MONITORING VINEYARD CANOPY STRUCTURE BY AERIAL AND GROUND-BASED RGB AND MULTISPECTRAL IMAGERY ANALYSIS

Authors:Jingyun OUYANG[1], Roberta DE BEI[1], Bertram OSTENDORF[2], Cassandra COLLINS[1*]

[1] *The University of Adelaide, School of Agriculture, Food and Wine, Waite Research Institute, PMB 1 Glen Osmond, 5064, South Australia. Australia*

[2] *The University of Adelaide, School of Biological Sciences, Adelaide, 5000, South Australia. Australia*

*Corresponding author:*Cassandra.Collins@adelaide.edu.au*

Abstract:

Context and purpose of the study - Unmanned Aerial Vehicles (UAVs) are increasingly used to monitor canopy structure and vineyard performance. Compared with traditional remote sensing platforms (e.g. aircraft and satellite), UAVs offer a higher operational flexibility and can acquire ultra-high resolution images in formats such as true color red, green and blue (RGB) and multispectral. Using photogrammetry, 3D vineyard models and normalized difference vegetation index (NDVI) maps can be created from UAV images and used to study the structure and health of grapevine canopies. However, there is a lack of comparison between UAV-based images and ground-based measurements, such as leaf area index (LAI) and canopy porosity. Moreover, most vineyard 3D model studies provide limited details on how they can be used to guide vineyard management. This study evaluated the accuracy of UAV-based canopy measurements, including canopy volume and NDVI and compared them with ground-based canopy measures, such as LAI and canopy porosity.

Material and methods - Throughout the 2017-18 growing season, UAV flights were performed to collect RGB and multispectral images in the research vineyard at the Waite Campus, University of Adelaide, South Australia. Using these images, canopy volume and NDVI were calculated. Ground-based measurements for LAI and canopy porosity were also carried out for comparison.

Results - LAI measured from budburst to harvest showed a peak at around veraison, before starting to decline. Similar trends were also observed in canopy volume and NDVI. Using linear regression, canopy volume of Shiraz and Semillon blocks showed a strong positive correlation with LAI (R^2 = 0.75 and 0.68, respectively). NDVI was also positively correlated with LAI (R^2 = 0.75 and 0.45 for Shiraz and Semillon, respectively). Canopy volume extracted from UAV-based RGB imagery could be used to monitor canopy development during the growing season. However, canopy volume has limited capacity to inform on important canopy architecture properties such as leaf density, total leaf area and porosity, known to affect yield and fruit quality. The accuracy of NDVI was also found to be strongly affected by the presence of vegetation on the vineyard floor at early development stages.

Keywords:remote sensing, unmanned aerial vehicle, leaf area index, canopy architecture, canopy volume, NDVI

1. Introduction.

Monitoring vineyard canopy structure by aerial and ground-based RGB and multispectral imagery analysis

Wine Australia for Australian Wine

Jingyun Ouyang[1], Roberta De Bei[1], Bertram Ostendorf[2], Cassandra Collins[1*]

[1] *The University of Adelaide, School of Agriculture, Food and Wine, Waite Research Institute, PMB 1 Glen Osmond, 5064, South Australia. Australia*
[2] *The University of Adelaide, School of Biological Sciences, Adelaide, 5000, South Australia. Australia*
**Corresponding author: Cassandra.Collins@adelaide.edu.au*

Introduction & Aims

Grapevine canopy architecture is an important indicator of vineyard performance (Dokoozlian and Kliewer, 1995). Parameters such as plant area index (PAI), canopy volume and normalized difference vegetation index (NDVI) are used to describe the architecture and health of grapevine canopy. Canopy imagery by aerial-UAV (unmanned aerial vehicle) and ground digital camera can be used to calculated these parameters. However, there are limited comparative studies.

The current study compared the ability of ground and aerial imagery to monitor canopy development and canopy spatial variation.

Material and Methods

VSP-trained Shiraz and Semillon vineyards of the University of Adelaide at the Waite Campus, South Australia, Australia (Lat 34°58'3.0"S, Lon 138°38'0.6"E) were used for this study, during the 2017-18 growing season.

RGB and multispectral images were collected using UAV-based sensors. An innovative object based imagery analysis (OBIA) process was developed to extract canopy volume from RGB images (Fig 1.). NDVI was calculated from multispectral images (Parrot Sequoia).

Ground RGB images were collected by a smartphone camera and analyzed by the App VitiCanopy to calculated PAI (Fig 2., De Bei et al., 2016).

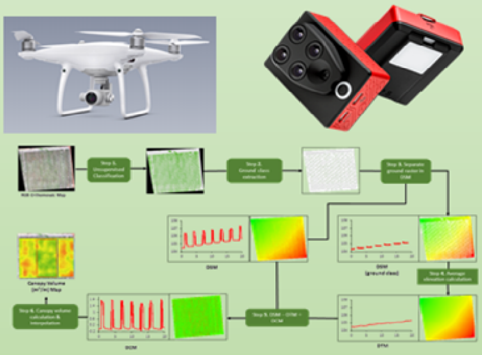

Figure 1. Top: Phantom 4 Pro (left) and Parrot Sequoia multispectral sensor (right). Bottom: new object based imagery analysis (OBIA) process.

Figure 2. Cover photography of the same cordon section of a Shiraz grapevine from budburst to harvest in the 2017-18 growing season, captured by VitiCanopy. DAB: day after budburst.

Canopy Variability Mapping

Canopy development peaked at veraison (around DAB 80) and similar spatial variabilities were observed between ground and UAV imagery.

Some divergence were observed in the Semillon vineyard between imagery types.

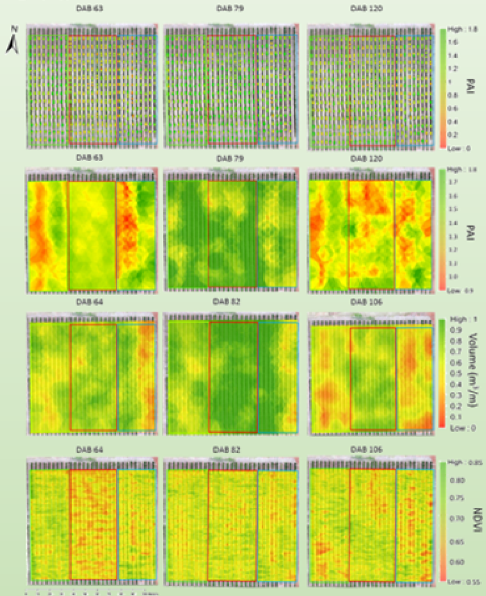

Figure 3. The temporal canopy development maps created from data by ground based and aerial-UAV measurements with block marks: Semillon (□) and Shiraz (□) vineyards.

Ground vs Aerial-UAV Measurements

	Ground - RGB	UAV - RGB & Multispectral
Target parameters	PAI and foliage cover, canopy porosity, etc.	Canopy volume & NDVI
Image acquisition	Manually acquired by the assessor	Automatically captured during flight
Imagery type	Upward looking	Downward & sideward looking
Processing time	Short	Medium
Precision and Map resolution	Meter level accuracy with medium resolution	Centimeter level accuracy with high resolution
Cost	Low	High
Weather requirements	Avoid rain & direct sunlight	Avoid rain and strong wind

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