IVES Technical Reviews vine & wine

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# Vineyard variability: can we assess it using smart technologies?

**>>> VitiCanopy is a smart-device computer application (app) that allows users to measure and interpret objective canopy architecture and its spatial distribution in the vineyard thus allowing for informed and targeted vineyard management decisions. <<<**

## Vineyards are variable

Vineyards are inherently variable however, the majority of them are managed on the assumption of uniformity. Understanding vineyard variability to target management strategies, apply inputs efficiently and deliver consistent grape quality to the winery is now essential. Moreover, canopy management, together with irrigation and fertilisation, is one of the main strategies applied in the vineyard to modify vine growth and achieve the desired fruit quality outcome. Significant savings can be made if the use of these practices is well-understood and targeted.

The wine industry uses significant resources to enable practitioners to measure vineyard vigour and its variability using techniques ranging from simple visual observations to sophisticated precision/digital viticulture (PV/DV). A survey on PV[1] showed that, in Australia, the main constraint to the adoption of these technologies was their cost, together with the lack of technical advice. Also, the survey respondents thought that PV tools and software were too complicated (less user friendly) for growers to use.

## Relationship between VitiCanopy and destructive measures

The relationship between leaf area index (LAI) measured by stripping vines of all leaves and LAI calculated using VitiCanopy has been described[2]. The findings suggest that the optimal distance from the cordon to take the canopy images is between 70 to 80 cm and the determination coefficient between the two methods showed a $R^2$=0.86 (Figure 1). Moreover, it was highlighted that VitiCanopy does not distinguish between leaf and other plant material so that the output could be referred to as Plant Area Index (PAI) rather than LAI.

## Using smart technologies to assess management outcomes: case studies

VitiCanopy can be used to assess the outcome of a management intervention. Figure 2 shows that following a shoot thinning operation targeted at removing 50 % of the total number of shoots on the vine, VitiCanopy was able to show a significant change in LAI (-38 %) and canopy porosity, that increased light transmission through the canopy to the fruit zone. When VitiCanopy is unable to show a change in canopy architecture after a treatment, the treatment often proves ineffective on vine performance. Canopy management operations such as shoot thinning or leaf removal are often carried out as routine and do not always impact on canopy architecture and final grape and wine quality. The cost of these operations can be significant, VitiCanopy could assist growers in making informed decision on canopy management, irrigation, fertilisation and pesticide application which could translate to substantial economical savings.

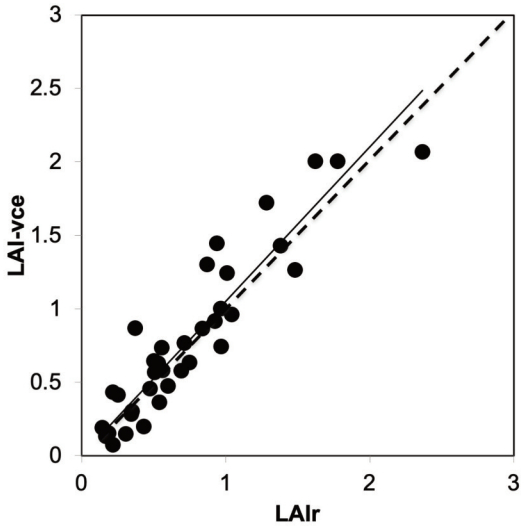



Figure 1. Relationship between the leaf area index (LAI) measured by destructively removing all the leaves (LAIr) and using the cover photography app VitiCanopy (LAIvce) extracting the Y – intercept related to cordon and non-leaf material inclusion. The continuous line represents the calculated regression; the dashed line represents the 1:1 relationship. Source: De Bei *et al.*, 2016.

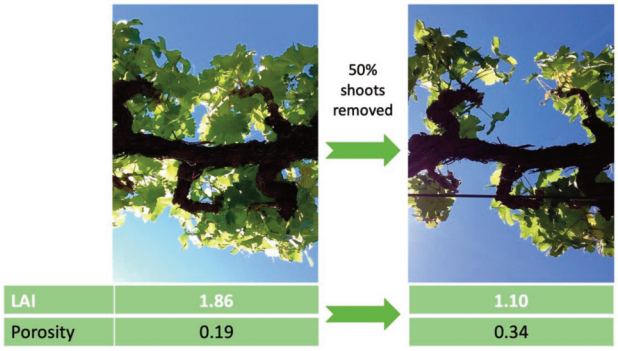



Figure 2. Leaf Area Index (LAI) and Canopy porosity measures before and after shoot thinning application.

By taking measurements with VitiCanopy during the growing season, canopy development can be monitored and canopy growth rate calculated (orange bars). Figure 3 shows a typical canopy growth curve showing a steady growth from EL 16 up to a maximum of LAI at around pea size (EL 29) after which a trimming was carried out which reduced the total LAI by 14 % on average for the whole vineyard. This type information can be used to adjust irrigation and spraying volumes.

