

Measuring the canopy development of fruit trees for direct spray volume adjustment

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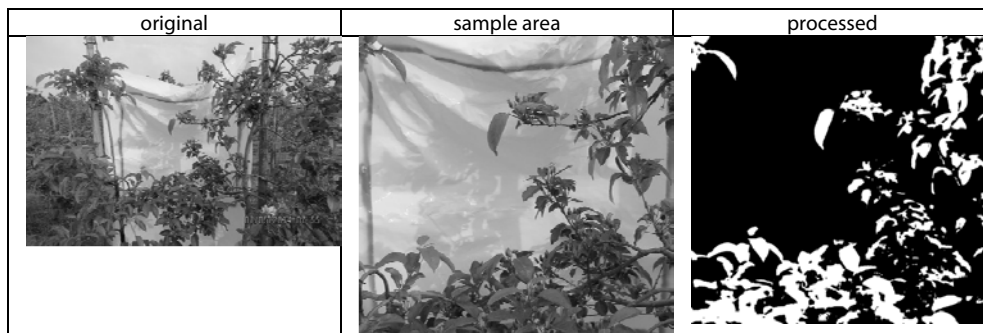
Introduction

In crop spraying the goal is to achieve a uniform spray deposition all over the crop canopy structure or soil surface. Losses to the soil underneath the crop and outside the orchard or field, through spray drift are to be minimised. It is known that sprayer settings are important for spray distribution in tree and crop canopy. Matching spray volume and direction to orchard tree sizes and shapes can reduce chemical application, thus reducing operational costs and environmental pollution. In order to build tailor made decision algorithm to adjust the spray volume based on tree row volume (TRV) more information is needed on the actual situation in the orchard to verify sensor obtained information. The effect of gaps in the crop foliage, differences in amount of foliage in tree canopy segments or between varieties and pruning systems is to be verified before dose algorithms for Variable Rate Application (VRA) or Canopy Density Spraying (CDS) can be developed. Canopy structure information of different sources is compared to evaluate the settings of a CDS orchard sprayer to optimise spray distribution in tree canopy.

Material and methods

We measured the development of the tree canopy on two ways. First we took photographs of the trees and measured the with leaves covered area by image processing using ImageJ (figure1).

figure 1: example of image processing leaf area



The same rows were sprayed with the CDS-sprayer with alaser scanner (Hokuyo URG-04LX-UG01 LIDAR) measuring the size and density of the tree canopy at five heights. This sprayer has a variable dosing system based on Lechler VarioSelect nozzle bodies containing pneumatically switchable sets of two standard hollow cone nozzles (Albuz ATR white, ATR lilac) and two spray drift reducing venturi hollow cone nozzles (TVI80-0050, TVI80-0075). The KWH-CDS sprayer can at three height levels in the tree adapt spray volume in four steps to the leaf development of the fruit crop.

The data of the laser measurements and the applied amounts were sampled during the spray application. The laser data was evaluated on the measured canopy and compared with the image analysis.

The characterisation of the orchards as Tree Row Volume (TRV) and the advised spray volume (L/ha) based on extension service advices from the Netherlands (vol 1) and Belgium (vol 2) are given in Table 1 following the used two calculation methods:

vol 1 = (TRV x 0.0125) + 125; vol 2 = 25 x TRV/1000.

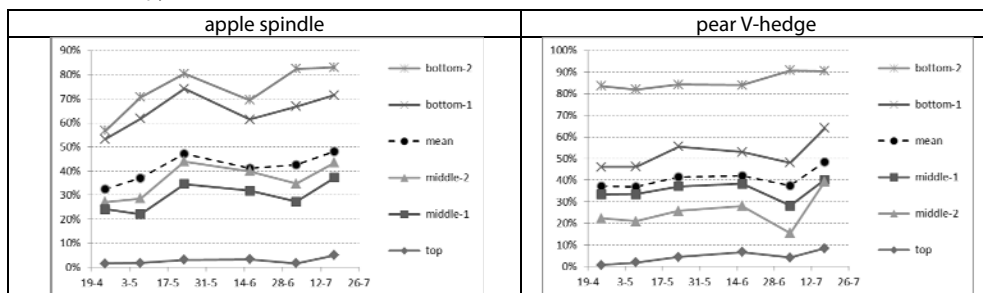
Table 1. Orchard dimensions and Tree Row Volume (TRV) measured (July) and calculated spray volume accordingly (two methods)

		row width [m]	height [m]	width [m]	TRV	vol 1 [L/ha]	vol 2 [L/ha]
Apple – spindle	Wellant 2010	3	2.1	1.2	8213	228	205
Pear	Conference	3.25	2.0	1.4	8578	232	214
V-hedge	Doyenné	3.25	2.3	1.3	9329	242	233

Results

From April till July there is a small increase of amount of leaf, but it is not a complete tight wall of leaves. The apple in full leaf stage had a coverage of 30%. The Doyenné pear had also a coverage of 30% at full leaf stage, the Conference pear was the most dense of the trees but with 65% it also didn't reach a full coverage.

Figure 2: leaf coverage of apple and pear tree canopy calculated from CDS laser data at five heights in the tree canopy



In apple: the average leaf density increased from 30% to 50% over the period April - July, in the bottom part the leaf density reaches 80%, in the top it is less than 10%.

In pear: the average leaf density increased from 35% to 50%, in the bottom part of the trees the leaf density reached 90% in July, in the top it was less than 10%.

On all dates the standard spray volume was 200 L/ha. This dose was based on the tree growth stadium with full canopy, which was reached only in June and then only in the bottom parts of the trees.