

Improvements of spray applications in greenhouses using hand-held trolleys with air assistance

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Introduction

Hand-held spray guns and lances are the most widely used methods of crop protection in greenhouses despite the heavy workload and high risk of operator exposure associated with these techniques (Foqué 2012). These spray application techniques have also proved to be less effective than spray boom equipment under many conditions while the advantages of using vertical boom sprayers compared with using hand-held sprayers or lances have been widely reported in terms of coverage and uniformity of spray distribution (Sánchez-Hermosilla, 2012). However, problems with penetration capacity have been described with vertical boom sprayers without air-assistance (Derksen 2001). The purpose of this research was to improve spray application techniques in greenhouses considering the spray quality on canopy by using hand-held trolley with vertical boom including an air assistance system.

Material and Methods

Two trials in different greenhouses with similar characteristics (LAI and plant layout) were carried out in comparable field conditions but with a hand-held trolley prototype with several improvements and variations. Experiment 1 compared the spray deposition of the hand-held trolley prototype with and without an air assistance system, while experiment 2 studied the spray deposition of the sprayer prototype using two different air flow rates.

Experiment 1 was carried out in a commercial tomato greenhouse in El Ejido (Almería, South Spain). Canopy characteristics were: LAI: 5.96 and TRV: 10868 m³·ha⁻¹. The sprayer had two vertical spray booms with flat fan nozzles spaced 0.3 m working at a 5.2 bar pressure, and was tested with and without air assistance. The air delivery system consisted of an air output for each spray nozzle with an average air velocity of 14 m·s⁻¹. The volume application rate was 1000 L·ha⁻¹ (according farmer experience) at a forward speed of 3 km·h⁻¹. In the mixture sprayed a tracer (Helios SC 500, Syngenta Crop Protection AG, Basel, Switzerland) was used at a concentration of 0.1% v/v. Twelve samples of 5 leaves each were randomly collected along the sprayed row from three heights and from the external and internal side of the canopy along the row. Values of deposition were expressed in ng·cm⁻² of leaf.

Experiment 2 was carried out in a commercial tomato greenhouse in Viladecans (Barcelona, North East Spain). Canopy characteristics were: LAI of 5.46 and TRV 10468 m³·ha⁻¹. In this case, the sprayer had two vertical booms with flat fan nozzles spaced 0.35m working at a pressure of 2 bar. A similar air assistance system to the first experiment was fitted up with the possibility to change the air blower unit: blower A consists of a motor engine turbine that generates 20 m·s⁻¹ air speed; and blower B was an electric engine turbine that generates 14 m·s⁻¹. An intended volume application rate of 800 L·ha⁻¹ was set-up at a forward speed of 3.5 km·h⁻¹. Tartrazine (E-102) was used as tracer at a concentration of 15 g·L⁻¹. To assess the spray distribution, artificial collectors (filter paper) were placed at three heights and two sides of canopy (internal and external) in nine replicates along the canopy row. Results were also expressed in µL·cm⁻².

Data from both experiments were normalized by tracer tank concentration and volume application rate.

Results and discussion

The results of Experiment 1 shows a significant increase of global spray deposition when air assistance is included (Figure1, left). Moreover, deposition of the internal part of the canopy was higher with air assistance(1.14 and 2.19 ng·cm⁻²with no air and air, respectively). In Experiment 2, blower B (14 m·s⁻¹) gave both the highest deposition on the canopy(Figure 1, right) and also the highest canopy penetration (0.09 and 0.11 µg·cm⁻²for blower A and blower B, respectively).

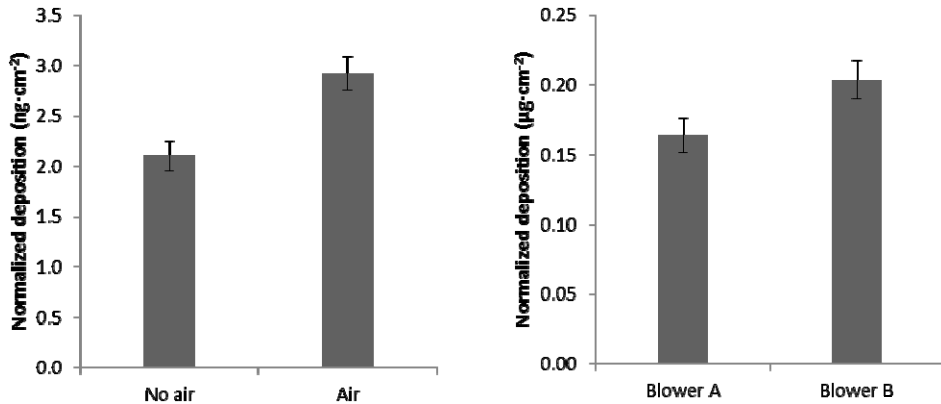


Figure1. Experiment 1: average spray deposition on leaves (left); Experiment 2: average spray deposition on filter paper (right).

Conclusions

The use of air assistance increased the deposition on the canopy and further improved penetration inside the crop. Comparing different air speed settings, there was no advantage increasing the air speed above 14 m·s⁻¹.

Acknowledgments

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