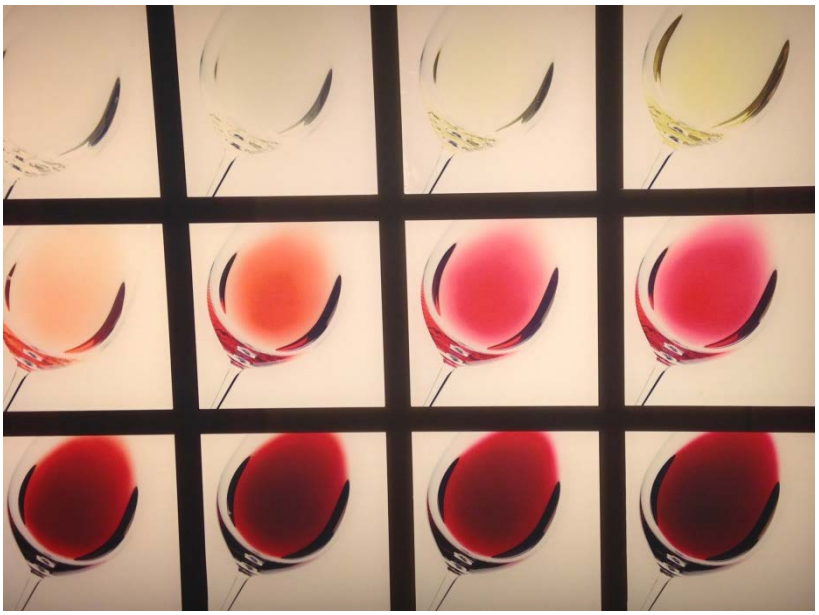
Participation at: 1) 19th International meeting GiESCO (Montpellier, 31 May - 5 June 2015) 2) SEB (Society of Experimental Biology) meeting 2015 (Prague 30 June - 3 July 2015) and 3) IX In Vino Analytica Scientia (Trento, Italy, 14 - 17 July 2015).



FINAL REPORT to AUSTRALIAN GRAPE AND WINE AUTHORITY

Project Number: GWT 1419

Principal Investigator: Dr Roberta de Bei

Research Organisation: The University of Adelaide

Date: 30 November 2015

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1. Executive Summary

The travel bursary was used to partially fund participation at three conferences in Europe during June and July 2015.

Information about the three conferences is detailed below:

1) The 19th International Meeting of Viticulture GiESCO 2015 was held from 31 May to 5 June in Pech Rouge and Montpellier (France).

The topics of discussion for this conference included:

- Ecophysiology, water and irrigation
- Climate and territory
- Training systems and cultivation techniques
- Grape berry and microclimate
- New technologies
- Rootstocks and soil

The last day of the conference was dedicated to the "International Academy of the vine and the wine". Also, a whole day was spent in Montpellier for what was called "Professional day" which was entirely dedicated to the topic of "sustainable viticulture".

240 delegates attended the conference and over 60 oral presentations and an abundant number of posters were discussed with all the papers published in the two volumes conference proceedings. An extra volume is dedicated to the oral presentations of the "professional day".

Various off site visits were organised everyday such as the visit of the INRA Pech-Rouge Experimental Centre in Gruissan and various vineyards visits with a choice of either a terroir or management focus.

At this conference I presented a paper on the AGWA-funded project UA 1207.

2) SEB (Society of Experimental Biology) meeting 2015 (Prague 30 June - 3 July 2015)

This was the Society of Experimental Biology's annual meeting and it covered a great variety of topics in the areas of animal and plant physiology and biology, environment, toxicology, biotechnology only to name some. Multiple sessions were on at the same time and I participated to the following: i) ecophysiology, ii) plant roots: new challenges in a changing world, iii) plant biotechnology: addressing the challenges for food security, health and sustainability, iv) innovations and best practices in undergraduate education.

3) IX In Vino Analytica Scientia (Trento, Italy, 14-17 July 2015).

The topics of discussion at this conference were:

- Chemical analysis and composition of grapes, wines and spirits
- Chemical and biochemical reactions
- Metabolomics, Chemometrics and Authenticity of products
- Sensory analysis

Key discussions, interesting conference presentations and possible collaborations will be discussed in greater detail later on this report.

2. Aim of the travel

Travel bursary GWT 1419 was intended for participating at:

- 19th International meeting GiESCO (Montpellier, 31 May-5 June 2015)
- SEB (Society of Experimental Biology) meeting 2015 (Prague 30 June - 3 July 2015)
- IX In Vino Analytica Scientia (Trento, Italy, 14-17 July 2015).

