Testing the influence of the air flow rate on spray deposit, coverage and losses to the ground in a super-intensive olive orchard in southern Spain

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Introduction

Olive tree is a key crop in the whole Mediterranean basin, and especially in Spain, where its economic and social importance rises as it is the main World producer. Nevertheless, pesticide application still exhibits an important lack of knowledge about the optimal parameters setup in commercial air blast sprayers. Even though the European Directive for the sustainable use of pesticides (Directive 128/2009, EP) refers to dose adjustment, low attention is paid to other key factors involved in the application quality as the Air Flow Rate (AFR).

Due to the high canopy volume and tree spacing existing in traditional olive tree crops (Miranda-Fuentes et al., 2015), most farmers tend to use a very high AFR, assuming the pesticide penetration of the canopy to be higher. This assumption induces the use of high power tractors and increases of pollution. Therefore, a trial was set up to determine the optimal AFR to be applied to obtain the optimal spray deposit on leaves, homogeneity and coverage.

Materials and methods

Three AFRs of 11.93, 8.90 and 6.15 $m^3 s^{-1}$ were tested in a field trial performed with a commercial air blast sprayer with axial fan (model 2200 l, Osuna Sevillano, Jauja, Spain) and hollow cone nozzles Albuz ATR Series (Albuz, Saint-Gobain Ceramiques Avancees Desmarquest, Evreux, France) in a super-intensive olive tree crop in a commercial field in Pedro Abad, Córdoba, Spain. Other application parameters are listed in table 1.

Table 1. Work parameters of the trial

Parameter	High Flow (HF)	Medium Flow (MF)	Low Flow (LF)
Nozzle type and colour	Albuz ATR Orange	Albuz ATR Orange	Albuz ATR Orange
Number of open nozzles	14 (2 x 7)	14 (2 x 7)	14 (2 x 7)
Pressure (bar)	15.0	15.0	15.0
Liquid flow rate ($l \cdot min^{-1}$)	24.01	23.11	24.71
Spray volume ($l \cdot ha^{-1}$)	768.2	744.2	778.2
Forward speed ($km \cdot h^{-1}$)	4.90	4.98	5.03
VMD* (µm)	136	136	136
PTO speed (rpm)	458.6	420.4	280.0
Air volumetric flow rate ($m^3 \cdot s^{-1}$)	11.93	8.90	6.15
Fan gear	2	1	1

Before the treatments, basic characteristics of the trees were measured. Food dye E-102 (tartrazine) was used as spray tracer to measure the normalized deposition inside the canopy and losses to the ground, and Water Sensitive Papers (WSP) were clipped to the leaves to determine the coverage and the number of impacts per area unit. Nine sampling zones were established inside the tree canopy, dividing it into three heights and three depths, and four sampling zones were established on the ground (fig.1).50 leaves and two WSPs, were collected from each sampling zone in the canopy, and an absorbent paper sheet of 260 x 210 mm from each sampling zone on the ground.

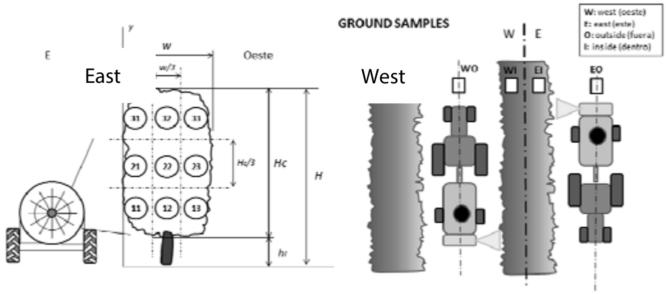

Figure 1. Sampling distribution in the canopy (left) and on the ground (right).

Results and discussion

Results show that AFR has significant effect on the mean spray normalized deposit, corresponding the highest deposit (13.0 µg cm^{-2}) to the Medium Flow (MF) treatment. The lowest mean deposit (10.5µg cm^{-2}) was found in the High Flow (HF) treatment, and the Low Flow (LF) produced the intermediate mean deposit (11.1µg cm^{-2}).About the percentage penetration of the spray, calculated as the inner zones' mean deposit divided by the mean of the outer zones' mean deposit, the HF treatment gave the lowest penetration percentage (79.1 %) while the highest penetration was obtained with the MF treatment (91.4 %). LF gave the intermediate value (82.2 %).In terms of homogeneity of distribution of the applied spray, measured by the CV (%)of deposition values in the whole canopy, the three tested AFRs gave similar results: the HF gave the lowest homogeneity (CV = 37.0 %) in opposition to LF, which gave the highest homogeneity (CV = 32.2 %). The LSD All-Pairwise Comparisons Test ($\alpha = 0.05$) showed no significant differences between treatments for homogeneity.

Losses to the ground did not vary significantly with the AFR, with deposits of 3.58, 3.44 and 4.21 µg cm^{-2} for the HF, MF and LF, respectively. Nevertheless, the highest losses to the center of the track were found to be produced, significantly, with the HF treatments (4.41 µg cm^{-2}), while the lowest were produced by the LF treatment (2.54 µg cm^{-2}). The opposite case is found under the trees, where the LF presents the highest deposits (5.89 µg cm^{-2}) and the HF the lowest (2.74 µg cm^{2}).

The mean percentage coverage of the upper side of the leaves, with 77.4%, 66.5% and 58.9% for the HF, MF and LF treatments respectively, did not present significant differences for the tested AFRs, but the underside did. The highest coverage was achieved with the HF (71.0 %), whilst the lowest (37.2 %) corresponded to the LF treatment. The MF produced mean underside coverage of 57.4 %. Nevertheless, the number of impacts did not present significant differences in any case.

Conclusions:

The tested AFRs produced differences in deposits and their distribution. The medium air flow rate of 8.90 m^{3} s^{-1} seems to be the most balanced regarding the high deposits, the best penetration and the medium losses to the ground and coverage quality parameters. Special attention should be paid to the upper parts of the canopy, where deposits are much lower and located application could be an interesting choice for future sprayer designs. The trial results are against the popular beliefs of the Spanish farmers in the sense that highest AFRs are not the best at penetration and mean deposits, and generate excessive leaf coverage.

Bibliography

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