OPTIMIZATION OF THE SPRAY APPLICATION TECHNOLOGY IN BAY LAUREL (LAURUS NOBILIS)

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SUMMARY

Bay laurel is an evergreen, commercially grown and expensive ornamental pot plant, which is susceptible to different pests like aphids, scale and lerp insects, thrips, caterpillars of codling moth and sooty molds. Recently, caterpillars of the mediterranean carnation leafroller (Cacoecimorpha pronubana) cause more and more problems. These pests can lead to important financial losses for the growers.

During summer the individual pot plants are placed on a field-container in a fairly dense configuration. Crop protection is traditionally done by moving with a spray lance between the rows of pot plants and treating each individual plant from bottom to top. Good penetration is clearly an important advantage of this spray technique but it is very time-consuming, unhealthy and laborious. Some other growers use a ‘spray platform’ on a high-clearance tractor. Plants sprayed from this platform are exclusively approached from above resulting in an inferior spray deposition on the lower parts of the plants. To overcome the disadvantages of both available techniques, the potential of an automated tunnel sprayer was investigated.

Five different nozzle types were evaluated under laboratory conditions i.e. hollow cone, standard flat fan, air inclusion flat fan, deflector flat fan and twin air inclusion flat fan at spray pressures varying from 3.0 to 7.0 bar depending on the type of nozzle. For each nozzle type, three nozzle sizes were included in the experiments which resulted in 15 different spray application techniques. All experiments were done at a speed of 2.5 km.h⁻¹. This resulted in three different application volumes: 2450, 4900 and 7300 l.ha⁻¹.

After optimizing the nozzle configuration (distance and orientation) using water-sensitive paper, deposition tests with five different mineral chelates as tracer elements were performed. Filter papers were used as collectors at 20 different positions to measure spray deposition, distribution and penetration in the canopy. For each application technique, four plants were selected as repetitions. Irrespective of the nozzle type and spray pressure, 4900 l.ha⁻¹ was found to be the optimal spray volume with deposition rates varying from about 50 to 70% depending on the nozzle type. The best results were found for the hollow cone, the standard flat fan and the air inclusion flat fan nozzles. Nozzle type and pressure and the corresponding droplet characteristics were closely related with the penetration and deposition results. With this automated tunnel system, it is possible to obtain a good spray result in combination with an increase in the productivity and a reduction in operator exposure.

**Key words:** horticulture, ornamentals, spray application, spray nozzle, vertical spray boom, crop protection, bay laurel, droplet characteristics.

INTRODUCTION

Bay laurel is an evergreen, commercially grown and expensive ornamental pot plant, which is susceptible to different pests like aphids, scale and lerp
insects, thrips, caterpillars of codling moth and sooty molds. Recently, caterpillars of the Mediterranean carnation leafroller (*Cacoecimorpha pronubana*) cause more and more problems. These pests can lead to important financial losses for the growers.

During summer the individual pot plants are placed on a field-container in a fairly dense configuration. Since it takes years to grow a pyramid or sphere out of a cutting, bay laurel is a reasonable expensive ornamental plant. Bay laurel pot plants typically have a height of 1.5 m and a width of 0.4 m and are placed in rows. The distance between the rows is 0.6 m or even less. Crop protection is traditionally done by moving with a spray lance between the rows of pot plants and treating each individual plant from bottom to top. Good penetration is an important advantage of this technique but it is very time-consuming, unhealthy and laborious. Some other growers use a ‘spray platform’ on a high-clearance tractor. Plants sprayed from this platform are exclusively approached from above resulting in an inferior spray.

To overcome all these problems, tests were done to optimize the spray application technique in this crop type using vertical spray booms. Previous studies already demonstrated that the use of vertical spray booms improve spray distribution (Nuyttens *et al.*, 2004a) and reduce labour costs and operator exposure (Nuyttens *et al.*, 2004b & 2009). These tests were performed within the framework of a research project about the optimization of spray application techniques in ornamental growing (*Braekman et al.*, 2008 & 2009).