3. Travel itinerary and activities outline

Location	Activity	Dates
Gruissan – France	Attend and present at GiESCO	31 May – 5 June
Bordeaux (France)	Visit vineyards and wineries in the Bordeaux wine region	6-9 June
Logrono (Spain)	Present research seminars and discuss collaboration with Professor Javier Tardaguila, Professor of Viticulture and Dr MPaz Diago, Institute of Grapevine and Wine Sciences, University of La Rioja Logroño, Spain.	10-12 June
Prague (Czech Republic)	Attend the Society for Experimental Biology Conference (SEB)	29 June – 4 July
Trento (Italy)	Attend In Vino Analytica Scientia Symposium	14-17 July

4. Project outputs

Output	Performance Targets	Date
Attendance at the 19th International meeting GiESCO (Montpellier, 31 May - 5 June 2015) and delivery of an oral presentation entitled “Linking canopy architecture to grape quality using LAICanopy App”.	Abstract submitted and accepted for oral presentation, conference attended and presentation delivered.	Completed
Attendance at the SEB (Society of Experimental Biology) meeting (Prague 30 June - 3 July 2015). Attendance to IX In Vino Analytica Scientia (Trento, Italy, 14-17 July 2015).	Conferences attended.	Completed
Disseminate new knowledge through publication of an article in one of the wine industry journals. Submission of a final travel report to AGWA.	Article submitted and accepted. AGWA report completed and submitted.	Delayed*

*Please note: Prof Victor Sadras has already published an article about the GiESCO conference in “Australian and New Zealand Grape Grower and Winemaker”. However, with the other scientists from the University of Adelaide that were present at the “In Vino Analytica Scientia” conference, we are planning a joint article, which we hope to be submitted by March 2016.

5. 19th International Symposium GiESCO

The GiESCO symposium is a meeting of key international viticultural scientists combined with expert viticulturists from around the world and is the leading conference on practical viticultural science. Sessions were focused on sustainable viticulture, vineyard management, productivity and quality and align with my current research activity and AGWA funding in these areas. My paper on the VitiCanopy App (previously called LAICanopy) was accepted as an oral presentation at the conference and it was published in the conference proceedings.

The paper is reported below:

LINKING CANOPY ARCHITECTURE TO GRAPE QUALITY USING THE LAICANOPY APP

RELIER L'ARCHITECTURE DE LA CANOPEE A LA QUALITE DE LA GRAPPE DU RAISIN VIA L'APPLICATION LAICANOPY APP

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Abstract

For grapevines, monitoring canopy architecture is important to assess growth, vigour and light transmission through the canopy to the developing buds and inflorescences, and fruit zone. These parameters, that reflect canopy development, can be correlated to yield, grape quality and productivity. Leaf area index (LAI) is widely used to measure canopy development through the season. However, this parameter is difficult to measure since it requires either labour-intensive direct techniques, such as allometry, or expensive instrumentation for indirect estimates. The University of Adelaide has developed an image analysis application (LAICanopy) for iOS devices that estimates LAI and canopy porosity for grapevine. LAICanopy uses cover digital photography and automated analysis by applying gap size assessment algorithms (Macfarlane et al., 2007, Fuentes et al., 2008). During the 2013-14 season, LAICanopy was used on 22 Shiraz vineyards and was effective in characterising canopy architectural parameters both within and across vineyards. It was also found that an independent grape quality assessment was significantly correlated to the relationship between LAI and fruit yield (an indicator of vine balance). This newly developed App could be used as a less expensive, accurate and highly portable alternative to other destructive or non-destructive methods to estimate LAI.

***Keywords**: canopy architecture, Leaf area index, vine balance, image analysis*

Résumé

Dans le cadre de la viticulture, le suivi de l'architecture de la canopée est important afin d'évaluer la croissance, la vigueur, ainsi que la transmission de la lumière à travers la canopée vers les bourgeons, les inflorescences en développement, ainsi que vers la zone de fruits. Ces paramètres, qui rendent compte du développement de la canopée, peuvent-être corrélés au rendement et à la productivité de la vigne, ainsi qu'à la qualité du raisin. L'indice de surface foliaire (LAI) est la manière la plus répandue pour mesurer et quantifier le développement de la canopée au cours de la saison. Cependant, ce paramètre est difficile à déterminer, car il requiert soit l'emploi d'une main d'œuvre importante pour le mesurer directement, soit des outils chers pour l'estimer. L'Université d'Adélaïde a développé pour les terminaux iOS une application d'analyse d'images (LAICanopy) qui estime le LAI, ainsi que la porosité de la canopée de la vigne. LAICanopy utilise des photographies numériques du couvert végétal, qu'elle traite par le biais d'algorithmes de mesure de porosité (Macfarlane et al.,

2007, Fuentes et al., 2008). Au cours de la saison 2013-14, LAICanopy a été utilisée sur 22 vignes de Shiraz, et s'est révélée efficace dans l'évaluation des paramètres architecturaux de la canopée, aussi bien au sein des vignes qu'entre elles. Il a également été constaté que la qualité du raisin été significativement corrélée à la relation entre LAI et rendement en fruit (un indicateur de l'équilibre de la vigne). Cette application nouvelle pourrait être utilisée comme une alternative efficace, moins cher et facilement mise en place aux autres méthodes de mesures destructives ou non destructive de l'estimation du LAI.

Mots-clés: architecture de la canopée, indice de surface foliaire, équilibre de la vigne, analyse d'images

1. Introduction

Vineyard managers use a variety of practices (pruning, fruit removal, canopy manipulations) in order to control canopy size and to achieve vine balance. According to Iland et al. (2011) and Gladstone, (2011), a vine, or a vineyard, is balanced when vegetative vigour and fruit load allow the production of high quality fruit of a targeted style. Therefore, to help assist management decisions, researchers have developed indices to assess vine balance and vine performance. Some of the most used indices are: i) the ratio of yield (Y) to pruning weight (P) and ii) the ratio of leaf area (LA) to fruit weight (Y). However these indices can be subjective and difficult for growers to apply, since they are manual and time consuming, especially for LA/Y. Currently LA is measured using sophisticated and expensive instrumentation (such as the Licor 2000) or labour intensive and destructive allometric measurements.

