/h)} \times 1000}{K \approx (2-3)}
\]

Example for uniform orchard calibration

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

Flow rate (l/min) = \[
= 600 \text{ l/ha} \times 4 \text{ m} \times 4 \text{ km/h} \]

= 16 l/min

\[
= \frac{16 \text{ l/min}}{16 \text{ nozzles}} = 1 \text{ l/min}
\]

Nozzle selection on catalogue
### Results

**Caudal (litros por minuto)**

<table>
<thead>
<tr>
<th>Boquilla</th>
<th>Presión de trabajo (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>lila</td>
<td>0.37</td>
</tr>
<tr>
<td>marrón</td>
<td>0.48</td>
</tr>
<tr>
<td>amarilla</td>
<td>0.58</td>
</tr>
<tr>
<td>naranja</td>
<td>0.98</td>
</tr>
<tr>
<td>roja</td>
<td>1.39</td>
</tr>
</tbody>
</table>

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

### Example for non uniform canopy distribution

1/3 volume

2/3 volume

4 m

3 km/h
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)

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 \text{ l/min} \times \frac{1}{3} = 3.5 \text{ l/min}
3.5/3 nozzles = 1.18 \text{ l/min}

10.6 \text{ l/min} \times \frac{2}{3} = 7 \text{ l/min}
7/5 nozzles = 1.4 \text{ l/min}
### Caudal (litros por minuto)

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</tr>
<tr>
<td>Amarilla</td>
<td>0.74</td>
</tr>
<tr>
<td>Naranja</td>
<td>0.98</td>
</tr>
<tr>
<td>Rojo</td>
<td>1.39</td>
</tr>
</tbody>
</table>

1.11 x 3 = 3.33 l/min
1.46 x 5 = 7.30 l/min
10.63 l/min → 797 l/ha

### Air flow adjustment: objective the canopy

**TRACTOR**
- RPM
- Tractor gear

**SPRAYER**
- Transmission gear
- Propeller blade setting
- Section air outlets
How to calculate the air needs

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

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”
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**

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

\[
\text{Volume [l/ha]} = \text{TRV [m}^3\text{/ha]} \times i \text{ [l/m}^3\text{]}
\]

Dosage des fongicides en fonction du volume de la vigne

www.agrometeo.ch

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**Leaf Wall Area (LWA) concept**

\[
\text{Volume [l/ha]} = \frac{\text{Flow rate [l/min] \times 600}}{a \text{ [m] \times Fwd. Speed [km/h]}}
\]
### Leaf Wall Area (LWA) concept

<table>
<thead>
<tr>
<th>Raw distance (m)</th>
<th>Raw length/ha (m)</th>
<th>Spray time/ha (min)</th>
<th>Spray volume (L/ha)</th>
<th>Leaf wall area, both sides (m²/ha)</th>
<th>Spray volume (L/10,000 m² LWA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7</td>
<td>5.800</td>
<td>58</td>
<td>421</td>
<td>6.960</td>
<td>605</td>
</tr>
<tr>
<td>1.8</td>
<td>5.500</td>
<td>55</td>
<td>400</td>
<td>6.600</td>
<td>606</td>
</tr>
<tr>
<td>2.0</td>
<td>5.000</td>
<td>50</td>
<td>363</td>
<td>6.000</td>
<td>605</td>
</tr>
<tr>
<td>2.2</td>
<td>4.500</td>
<td>45</td>
<td>327</td>
<td>5.400</td>
<td>605</td>
</tr>
<tr>
<td>3.0</td>
<td>4.000</td>
<td>30</td>
<td>213</td>
<td>3.600</td>
<td>605</td>
</tr>
</tbody>
</table>

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### 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 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)

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
- Parajet 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
- Insigma 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 m³/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
Importance of calibration
Calibration procedure
Dose expression alternatives
Tools for an easy calibration
Sprayer maintenance
On-line tools for sprayer calibration

Calibration tools
Importance of calibration
Calibration procedure
Dose expression alternatives
Tools for an easy calibration

Sprayer maintenance

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