Remote sensing of pesticide spray drift: a tool for estimating and reducing air pollution from agriculture

O. Kira*, R. Linker and Y. Dubowski

Faculty of Civil and Environmental Engineering, Technion-Israel Institute of Technology, Technion City, Haifa 3200003, Israel.
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Presenting author email: ozkira@campus.technion.ac.il

The use of pesticides is important to ensure food security around the world. Unfortunately, acute and chronic exposures to pesticides may result in adverse effects on human health. Exposure to pesticide can be via digestion, contact with contaminated surface, or inhalation of airborne pesticide drift from field. The present work focused on measurement of pesticide drift.

Measurement of aerosolized pesticide drift in real time is very challenging. The active ingredient is diluted with water up to a concentration of ~0.1%v. The sprayed solution is exposed to constantly changing meteorological conditions which may alter its properties (e.g., size distribution of spray droplets). Additionally, the active ingredient can evaporate and partition between condense and gas phases. These facts, together with the large variety of pesticides commonly used, make it extremely difficult to monitor airborne pesticide drift in real time in the field.

This study examines detection, quantification, and identification of pesticide spray drift using ground based remote sensing. The spectral measurements were done using Open Path Fourier Transfer Infra-Red (OP-FTIR) spectroscopy. Many materials have a distinctive spectral signature in the OP-FTIR measuring range (500-5000cm^{-1}), which makes this technique ideal for detecting and identifying pesticides drift.

The experiments were conducted in a research farm with several types of orchards and sprayers. The experiments were divided into two main setups: (1) Measurements at a height of 1.5 meters at the edge of an orchard to establish OP-FTIR capabilities for drift-cloud quantification and identification of the active ingredient in it. (2) Measurements at different heights in order to study the vertical profile of the drift. Water sensitive papers were placed along the line of sight (LOS) of the device to measure the droplets size distribution, which was required in order to estimate the water load.

Results

The first experimental setup demonstrated the detection of two fungicides (Impulse and Bogiron) by OP-FTIR during spraying operation in fallow field, young and mature apple orchards (figure 1). Additionally, water load in LOS during each spraying event was quantified, which allowed estimation of the drift magnitude.

During the second experimental stage, the OP-FTIR was used to detect and quantify spray drift generated by three different sprayers at various heights (3, 4, 5, and 6m). The obtained vertical profile provided new insight about the pattern generated by each sprayer, helping to better compare the environmental footprint of these sprayers (figure 2).

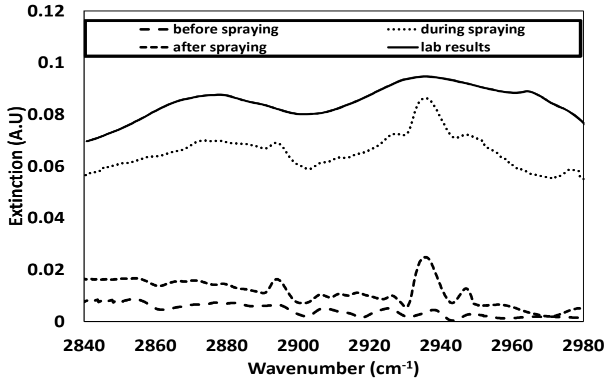

Figure 1: OP-FTIR measurements in the mature orchard before, during and after Impulse application. Laboratory measured Impulse spectrum is shown for comparison.

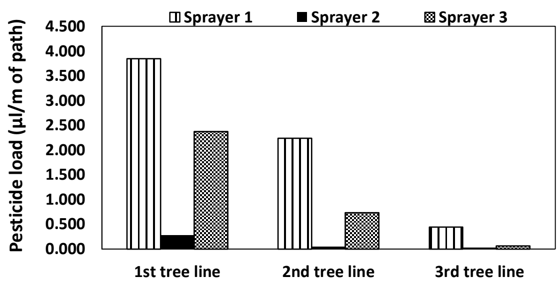

Figure 2: Estimated pesticide load in the LOS along the entire height of the measurement. Pesticide concentration in the applied solution: Sprayer 1=~0.1%v, Sprayer 2=~0.1%v, and Sprayer 3=~1.0%v.

Conclusion

This work demonstrates the potential of OP-FTIR for detecting and quantifying drift of airborne pesticides in real time. The OP-FTIR can thus be a useful tool for assessing pesticide exposure and spraying efficiency.

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