The University of Adelaide is developing an "infield" assessment toolbox (mostly in the form of smartphone and tablet PC Apps) that can be used to aid vine management in order to more readily assess vine performance. The first computer application (App) developed for iPads and iPhones through this project has been named LAICanopy (Figure 1). This App allows the user to obtain canopy architectural parameters for grapevine by using cover digital photography and automated analysis by applying gap size assessment algorithms (Macfarlane et al., 2007, Fuentes et al., 2008, Fuentes et al., 2014).

LAICanopy has been tested on different vineyards and varieties and it was found effective in characterising canopy architectural parameters both within and across vineyards. The relationship between canopy architecture and yield, which is used as an indicator of vine balance, was significantly correlated with the final grape grade for Shiraz in McLaren Vale (De Bei et al., 2014). In this paper the link between canopy architecture measured with LAICanopy and berry colour at harvest is presented and discussed. This work is part of a larger project that aims to determine which canopy parameters reflect accurately optimal vine performance and berry and wine quality.

2. Material and methods

A trial was carried out in the McLaren Vale wine region on 22 commercial vineyards planted with the cv. Shiraz. The vineyards were chosen to represent a range of grape quality based on their performance in the last three seasons. All vineyards were under drip irrigation, and ranged in area from 1 to 5 hectares. Management varied across vineyards.

LAICanopy was used to collect canopy images at the following key phenological stages: i) flowering, ii) veraison and iii) immediately before harvest. Images were obtained from six vines per vineyard using an iPad 4 (Apple Inc. Corp. Cupertino, CA. USA) and analysed using LAICanopy (The University of Adelaide, Adelaide. Australia). To collect the images, the iPad was positioned 70 cm below the cordon.

LAICanopy allows the acquisition of upward-looking digital images and it calculates the following canopy architecture parameters:

- Leaf area index (LAIm): total one-sided area of leaf tissue per unit ground area
- Effective leaf area index (LAIe): LAIm corrected by the clumping index.
- Crown/Canopy cover: percentage (fraction) of ground area covered by the vertical projection of the canopy. Canopy cover equals 1 when leaves with no gaps cover the whole image.
- Crown/canopy porosity: percentage of gaps within the image (spaces), which can be related to light penetration through the canopy.
- Clumping index: ratio of effective plant or leaf area index to the actual plant or leaf area index (Macfarlane, 2007). It equals 1 when foliage is randomly distributed in a canopy and it is less than one when foliage becomes more clustered in lumps. For grapevine this factor is close or equal to 1 (random dispersion), unless there are sections of the image with big gaps of missing leaves.

Since the App uses the GPS capabilities of iPhones and iPads, spatial measurements within a vineyard can be mapped using current GIS-based software such as SURFER (Golden Software, Golden, CO. USA)

The above-mentioned parameters are calculated according to the algorithms described in Fuentes et al. (2008, 2014), which were obtained originally from Macfarlane et al., (2007).

From the same vines where images were taken, at harvest, yield and yield components were measured. Berry colour and phenolics analysis was carried out as described by Mercurio et al., (2007).

3. Results and discussion

For all the 22 vineyards considered in this study, the colour measured on the berries at harvest varied significantly, ranging from 3.00 to 5.84 mg/g of fresh berry. The canopy porosity measured at veraison using LAICanopy showed a range of values from 0.33 to 0.47 with higher numbers associated to more porous and open canopies. A positive and linear correlation was found between the porosity of the canopy at veraison and the colour of the berries at harvest. These results show that for the 22 Shiraz vineyards considered in the study, a more porous canopy at veraison achieved a higher final berry colour, most likely due to higher exposure of bunches to sunlight (Figure 2).

These findings are in accordance with other studies that demonstrate an association between higher canopy porosity and better light interception through the canopy and better bunch exposure. Smart (1985) showed that fruit exposure influences grape and wine quality and Tardaguila et al., (2010) demonstrated that higher sugars levels, anthocyanins and phenolics are associated with greater fruit exposure. Canopy porosity could also affect bud fruitfulness for the following season as reported by May et al., (1976) and Sanchez and Dokoozlian, (2005). De Bei et al., (2014) have previously shown that the relationship between canopy architecture (measured with LAICanopy) and yield, which is used as an indicator of vine balance, was significantly correlated with the final grape grade.

4. Conclusions

This study showed that canopy porosity measured at veraison with LAICanopy is linked to final berry colour. This validates the effectiveness of using LAICanopy as a management tool for vineyard practitioners. Vineyard managers could use LAICanopy to make informed decisions on canopy interventions at veraison (leaf plucking) targeted to a desired berry colour at harvest. As described previously (De Bei et al., 2014), LAICanopy offers an easy to use, inexpensive, versatile and accurate tool to monitor canopy architecture to be associated to quality parameters of berries and final wine produced.

