Evaluation and optimization of spray application in apple and pear trees

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Introduction

The application process of plant protection products has not changed significantly over the last decades. Applications are affected by the different types of orchard sprayers, training systems and ambient conditions. The goal of the project was to optimize the deposition of plant protection products at the trees and to reduce the losses caused by drift. An optimized deposition might improve the biological efficiency.

Method

We performed deposition and drift measurements to optimize the orchard spraying process and achieve better distribution and a reduction of spray drift. We considered different types of training systems of apple and pear, sprayer types, fan speed settings and nozzles. A standard axial sprayer, a cross-flow sprayer and a sprayer with individual spouts were compared. The project was supported by the development of a computational fluid dynamics model (CFD) (1). As input for the model tree structure and dimensions were scanned. By indoor measurements we observed nozzle and sprayer characteristics as droplet size, liquid flow rate, outlet air flow patterns and liquid distribution. Indoor drift and deposition tests on artificial trees were used to optimize the model, after which it was validated by drift and deposition measurements in the orchard.

Results

We measured a strong relationship between the air flow rate of the sprayer and the deposition in the trees. The sprayer with individual spouts had a low air flow rate, which resulted in a high deposition on the target. The axial and cross-flow sprayers, producing a higher air flow rate resulted in less deposition. For the ground deposition behind the trees, a similar effect was noticed.

For drift we found a strong relationship with the air flow rate of the machine. We observed this for the different sprayers and for different settings of the fan speed. The axial sprayer resulted in a higher drift than the cross-flow sprayer. Extended trials with the cross flow sprayer (figure 1 and 2) demonstrated the positive effect of drift reducing nozzles. A lower fan speed setting had a similar effect. Only replacing the three upper nozzles by drift reducing nozzles had a smaller effect towards drift compared to the test with the standard nozzles. The drift reducing nozzles had a similar deposition on the trees as the standard nozzles (figure 3 and table 1). Spraying the trees from both sides remains necessary with both types of nozzles. Based on the results obtained from the trials we were able to provide guidelines to the growers regarding the use of their sprayer and differences in sprayer types.

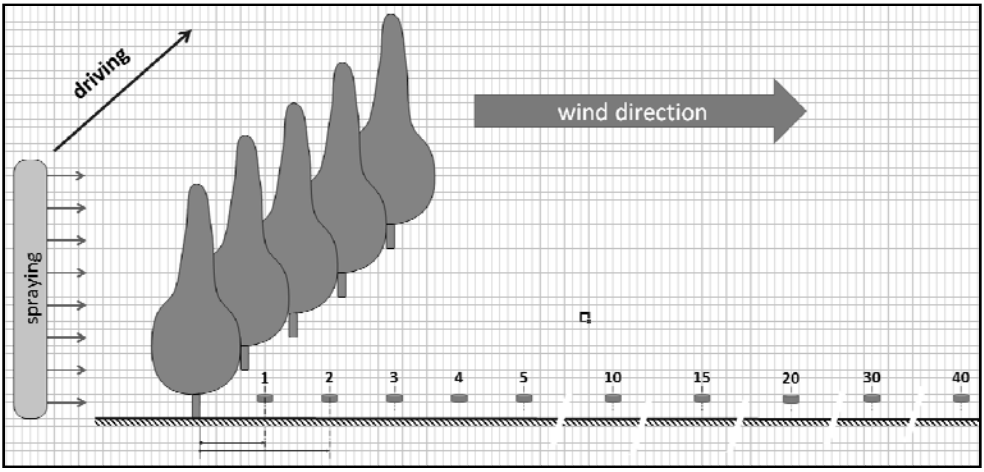

Figure 1. Drift trials were performed by spraying in the direction of the last row. Tracers were placed in open field at various distances behind the last row.

