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Comparison of vertical and horizontal collecting methods for spray deposits in crop canopy and airborne spray drift assessment

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Introduction

The extent of the application of plant protection products (PPP) on various fruit crops showed that in some cases up to over 50% of the PPP does not reach the target (Salyani et al., 2007). Due to side wind, a fraction of the product can be found downwind on a spray drift area but simultaneous measurements on the target crop and on the spray drift area indicates that a fraction remains undetected (Douzals, 2012). In the particular case of high crops, like banana, the difference in height between the drift collection plane and the canopy questioned of an evaluation based only on ground deposition of spray drift is relevant. In practice, a downwind area of more than 100 m limits spray drift measurements especially when the wind direction may displace the spray plume outside the collecting area. A complementary method is then specified by ISO 22866 standard through the use of a vertical array of collectors close to the crop boundary for the assessment of airborne drift flux. The present work aims first at evaluating the collection efficiency of two vertical array of collectors with PVC strings of 2 mm diameter placed close or far from the sprayed area. Second a horizontal array of collector device is implemented to measure ground deposits between the two vertical collectors devices. On the horizontal one, PVC strings collection efficiency is compared to Petri dishes and PVC stripes which represent respectively discrete and integrative collectors. PVC strings are placed at different distances from the spray release point. The collection efficiency is studied indoor. Measurements are made for both aqueous and mineral oil-based mixtures (Banole®). Finally the implementation of the complete spray drift measurement protocol for a banana field is presented.

Materials and Methods

Indoor measurements

An original mistblower was specifically developed for ground-based banana crop spraying (Cotteux et al., 2011). Either water or Banole® added with the fluorescent tracers *BSF or CFS 00-6* were respectively applied on experimental vertical and horizontal patternator devices (Table 1. Figure 1a&b). Spray direction is horizontal with a release height of 1 m. The spraying device is composed of two nozzles specifically placed so as to obtain the most homogeneous footprint in terms of application volume along the spray range. Sprayer flow rate, operating pressure, air

temperature and relative humidity are recorded every second. The tractor speed is 4.5 km/h travelling over a distance of 11 m for indoor experiment

Table 1. Characteristics of array collector device

Devices	Collector	Distances	
		Horizontal from sprayer	Vertical from ground
Horizontal	Petri dishes Ø 8.6 cm	Every 0.5m up to 10 m then every 1m up to 15 m	0.25 m
	PVC stripes 5x50 cm	Every 0.5m up to 5 m	0.25 m
	PVC strings Ø2 mm / 4 m length	Every 0.5m up to 5 m	0.25 m
Closest Vertical 1	PVC strings Ø2 mm / 50 cm length	Different positions up to 10 m	every 20 cm from 0,5 m up to 2,5 m
Farthest Vertical 2	PVC strings Ø2 mm / 4 m length	15 m	every m from 1 m up to 8 m

Outdoor measurements

For crop experiment tractor speed is around 4 km/h over a distance of 80 m (Figure 2 a&b). The crop area treated corresponds to about 0.5 ha (80 x 60 m). Only Banole is sprayed for crop experiment. The air speed generated by the mist blower is about 55 m.s^{-1} at the spout outlet.

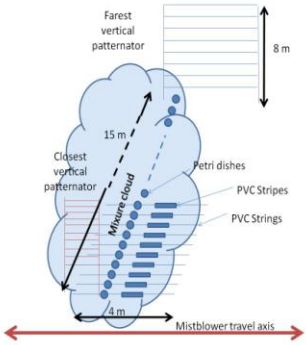

Figure 1a: Experimental patternator devices (indoor)

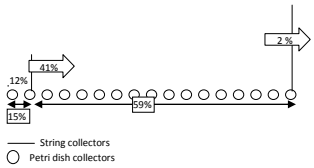

Figure 1b : Results for % of collected product on different array of collector for water test (indoor test)

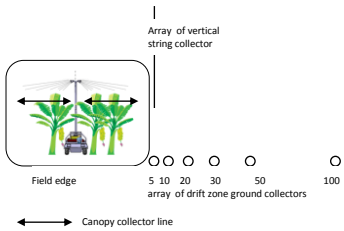

Figure 2a: Experimental patternator devices (banana crop)

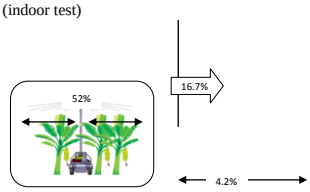

Figure 2b : Results for % of collected product on different array of collectors for banole test on banana crop

Laboratory analysis

Collectors are washed with water for aqueous mixture or dearomatized oil for Banole® respectively. BSF and CFS 006 concentration was quantified by fluorimetry. Recovery efficiency corresponds to the ratio between the total collected volume compared to the sprayed volume normalized for 1 m of travel.

Results

For indoor experiments, when water is sprayed, only 74 % of sprayed volume was recovered on the 15 m horizontal collectors device; 12% were collected on the first 1.5 m with string collectors and 15% on Petri dishes. Recovery rate appears quite similar for both Petri dishes and strings on horizontal array of sampling collectors along the 5 first meters from spraying point (respectively 48% and 45%). Meanwhile vertical collectors placed at 1.5 m from spraying points collected only 41% of products compared to 62% expected (74-12=62). At maximum distance, only 2% of sprayed volume is recovered on vertical patternator located at 15 m from sprayer with water solution compared to 26% sprayed volume which is missing. When Banole® is sprayed, much product is collected on the farthest vertical array of collector (6%) and less product is collected on ground collectors (50%). Those results confirm also that Banole® tends to be more sensitive to air assistance than water (Douzals et al., 2010). Based on these preliminary results an experimental setup has been tested in banana crop in the objective of a mass balance assessment with a combination of collectors. The first results indicate that much product is collected on a 12 m height vertical array of string collectors placed at 5 m downwind of a crop than product collected on ground collector placed on the downwind drift zone.

For experiment on banana crop, a complete mass balance has not been achieved. But it was shown that the vertical array collectors device allow a better quantification of airborne drift compared to ground measurement device.

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