5. Acknowledgements

LAICanopy was designed and developed by the School of Agriculture, Food and Wine, The University of Adelaide, www.agwine.adelaide.edu.au. The development of this App was supported and made possible by the former “Wine 2030” initiative of the University of Adelaide (now the University of Adelaide Wine Future-UAWF- http://www.adelaide.edu.au/wine-future) and the Australian Grape and Wine Authority (AGWA) through the project UA1207 “Optimising vine balance in Australian vineyards: developing a toolbox for industry to ensure best practice, sustainability and profitability”.

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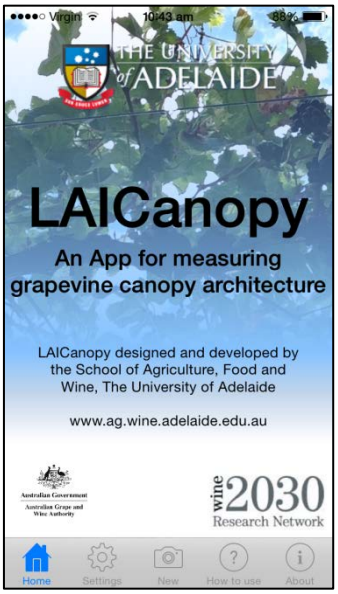


Figure 1: App home screen as shown on the iPad 4 displaying the main menu with the 'Home', 'Setting', 'New', 'How to Use It' and 'About' functions.

Figure 1 : Ecran d'accueil du logiciel d'application LAICanopy comme vu sur l'iPad 4, montrant le menu principal avec les fonctions 'Accueil' , 'Parametres ' , 'Nouveau' , ' Comment l'utiliser' et 'à propos de'.

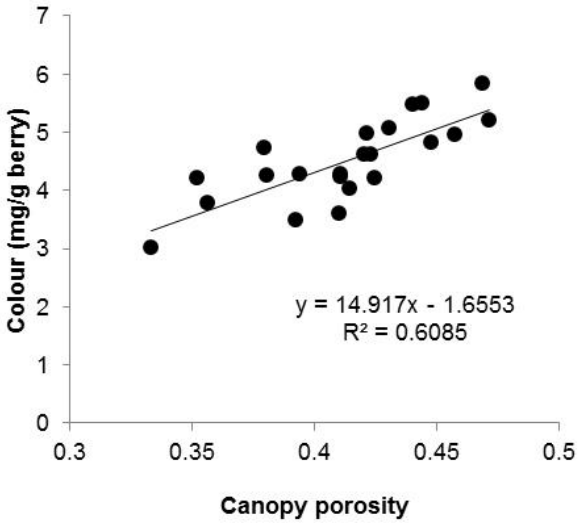
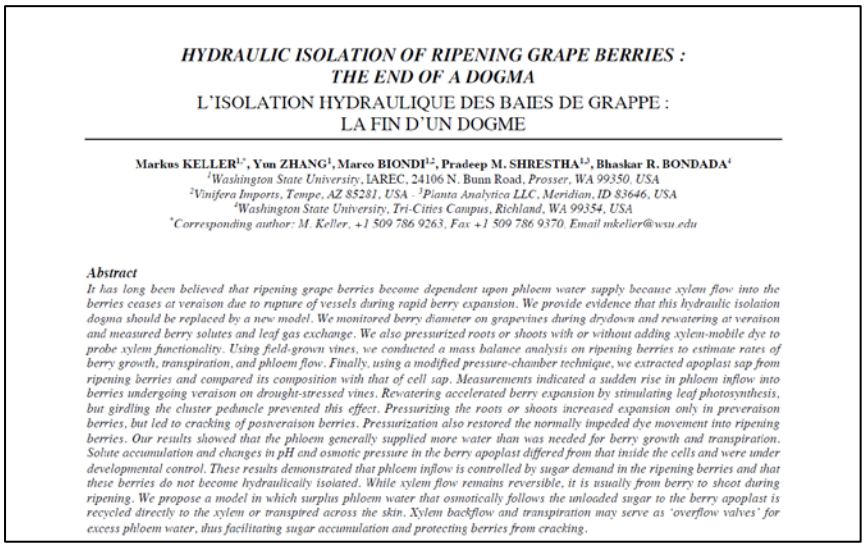


Figure 2: Relationship between Berry colour at harvest and Canopy porosity measured at veraison with LAICanopy for the cv. Shiraz in McLaren Vale.

Figure 2 : Correlation entre la couleur du fruit à la récolte et la porosité de la cime, mesurée à la véraison avec LAICanopy pour le cultivar Shiraz à McLaren Vale.