**MATERIALS AND METHODS**

A self-propelled tunnel sprayer was constructed out of an aluminium frame and was equipped with 2 vertical spray booms. Five different nozzle types were evaluated under laboratory conditions i.e. hollow cone, standard flat fan, air inclusion flat fan, deflector flat fan and twin air inclusion flat fan at spray pressures varying from 3.0 to 7.0 bar depending on the type of nozzle. Preliminary tests with water sensitive paper were used to optimize the nozzle configuration (number of nozzles, nozzle distance, spray distance) to achieve the best possible spray distribution. Each vertical spray boom was equipped with five spray nozzles with nozzle distances varying from 12.5 cm to 37.5 cm as presented in Figure 1. Distance between spray boom and stem of the plants was 0.30 m.

For each nozzle type, three nozzle sizes were included in the experiments which resulted in 15 different spray application techniques (Table 1). All experiments were done at a speed of 2.45 km.h$^{-1}$. This resulted in three different application volumes: 2450, 4900 and 7300 l.ha$^{-1}$.

Deposition tests were performed with five different mineral chelates (Cu, Zn, Mn, Fe, Co; 1 g litre$^{-1}$) as tracer elements. Schleicher & Schuell filter papers (2589 D) were used as collectors at 20 different positions in the crop to measure spray deposition, distribution and penetration in the canopy as presented in Figure 1. These collectors were equally distributed among the two crop zones and the leaves (underside and top side) and stem.
For each application technique, four plants were selected as repetitions. The individual bay laurel plants were arranged in a row with a spacing of 0.55 m (stem to stem).

**Table 1. Overview of the tested spray application techniques**

<table>
<thead>
<tr>
<th>Nozzle Type</th>
<th>ISO nozzle size</th>
<th>Spray angle (°)</th>
<th>Pressure (bar)</th>
<th>Flow rate (l min⁻¹)</th>
<th>Spray volume (l ha⁻¹)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hollow cone (TeeJet TXB)</td>
<td>01</td>
<td>7.5</td>
<td>0.6</td>
<td>2.450</td>
<td></td>
</tr>
<tr>
<td></td>
<td>02</td>
<td>7.1</td>
<td>1.19</td>
<td>4.860</td>
<td></td>
</tr>
<tr>
<td></td>
<td>03</td>
<td>6.9</td>
<td>1.79</td>
<td>7.310</td>
<td></td>
</tr>
<tr>
<td>Standard Flat fan (TeeJet XR)</td>
<td>015</td>
<td>3.1</td>
<td>0.6</td>
<td>2.450</td>
<td></td>
</tr>
<tr>
<td></td>
<td>03</td>
<td>3.1</td>
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<td>4.860</td>
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<td>04</td>
<td>3.9</td>
<td>1.79</td>
<td>7.310</td>
<td></td>
</tr>
<tr>
<td>Deflector flat fan (Turbo TeeJet TT)</td>
<td>015</td>
<td>3.1</td>
<td>0.6</td>
<td>2.450</td>
<td></td>
</tr>
<tr>
<td></td>
<td>03</td>
<td>3.1</td>
<td>1.19</td>
<td>4.860</td>
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</tr>
<tr>
<td></td>
<td>04</td>
<td>3.9</td>
<td>1.79</td>
<td>7.310</td>
<td></td>
</tr>
<tr>
<td>Air inclusion twin flat fan (Albuz AVI-Twin)</td>
<td>01</td>
<td>6.8</td>
<td>0.6</td>
<td>2.450</td>
<td></td>
</tr>
<tr>
<td></td>
<td>02</td>
<td>6.7</td>
<td>1.19</td>
<td>4.860</td>
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</tr>
<tr>
<td></td>
<td>03</td>
<td>6.7</td>
<td>1.79</td>
<td>7.310</td>
<td></td>
</tr>
<tr>
<td>Air inclusion flat fan (Lechler ID)</td>
<td>01</td>
<td>7</td>
<td>0.6</td>
<td>2.450</td>
<td></td>
</tr>
<tr>
<td></td>
<td>02</td>
<td>6.7</td>
<td>1.19</td>
<td>4.860</td>
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<td></td>
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<td>6.8</td>
<td>1.79</td>
<td>7.310</td>
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</tbody>
</table>

