Measuring canopy density in orchards and vineyards

A LANDERS, T PALLEJA\(^2\) and J LLORENS\(^3\)

NYSAES, Cornell University, Geneva, NY 14456, USA

\(^2\)Department of Computer Science and Industrial Engineering, University of Lleida, Jaume II, 69, 25001 Lleida, Spain

\(^3\)Department of Agricultural and Forest Engineering, Research Group in AgroICT and Precision Agriculture, University of Lleida – Agrotecnio Center, Rovira Roure, 191, 25198 Lleida, Spain
Modern versus traditional planting systems

CROP: Tree density/row spacing/narrow canopy/plenty of rows

SPRAYER: 1960’s technology/excess air volume & speed, no direction, no finesse
The objective of this work is to validate a method of measuring canopy density.
Precision fruit spraying

Andrew Landers and Tomas Palleja
Cornell University
2014 Results

Apple tree

Vineyard

The signal grew throughout the season, but it was not compared with real density.

Ultra sonic canopy density sensor

Point Quadrat Analysis (PQA)

Introducing a probe to count the number of leaf layers

- The frames have 4 horizontal bars, matching the ultrasonic sensors’ height.
- Each horizontal bar has 6 marks spaced 10 cm apart

0.5x2 m
2015 & 2016 Experiments and Results

1. Analysis of two vineyards and one apple orchard.
   1. Vignoles: 70m, 36 vines.
   2. Cabernet Franc: 63m, 30 vines
   3. Macoun: 100m, 95 trees.

2. Weekly sensor/density and PQA trials.
   1. Four ultrasound sensors working at 4Hz.
   2. PQA carried out on 4 treatments per row and includes leaf area

Vignoles

14-May-2015

22-Jun-2015

27-May-2015

2-Jul-2015
Vignoles

- **WCR (v)**
  - east
  - west
  - average

- **PQA**
  - 04/26 05/16 06/05 06/25 07/15

- **PQA x leaf area**
  - 05/16 06/05 06/25 07/15
Cabernet Franc

14-May-2015
27-May-2015
22-Jun-2015
2-Jul-2015
Cabernet Franc

Graphs showing the growth of WCR (v) and PQA over time for east, west, and average orientations.

- WCR (v) vs. date: The east orientation shows the highest WCR (v) throughout the period, followed by the west and then the average.
- PQA vs. date: There is a steady increase in PQA from 05/16 to 07/15.
- PQA x leaf area vs. date: The PQA x leaf area also shows an increase from 05/16 to 07/15.
- PQA vs. PQA x leaf area: The relationship between PQA and PQA x leaf area is positive and linear.
Vineyard (Cabernet franc) over the 2015 season
var. Macoun

var. Macoun

Graphs showing changes in PQA, WCR, and PQA x leaf area over dates from 04/26 to 07/05.
Adjusting liquid flow

Capstan/Wilger nozzles

Lechler VarioSelect nozzles


Adjust airflow to match canopy size based upon canopy density.
Gill sonic anemometers
2011
Airflow and sensor trials, var.Aceymac, Lamont Fruit farms 2014
Application Technology Group
NYSAES, Geneva, NY
Air flow regulation system – SARDI fans, Lamont Fruit Farms 2016
The graph shows the relationship between wind speed (in m/s) and fan power (%). The line with open circles represents the wind speed before the tree, while the line with open squares shows the wind speed after the tree. The line with filled squares indicates the reduction in wind speed. The vertical dashed line at 56% fan power indicates the optimum for ultrasounds.
Canopy density sensors fitted to Croplands Quantum Mist
Lamont Fruit Farms, NY,
August 2016
EPILOGUE

• Ultrasonic sensors can provide an estimate of density in fruit canopies
• Density information can be used to adjust air and liquid flow in real time thus improving deposition and reducing drift.
Acknowledgements

• NYS Apple Research and Development Program (ARDP), Lake Erie Grape Producers, USDA, EPA
• Lechler Nozzles Inc., Durand Wayland Inc.
• Co-operating grower: Rod Farrow of Lamont Fruit Farms
• Colleagues at Cornell University and summer student workers