The scientific highlight of the meeting was work presented by Prof. Markus Keller entitled “Hydraulic isolation of ripening grape berries: the end of a dogma”. Abstract of the work is reported below:



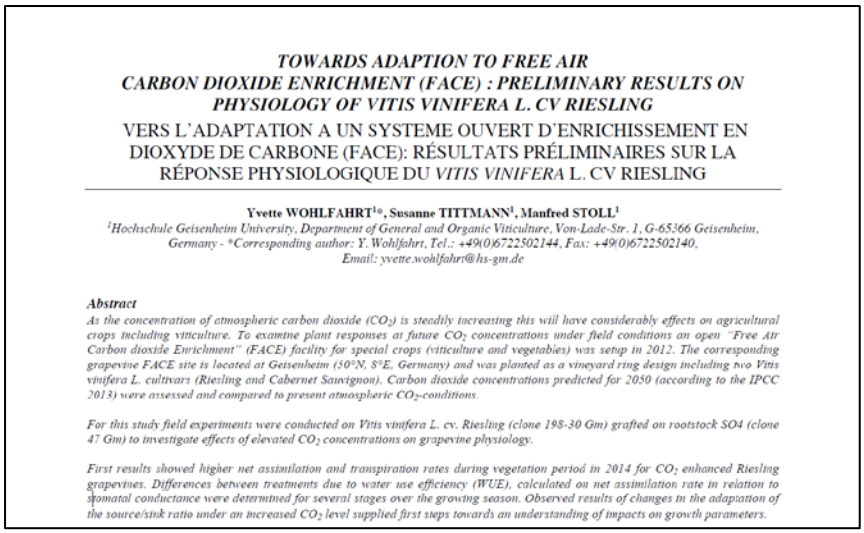
HYDRAULIC ISOLATION OF RIPENING GRAPE BERRIES : THE END OF A DOGMA

L'ISOLATION HYDRAULIQUE DES BAIES DE GRAPPE : LA FIN D'UN DOGME

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Abstract
It has long been believed that ripening grape berries become dependent upon phloem water supply because xylem flow into the berries ceases at veraison due to rupture of vessels during rapid berry expansion. We provide evidence that this hydraulic isolation dogma should be replaced by a new model. We monitored berry diameter on grapevines during drydown and rewatering at veraison and measured berry solutes and leaf gas exchange. We also pressurized roots or shoots with or without adding xylem-mobile dye to probe xylem functionality. Using field-grown vines, we conducted a mass balance analysis on ripening berries to estimate rates of berry growth, transpiration, and phloem flow. Finally, using a modified pressure-chamber technique, we extracted apoplast sap from ripening berries and compared its composition with that of cell sap. Measurements indicated a sudden rise in phloem inflow into berries undergoing veraison on drought-stressed vines. Rewatering accelerated berry expansion by stimulating leaf photosynthesis, but girdling the cluster peduncle prevented this effect. Pressurizing the roots or shoots increased expansion only in preveraison berries, but led to cracking of postveraison berries. Pressurization also restored the normally impeded dye movement into ripening berries. Our results showed that the phloem generally supplied more water than was needed for berry growth and transpiration. Solute accumulation and changes in pH and osmotic pressure in the berry apoplast differed from that inside the cells and were under developmental control. These results demonstrated that phloem inflow is controlled by sugar demand in the ripening berries and that these berries do not become hydraulically isolated. While xylem flow remains reversible, it is usually from berry to shoot during ripening. We propose a model in which surplus phloem water that osmotically follows the unloaded sugar to the berry apoplast is recycled directly to the xylem or transpired across the skin. Xylem backflow and transpiration may serve as 'overflow valves' for excess phloem water, thus facilitating sugar accumulation and protecting berries from cracking.

Other papers that I believe could be of interest for the Australian wine industry are listed below. (Please do not hesitate to contact me if a full paper is required for further reading).



TOWARDS ADAPTION TO FREE AIR CARBON DIOXIDE ENRICHMENT (FACE) : PRELIMINARY RESULTS ON PHYSIOLOGY OF VITIS VINIFERA L. CV RIESLING

VERS L'ADAPTATION A UN SYSTEME OUVERT D'ENRICHISSEMENT EN DIOXYDE DE CARBONE (FACE): RÉSULTATS PRÉLIMINAIRES SUR LA RÉPONSE PHYSIOLOGIQUE DU *VITIS VINIFERA* L. CV RIESLING

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Abstract
As the concentration of atmospheric carbon dioxide (CO_2) is steadily increasing this will have considerably effects on agricultural crops including viticulture. To examine plant responses at future CO_2 concentrations under field conditions an open "Free Air Carbon dioxide Enrichment" (FACE) facility for special crops (viticulture and vegetables) was setup in 2012. The corresponding grapevine FACE site is located at Geisenheim (50°N, 8°E, Germany) and was planted as a vineyard ring design including two Vitis vinifera L. cultivars (Riesling and Cabernet Sauvignon). Carbon dioxide concentrations predicted for 2050 (according to the IPCC 2013) were assessed and compared to present atmospheric CO_2-conditions.

For this study field experiments were conducted on Vitis vinifera L. cv. Riesling (clone 198-30 Gm) grafted on rootstock SO4 (clone 47 Gm) to investigate effects of elevated CO_2 concentrations on grapevine physiology.

First results showed higher net assimilation and transpiration rates during vegetation period in 2014 for CO_2 enhanced Riesling grapevines. Differences between treatments due to water use efficiency (WUE), calculated on net assimilation rate in relation to stomatal conductance were determined for several stages over the growing season. Observed results of changes in the adaptation of the source/sink ratio under an increased CO_2 level supplied first steps towards an understanding of impacts on growth parameters.