* all sprayings at 2.45 km h⁻¹ with a row distance of 0.60 m

**Figure 1.** Set-up of the vertical spray boom and the collectors
RESULTS AND DISCUSSION

Figure 2 presents the total amount of spray deposit (expressed as µg of tracer deposit per cm²) on the plants for the three spray volumes. Doubling the spray volume from 2450 l.ha⁻¹ up to 4900 l.ha⁻¹ increases the amount of spray deposit with a factor of three. Further increase of spray volume up to 7300 l.ha⁻¹ does not increase spray deposition significantly which indicates a loss of pesticide caused by runoff. Hence, from the three tested spray volumes and irrespective of the nozzle type, 4900 l.ha⁻¹ gave the best deposition results.

Figure 2. Effect of spray volume on the total amount of spray deposit

In figure 3, the effect of spray volume and nozzle type on the total deposition rate is presented in more detail. Deposition is expressed as a percentage of the maximum feasible deposition, assuming a perfectly uniform distribution.
of the spray liquid on the contours of the crop canopy. For all nozzle types, highest deposition rates were found for a spray volume of 4900 l.ha\(^{-1}\) although important differences between the different nozzle types can be observed. For the spray volume of 4900 l.ha\(^{-1}\), best results were found for the standard flat fan, the air inclusion and the hollow cone nozzle. In general, these nozzles also performed well for the lowest and the highest spray volume except for the standard flat fan nozzle at the low spray volume and the air inclusion nozzle at the high spray volume. In the first case, pesticide loss might be caused by evaporation because of the fine spray cloud. In the last case, runoff of the big droplets probably causes the lower deposition of the air inclusion nozzle at the high spray volume. The effect of spray volume and nozzle type is most pronounced for crop zone I.

Looking into detail to the different crop zones, Figure 4 presents deposition rates on the stem in crop zone I. These results indicate that the penetration capacity of a spray cloud is related with droplet size as well as with spray direction. For example for the standard flat fan nozzles, there is a factor of two of difference between the small and the medium nozzle size which can be attributed to the droplet size effect. The small standard flat fan nozzle with its small spray droplets (Nuyttens et al., 2007) clearly has a lower penetration capacity. Besides the droplet size effect on penetration capacity, there is also an effect of spray direction illustrated by the twin air inclusion nozzle. Of all nozzles, this nozzle type clearly has the lowest penetration capacity although its droplet sizes are medium to coarse. This can be explained by the different spray direction of this nozzle type relative to the crop compared with other nozzles.

Figure 4. Effect of spray volume and nozzle type on penetration capacity

The direction of movement and the spray direction also have their effect on the difference between the deposition on the front side and the back side of the plant. Spray deposition on the front side is higher than the back side for all nozzle types because of the effect of the direction of movement. This effect
is most pronounced for the deflector flat fan nozzle because of its forward spray direction. Because some pests are mainly situated at the underside of the leaves, the ratio between topside and underside of the leaves was also considered. Biggest differences between top and underside were found for the lowest spray volume and the best deposition on the underside of the leaves was found for the air inclusion nozzle at 4900 l.ha$^{-1}$ with a ratio of nearly 1.

**CONCLUSIONS**

The use of an automated tunnel sprayer equipped with vertical spray booms is a valuable alternative for the traditional spray lance in crops like bay laurel, offering different advantages like a decrease in operator exposure and labor intensity and a more uniform spray distribution. From the three tested spray volumes, 4900 l.ha$^{-1}$ was the optimum. Besides the effect of spray volume, an important effect of nozzle type and spray deposition and distribution was observed. Differences in droplet characteristics and direction had their effect on crop penetration, the ratio between top and underside of the leaves and the difference between front and back of the plant.

In future, it would be interesting to verify our findings in other crops, to link the results with biological efficacy and to evaluate the effect of air assistance.

**ACKNOWLEDGEMENTS**

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**LITERATURE**