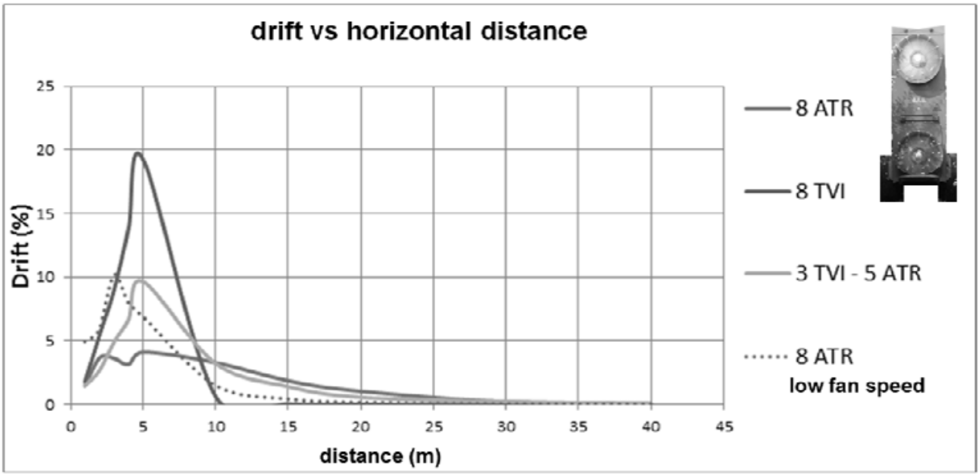

Figure 2. Drift deposition as a percentage of the used water volume in the orchard after application with the cross flow sprayer. Different nozzle types and fan speed were performed.

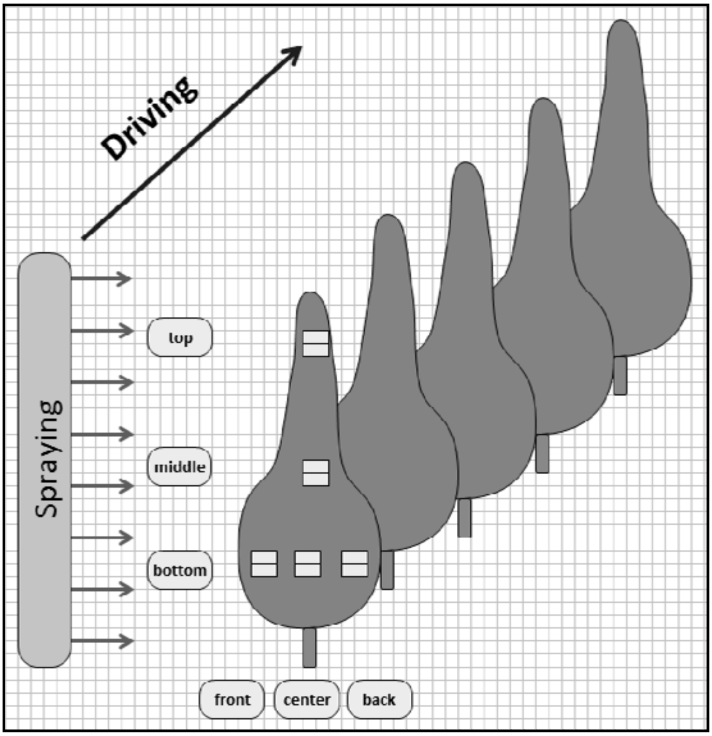

Figure 3. Deposition trials were performed by spraying in one direction. Tracers were placed on the upper and lower side of the leafs at each position.

Tabel 1. Deposition values after application with the cross flow sprayers with different nozzle types and fan speed.

Deposition in µl/cm²		8 ATR			8 TVI			8 ATR low fan speed		
location in tree	side of leaf	front	center	back	front	center	back	front	center	back
top	upper		0,036			0,076			0,116	
	lower		0,504			0,585			0,703	
middle	upper		0,543			0,711			0,570	
	lower		0,463			0,635			0,543	
bottom	upper	0,248	0,130	0,114	0,399	0,129	0,042	0,449	0,209	0,077
	lower	0,426	0,153	0,133	0,485	0,191	0,094	0,435	0,176	0,085

References

A. T. Duga, D. Dekeyser, K. Ruysen, D. Bylemans, D. Nuyttens, B. Nicolai, P. Verboven (2015). CFD analysis of the effects of wind and sprayer type on spray distribution in different orchard training systems. Boundary Layer Meteorology (Submitted)