Evaluation of sprayers used for regulatory efficacy assessment trials

Carla Román, Jordi Llorens, Santiago Planas
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carlaroman@eagrof.udl.cat
of 21 October 2009
concerning the placing of plant protection products on the market and repealing Council Directives
79/117/EEC and 91/414/EEC

COMMISSION REGULATION (EU) No 546/2011
of 10 June 2011
Trials shall be designed to investigate specified issues, to minimise the effects of random variation between different parts of each site and to enable statistical analysis to be applied to results amenable to such analysis. The design, analysis, conduct and reporting of trials shall be in accordance with the specific standards of the European and Mediterranean Plant Protection Organisation (EPPO), where available. Deviations from available EPPO guidelines, may be acceptable provided the trials design meets the minimum requirements of the relevant EPPO standard, and is fully described and justified. The report shall include a detailed and critical assessment of the data.
The net result of the positive and negative effects should be a sufficient overall agricultural benefit to justify the use of the plant protection product.

3. Assessment of efficacy

Efficacy is assessed by the consideration of data from several different sources. Direct efficacy (effectiveness) is evaluated in specific trials. Information on phytotoxicity, effects on non-target pests and beneficial organisms and damage to succeeding or adjacent crops can come from observations made during efficacy evaluation trials, but may also need specific trials, some of which may be performed as part of the evaluation of risk to the environment. Data on resistance comes from separate data sets within the registration dossier. Other information on, for example, ease of use and compatibility with other practices is obtained from data on use pattern(s).

These main trial results may be influenced, positively or negatively, by a number of other factors which, according to the Standard, should be recorded during the trial:
(a) Suitability of crop (including cultivar, growth stage);
(b) Suitability of test organism (strain, life stage, population density);
(c) Suitability of trial site;
(d) Reliability of equipment;
(e) Correct dosage;
(f) Influence of other plant protection products applied;
(g) Climate;
(h) Soil type and condition.

Expert judgement is needed to decide if any of these factors could have influenced the efficacy and whether the effect was an apparent increase or decrease of direct efficacy. In addition, the expert assessor may be able to recognize other possible influences on direct efficacy from an examination of the data set presented for registration; for example, distribution of use in relation to weather conditions.
Reliability of equipment (sprayers)

Efficacy trials

Farm level

1000 L/ha

850 L/ha
Reliability of equipment (sprayers)

Efficacy trials

Farm level

500 - 1000 L/ha

<500 L/ha
Study aim

• To compare two sprayers used for efficacy evaluation for the Biological Assessment Dossiers (BAD) and two sprayers used by farmers.
MATERIAL AND METHODS
SPRAYER 1- GUN & Engine pump*

Nozzle: 1 (ceramic nozzle AMT type)
Spray control: Working pressure adjustment and nozzle output angle adjustment.

*Sprayer commonly used in Biological Assessment Dossier
SPRAYER 2- Motorized KNAPSACK*

Nozzle: Pneumatic diffusor
Spray Control: Output flow rate adjustment (no operational)

*Sprayer commonly used in Biological Assessment Dossier
FARMER SPRAYER: Air-blast

Nozzles: 24
   22 Albuz ATR 80 Orange
   12 Albuz ATR 80 Yellow

Spray control: Console ARAG BRAVO 180 + GPS
FARMER SPRAYER: Vertical booms (turbine)

Nozzles: 24 (6 for each block)
4 Albuz ATR 80 Orange
2 Albuz ATR 80 Yellow

Spray control: Working pressure adjustment.
LOCATION

Gimenells

a) Apple orchard

b) Vineyard

Raïmat

a) Tree of security distance between different treatments.

b) 5 tree of security distance between different treatments.
## CANOPY CHARACTERIZATION

<table>
<thead>
<tr>
<th>Apple Orchard</th>
<th>Vineyard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop stage BBCH</td>
<td>75-77</td>
</tr>
<tr>
<td>Row distance (m)</td>
<td>4,00</td>
</tr>
<tr>
<td>Tree distance (m)</td>
<td>1,40</td>
</tr>
<tr>
<td>Canopy height (m)</td>
<td>4,00</td>
</tr>
<tr>
<td>Canopy width (m)</td>
<td>1,88</td>
</tr>
<tr>
<td>LAI** estimated DOSA3D</td>
<td>3,70</td>
</tr>
</tbody>
</table>

** Leaf área Index estimated at www.dosa3d.cat/en
# TREATMENTS

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sprayer</strong></td>
<td>GUN</td>
<td>Motorized knapsack</td>
<td>Air-blast sprayer</td>
</tr>
<tr>
<td><strong>Application Volume</strong></td>
<td>1116 l/ha</td>
<td>952 l/ha</td>
<td>1000 l/ha</td>
</tr>
<tr>
<td><strong>Forward speed</strong></td>
<td>0.9 Km/h</td>
<td>0.3 Km/h</td>
<td>5-6 Km/h</td>
</tr>
<tr>
<td><strong>Working pressure</strong></td>
<td>&gt;20 Bar</td>
<td>--</td>
<td>10-12 Bar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sprayer</strong></td>
<td>GUN</td>
<td>Motorized knapsack</td>
<td>Vertical booms</td>
</tr>
<tr>
<td><strong>Application Volume</strong></td>
<td>439 l/ha</td>
<td>590 l/ha</td>
<td>532 l/ha</td>
</tr>
<tr>
<td><strong>Forward speed</strong></td>
<td>0.9 Km/h</td>
<td>0.3 Km/h</td>
<td>6 km/h</td>
</tr>
<tr>
<td><strong>Working pressure</strong></td>
<td>&gt;20 Bar</td>
<td>--</td>
<td>10 Bar</td>
</tr>
</tbody>
</table>
TREATMENTS