USE OF CANOPY TEMPERATURE FOR PRECISION IRRIGATION OF WINE GRAPES

UTILISATION DE LA TEMPÉRATURE DU FEUILLAGE POUR L'IRRIGATION DE PRÉCISION DES VIGNES

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Abstract

The objective of this research was to develop a method for calculating a water stress index (CWSI) for wine grape without direct measurement of well-watered and non-transpiring vines. 'Syrah' grapevines were grown under arid conditions in treatment plots that were drip-irrigated at a frequency of one or three times per week to supply either 70 or 35% of evapotranspiration-based vine water demand (ET_c) in Parma, ID USA (43.78N, 116.94W; 750 m asl). Vines located in the trial perimeter were irrigated at >100% ET_c. Infrared radiometers (20 cm diameter temperature sensing area), installed ~30 cm above sun-exposed, fully-expanded leaves at the top of the vine canopy, were used to record canopy surface temperature of vines in irrigation treatment plots and in the trial perimeter. Meteorological sensors recorded air temperature, relative humidity, total solar radiation and wind speed. An artificial neural network was trained to predict canopy temperature under well-watered conditions using data collected during the 2h period encompassing solar noon. The linear regression of predicted versus observed values for well-watered vines had a correlation coefficient of 0.91 with a root mean square error of 0.95 °C.

The canopy temperature of non-transpiring vines was estimated from the cumulative probability distribution of the temperature difference between the canopy of vines irrigated at 35% ET_c and ambient air. A CWSI was calculated for vines in irrigation trial plots using their measured canopy temperatures and the estimated and predicted values for non-transpiring and well-watered vines. The CWSI for irrigation treatment plots was linearly correlated with midday leaf water potential and its slope and intercept varied with irrigation frequency. Results showed that meteorological data input into a neural network model combined with measured canopy temperature can be used to calculate a real-time CWSI without direct measurement of well-watered or non-transpiring vines.

SEVERE LEAF REMOVAL IMPROVES VINE SOURCE-SINK BALANCE AND COMPOSITION OF "MERLOT" GRAPES AND WINE

UN EFFEUILLAGE SEVERE AMELIORE L'EQUILIBRE SOURCE - PUITS ET LA COMPOSITION DES RAISINS ET DES VINS DU MERLOT

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Abstract

Basal leaf removal is a widespread cultural practice that alters the microclimate of the fruit zone as well as the source-sink balance of a vine. Severe defoliation may result in vine devigoration via reduced photosynthetic capacity and could be beneficial for vigorous canopies to reduce the concentrations of methoxypyrazines (MPs), a class of volatile compounds that contribute to green aromas, in the fruit. To test these hypotheses, a study was conducted on vigorous 'Merlot'/101-14 grapevines (Vitis vinifera L.) in which severe leaf removal (SLR; removal of over half of the basal leaves on each shoot) was done after fruit set. Two levels of SLR were done on primary shoots on the morning-side of the canopy, while alternate basal leaf removal, where only leaves 1, 3 and 5 from the base of the shoot were removed, was done on the afternoon-side to minimize the risks of berry sunburn and shrivel. Based on several pruning metrics, SLR resulted in the greatest devigoration compared to conventional and no leaf removal treatments. After leaf removal was performed, photosynthesis decreased sharply, particularly in vines that had the highest levels of defoliation. SLR treatments also altered the fruit zone microclimate and had the highest cluster exposure flux availability and berry skin temperatures. Wine composition and sensoric analyses indicate that SLR results in the lowest concentration of MPs. These results suggest that SLR done shortly after fruit set may be a beneficial practice to improve the source-sink balance of high-vigor vines and to enhance grape and wine composition without sacrificing yield.

RESPONSE OF LEAF AND BERRY SKIN COMPOUNDS TO DIFFERENT CANOPY MANIPULATION TECHNIQUES IN VITIS VINIFERA L. CV. RIESLING INVESTIGATED WITH NON-DESTRUCTIVE METHODS

DIFFÉRENCE DE COMPOSITION DES FEUILLES ET DES BAIES DE *VITIS VINIFERA* L. CV. RIESLING EN RÉPONSE A DIFFERENTES MODIFICATIONS DU MUR DE FEUILLAGE, ÉTUDIÉ AVEC DES MÉTHODES NON DESTRUCTIVES

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Abstract

The adaptation of viticultural management systems is important in order to reply adequately to weather-related changes affecting the vineyards microclimate. Therefore, this study was examined to validate non-destructive methods to determine the response of leaf and berry compounds. Weekly measurements (2013 and 2014) in a field trial comparing different canopy manipulation techniques in two different plots (Vitis vinifera L. cv. Riesling) were performed to investigate the response of leaf and berry compounds (nitrogen, blue-green fluorescence and flavonols) with a handheld polyphenolmeter (Multiplex®3 [Mx3], Force-A, Orsay, France). The instrument excites the plant material with RGB and UV-LED responding in different indices (chlorophyll index (SFR_G), nitrogen balance index (NBI_G), flavonol index (FLAV) and anthocyanin index (ANTH)). During maturation berries were sampled and measured under laboratory conditions, while leaves were measured in the field. After measuring the berries using the Mx3, total soluble solids, total acidity, pH and N-OPA were determined.