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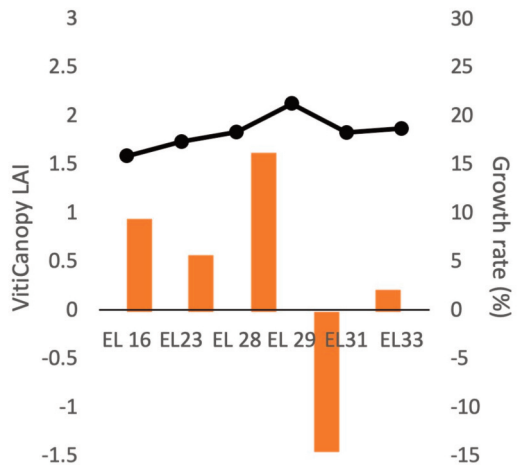



Figure 3. Example of canopy development throughout a growing season (black line) and calculated growth rate between phenological (EL, Coombe, 1995) stages (Orange bars).

## Using smart technologies to assess vineyard variability

All data generated by VitiCanopy is geo-referenced allowing for maps to be created to illustrate the spatial distribution of PAI and canopy porosity in the vineyard when enough data is collected spatially. VitiCanopy is now capable of producing spatial variability maps within the app without the need to rely on third party mapping tools. The sampling required to obtain the maps depends on the specific site requirements. In the examples reported in figure 4, every third vineyard row was imaged by taking one photo per panel. The time required for a team of four operators to acquire 500 images is about 30 minutes. The team at the University of Adelaide is implementing a tractor/quad bike camera system able to acquire images while carrying out other vineyard operations such as spraying or slashing. Figure 4 shows PAI maps for two vineyards at two phenological stages (veraison and harvest). Figures 4A and 4B denote similar within-vineyard variability from veraison to harvest with smaller canopies towards the edges, along the tree lines, and bigger PAI in the central area of the block. This pattern is likely due to differences in soil type. Proximity to trees is also known to reduce vine vigour due to competition for resources, mostly water. Moreover, it can be seen that PAI increased from veraison to harvest. A different situation, most likely linked to a different canopy and water management strategy, is instead depicted in the vineyard in Figures 4C and 4D where a noticeable loss of PAI from veraison to harvest can be inferred. This is known as a typical canopy management strategy adopted by the vineyard manager at the specific location and is achieved by reducing or stopping irrigation after veraison.

These maps also highlight how different training systems (such as a box-hedged system in 4A and 4B and sprawling canopy in 4C and 4D) in different wine regions could present very different PAI values. The vineyard in Figures 4A and 4B reached a maximum PAI of 5 while the vineyard in 4C and 4D reaches a maximum PAI of 1.3.

These maps can be generated for different seasons and/or different developmental stages within a season to create a history of a vineyard. Practitioners can use this information to make site specific management decisions to meet the production goals in response to these results.

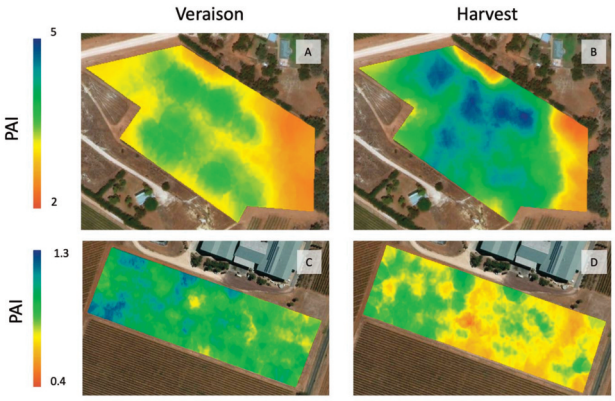



Figure 4. Plant Area Index (PAI) maps generated by collecting and analysing canopy images using VitiCanopy in a vineyard in the Riverland wine region (A and B) trained to spur pruned box hedge system and a vineyard in the Barossa Valley (C and D) trained to a permanent spur pruned cordon with a sprawling canopy. Measures were collected at veraison (A and C) and at harvest (B and D). Both Regions are in South Australia, Australia.

## Conclusion

VitiCanopy frees users from relying on third party instrumentation and software and enables them to take as many measurements as is required, at any point in time by simply taking an image of the canopy with a smartphone or tablet. ■

### VitiCanopy is an intelligent tool to help manage grapevines and it allows growers to:

- Quantify and map vineyard variability through objective canopy measurements to confidently make site specific management decisions to meet the production goals.
- Ground-truth remotely sensed measurements.
- Monitor canopy growth and implement management decisions: disease, water and nutrition.
- Create a history of different vineyards to anticipate yield and quality and manage vigour.
- Efficiently manage more vineyard area and direct resources to where they are needed most.

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**1** Bramley, R. (2013). Wine sector attitudes, to the adoption of *Precision Viticulture. Wine and Viticulture Journal* 28 (5), 69-73.

**2** De Bei, R., Fuentes, S., Gilliham, M., Tyerman, S., Edwards, E., Bianchini N., Smith J. and Collins, C. (2016). VitiCanopy: A free computer App to estimate canopy vigor and porosity for grapevine. *Sensors* 16(4): 585.