**Tracer:** food dye Tartrazine (E-102)
**Concentration:** 5 g/l
**SAMPLING STRATEGY**

Iso 22522:2007

Leaf sample: 3-4 leaf as natural collector (>50cm²)
SAMPLING STRATEGY

ISO 22522:2007

Soil sample: filter paper as artificial collector (333 cm²)
RESULTS
APPLE ORCHARD

**Leaf deposition (µl/cm²)**

- **Gun**: Mean differences using HSD.test with $\alpha = 0.05$, previous transformation of the data with square root. Different letters mean significant differences.
- **Motorized knapsack**: Mean differences using HSD.test with $\alpha = 0.05$, previous transformation of the data with square root. Different letters mean significant differences.
- **Air-blast**: Mean differences using HSD.test with $\alpha = 0.05$, previous transformation of the data with square root. Different letters mean significant differences.
Apple tree var. Golden (hedgerow) - Full stages
Frequency analysis (mean, standard deviation) of leaf deposition
normal distribution
for different sprayers (n=48)
## APPLE ORCHARD

<table>
<thead>
<tr>
<th>Sprayer type</th>
<th>Gun</th>
<th>Motorized knapsack</th>
<th>Air-blast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variation coefficient</td>
<td><strong>103,9 %</strong></td>
<td><strong>84,0 %</strong></td>
<td><strong>63,3 %</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>4,30</td>
<td>5,30</td>
<td>1,75</td>
<td>0,21</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>0,52</td>
<td>0,92</td>
<td>0,09</td>
<td>0,14</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>0,85</td>
<td>1,39</td>
<td>0,89</td>
<td>0,15</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>3,77</td>
<td>3,49</td>
<td>2,64</td>
<td>1,05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>2,02</td>
<td>2,13</td>
<td>0,93</td>
<td>0,38</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>1,43</td>
<td>1,03</td>
<td>0,34</td>
<td>0,10</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>1,13</td>
<td>1,08</td>
<td>0,57</td>
<td>0,23</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>3,37</td>
<td>2,42</td>
<td>0,81</td>
<td>0,37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>1,32</td>
<td>2,09</td>
<td>3,21</td>
<td>1,99</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>0,48</td>
<td>0,60</td>
<td>1,10</td>
<td>1,82</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>1,27</td>
<td>3,00</td>
<td>1,98</td>
<td>1,50</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>0,64</td>
<td>0,83</td>
<td>1,02</td>
<td>0,88</td>
</tr>
</tbody>
</table>

**Deposition (µl/cm²)**

- **Gun**: 103,9 %
- **Motorized knapsack**: 84,0 %
- **Air-blast**: 63,3 %
Mean differences using HSD.test with $\alpha = 0.05$, previous transformation of the data with square root. Different letters mean significant differences.
Grape var. Merlot (hedgerow) - Full stages
Frequency analysis (mean, standard deviation) of leaf deposition normal distribution
for different sprayers (n=36)
### VINEYARD

<table>
<thead>
<tr>
<th>Sprayer Type</th>
<th>Variation Coefficient (%)</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gun</td>
<td>78.8%</td>
<td>1.18</td>
<td>2.45</td>
<td>1.43</td>
</tr>
<tr>
<td>Motorized knapsack</td>
<td>65.7%</td>
<td>1.74</td>
<td>1.53</td>
<td>0.89</td>
</tr>
<tr>
<td>Vertical booms</td>
<td>84.8%</td>
<td>1.95</td>
<td>3.57</td>
<td>2.38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deposition (µl/cm²)</th>
<th>0.0</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LEAF RECOVERY & SOIL LOSSES

Graph showing efficiency, soil losses, and unaccounted fraction for different methods:
- **Gun**:
  - Efficiency: 35.9%
  - Soil losses: 13.2%
  - Unaccounted fraction: 50.9%
- **Motorized knapsack**:
  - Efficiency: 54.2%
  - Soil losses: 6.0%
  - Unaccounted fraction: 39.8%
- **Air-blast**:
  - Efficiency: 44.5%
  - Soil losses: 6.4%
  - Unaccounted fraction: 49.1%

Graph showing efficiency, soil losses, and unaccounted fraction for different methods:
- **Gun**:
  - Efficiency: 20.3%
  - Soil losses: 30.9%
  - Unaccounted fraction: 48.9%
- **Motorized knapsack**:
  - Efficiency: 62.4%
  - Soil losses: 9.5%
  - Unaccounted fraction: 28.2%
- **Vertical booms**:
  - Efficiency: 10.7%
  - Soil losses: 19.3%
  - Unaccounted fraction: 70.0%
Sprayers used in trials for Biological Assessment Dossiers (BAD) found important differences between intended and real volume rates.

Differences between sprayers used at Biological Assessment Dossiers trials and at farm level should be studied in order to minimize risks of over or underdosing.

It should be suitable to use updated farm level sprayers in biological assessment trials.
FURTHER WORKS next week...
Research Group in AgroICT and Precision Agriculture

Acknowledgements:

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