The SFR_G index decreased with increasing maturity in leaves and berries and showed differences within the treatments and for canopy exposure (east or west facing canopy). All indices on leaves decreased after véraison and differences amongst the treatments were determined. Canopy defoliation is an important management practice to impact on vine's microclimate and hence can be considered as a seasonal tool to alter fruit ripening.

ADRESSING VINEYARD VARIABILITY BY TARGETED BERRY SORTING

ÉVALUATION DE LA VARIABILITÉ DU VIGNOBLE PAR ÉCHANTILLONNAGE CIBLÉ DE RAISINS

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Abstract

Variability of grape quality traits is encountered in vineyards between individual vines, between clusters within a single vine, and between berries of single bunches. While precision viticulture addresses systematic geologic and microclimatic variance within a vineyard, the within-vine and within-bunch variability are inaccessible to targeted management or selective harvesting. Recently, a new generation of berry sorting systems has emerged on the market, which allows single berry sorting by berry size, shape or reflection in several parts of the electromagnetic spectrum. However, the implications of berry size and optical properties for wine quality need to be understood in order to conduct targeted berry sorting. The aim of this project was to determine to which extent variability of berry quality traits exists on within-vineyard, within-vine and within-bunch level and to determine the covariance of berry optical properties with berry quality traits and finally to determine berry size and color effects on wine quality of Riesling (Vitis vinifera L.). Therefore, variance of grape quality parameters withia vineyards, individual vines and bunches has been analyzed for sugar, organic acids, amino acids and skin phenolics (only within-bunch and within-vine variability) in the seasons 2010-2013. Results showed that within-vine and within-bunch variability exist on similar levels as within-vineyard variability. While organic acids, amino acids and phenolics correlated well with berry optical properties (VIS-Spectrum and Fluorescence) or berry size, others, especially sugars, showed little correlation. Results of a trial conducted in 2013 showed significant implications of berry size and color on the organic acid, terpenoid and norisoprenoid composition of wines obtained by micro-fermentation.

APPLICATIONS OF MACHINE VISION FOR GRAPEVINE PHENOTYPING

APPLICATIONS DE LA VISION ARTIFICIELLE POUR LE PHÉNOTYPAGE DE LA VIGNE

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Abstract

Computer vision systems are powerful tools to assess canopy status, fruit grading, and yield in agriculture. This work shows the application of machine vision techniques for grapevine phenotyping under laboratory and field conditions. The first approach aimed at determining automatically the number of flowers per inflorescence using a low cost camera under field conditions. Strong and significant relationships, with R^2 above 0.8 in Tempranillo, Graciano and Carignan cultivars were observed between actual and automated estimation of inflorescence flower numbers. The second approach aimed at analysing cluster morphology using image analysis under laboratory conditions. Berry weight, berry number per cluster and cluster weight were estimated using several algorithms of image processing. The best results (R^2 between 0.69 and 0.95 in berry detection and between 0.65 and 0.97 in cluster weight estimation) were achieved using the Canny algorithm. The model's capability based on image analysis to predict berry weight was R^2=0.84. The third approach aimed at working outdoors, developing in-field systems capable of assessing the leaf area and yield of the vineyard by acquisition and processing of digital images. Our algorithms allowed the total leaf area (R^2=0.81; p<0.001) and yield (R^2=0.73; p=0.002) per vine to be estimated. In conclusion, computer vision techniques can be applied in viticulture for plant phenotyping and vineyard monitoring. A large set of samples can be automatically measured, saving time and providing more objective and precise information.

VINEROBOT : ON-THE-GO VINEYARD MONITORING WITH NON-INVASIVE SENSORS

VINEROBOT : SURVEILLANCE EN TEMPS RÉEL DU VIGNOBLE AVEC CAPTEURS NON INVASIFS

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Abstract

In the last decades, the remarkable development of new technologies and the growing demand for greater competitiveness and sustainability have led to a great interest in precision viticulture, which proposes a differentiated agronomic management of vineyards based on the spatial-temporal variability of vegetative development, production, and quality of the grapes. A forefront and sustainable viticulture requires objective and continuous monitoring of key parameters for rational decision making. In this context, the first prototype of a novel use-case agricultural robot which will be equipped with several non-invasive sensing technologies is presented to monitor key agronomical and physiological parameters of the vineyard, such as vegetative growth, nutritional status and grape composition. This unmanned ground vehicle (UGV) is deployed with the aim of providing fast and accurate information to grape growers in order to optimize vineyard management and to improve grapes and composition and quality of wines. The integral monitoring of the vineyard over the entire season is intended, by placing the ground robot along the vineyards. The robot will incorporate an integrated sensing system that includes machine vision, fluorescence-based sensors and NIR spectroscopy devices. Canopy and fruit images and sensor data will be acquired on-the-go and processed in real time through customized map-building algorithms, displaying final maps in smart phones and other devices by grape growers and other end-users. Precision viticulture will capitalize from the scouting robot capabilities of not only being endowed with several non-invasive techniques to sense and assess crop status, but also with key data to allow for vineyard management, decision-making and forecasting solutions.

STRESS DETECTION IN VINEYARDS USING A LOW COST TERRESTRIAL MOBILE SYSTEM

DÉTECTION DU STRESS DANS LES VIGNOBLES PAR UTILISATION D'UN SYSTÈME TERRESTRE MOBILE À FAIBLE COÛT

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Abstract

Stress detection in vineyards is typically performed using plant-based techniques such as stem water potential or leaf gas-exchange rate. However, these types of measures are not representative of the whole vineyard, because they are performed on selected points or a limited group of vines within the vineyard. In this context, canopy temperature (T_c) has been proposed as a sensitive indicator of plant water status. At the present time T_c can be evaluated quickly with portable infrared temperature sensors. These sensors can be integrated to microcontroller boards, incorporating global position information from miniaturized GPS. Therefore, it is possible to obtain T_c records and its spatial distribution in the vineyard simultaneously. In this study we describe a low cost terrestrial mobile system used for registering T_c in a vineyard plot trained on a vertical shoot positioned (VSP) system. To verify the suitability and sensitivity of the mobile system, stem water potential was measured in selected plants inside of the vineyard plot. As a result, the system allowed the creation of a grid with canopy temperature and position; with this data it was possible to elaborate maps that reflected the spatial variability in the vineyard plot. In order to develop plant water status maps, the crop water stress index (CWSI) was calculated. The results show that the areas with water restrictions were identified allowing the definition of different zones within the plot.

DEVELOPMENT OF A METHOD FOR VINE YIELD ESTIMATION USING WITHIN FIELD HISTORICAL DATABASE

DÉVELOPPEMENT D'UNE MÉTHODE D'ÉSTIMATION DU RENDEMENT SUR LA BASE DE DONNÉES INTRA-PARCELLAIRES HISTORIQUES

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Abstract

Yield estimation is an important task for any vine grower to organize logistical operations such as harvest, wine storing and also sell it on the market. Some researches as well as results from vine growers in the central zone of Chile have reported errors about 15 to 40% in yield estimation using classical field manual sampling. Consequently, there is an urgent demand for improving yield estimation. This is a difficult labour due to the inherent variability from vine to vine, from zones to zones at the within-field level and also from field to field. This study aims at addressing the question of yield estimation before harvest. It also wants developing a methodology to estimate grapevine yield from punctual measurements of the year and a model build-up from within field historical yield database. The model assumes a temporal stability of the within field variability. That last is derived from the main factor of a principal component analysis (PCA). Thus, this approach was tested on seven seasons in a Syrah vine field under non-irrigated conditions in Narbonne region, France, and another database on four seasons in a Cabernet Sauvignon vine field under irrigated conditions in Maule region, Chile. Yield measurements at harvest were used to evaluate the model. The results showed a linear correlation between standardized within-field yield values over the different seasons, for both vine fields. This supports the use of a linear model resulting from the PCA to summarize the yield within variability and use this information to best locate the measurement site over time. Thus, it was possible to estimate yield for 6 seasons in the Syrah field and 3 at the Cabernet Sauvignon field with r^2 greater than 0.93 in both cases, using only six representative sampling sites within the vine fields. Also, the results indicated that the approach was able to estimate the mean yield of the fields with an error about 5%.

CHANGES TO VITICULTURE IN THE LAST FORTY YEARS. ARE THESE TENDENCIES SUSTAINABLE ?

LES CHANGEMENTS DE LA VITICULTURE AU COURS DES QUARANTE DERNIÈRES ANNÉES. CES TENDANCES SONT-ELLES DURABLES ?

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Abstract

It is 40 years since I made my first harvest of Syrah vines in the hot climate of Griffith, NSW, Australia. The commercial vineyards of the region were healthy and vigorous, extensively cultivated with heavy and wide tractors, own-rooted, flood irrigated, relatively high yielding (to 30 t/ha), hand pruned and harvested, and with non-positioned, highly-shaded canopies producing bulk wine in general. Vines are now less healthy due to ingress of trunk diseases, herbicides control weeds under the vine and weeds (euphemistically "cover crops") grow and may be mown in the inter row, and vines are sometimes grafted to trunk disease-infected and nematode resistant rootstocks. Harvest is always by machine, pruning is never by hand and maybe by machine, and the canopies are still shaded producing bulk wine in general. Machines typically are heavier.

Subsequently, with my friends and colleagues (Alain Carbonneau of France, Cesare Intrieri and Giovanni Cargnello of Italy, and Mark Kliewer of California, and all of us inspired by Nelson Shaulis of Cornell University) we led a canopy management "revolution" beginning in the 1970s. A plethora of new training systems were developed which reduced shade, and could improve yield, wine quality and sometimes mechanisation.

Of these many changes, most are sustainable. Machinery is not becoming lighter however, nor are recycling spray machines widely used. Improved canopy management is generally ignored, out of lack of commercial awareness of benefits, and sometimes concern about mechanisation.

And what of the future? Lowest paid workers may continue to be displaced by technology introduced by their higher-paid managers, although they in turn may be displaced by technology. Improved vineyard monitoring by remote sensors will impact on wine quality, and being "high tech" will cause excitement.

In my experience, the well-trained human eye is the most economical, reliable and discerning sensor one can use in vineyards, but the real benefits are generally ignored. One's eyes can be used to substantially improve yield and wine quality, if you know how!

GLOBAL CHANGE, SUSTAINABILITY AND CHALLENGES FOR GRAPE AND WINE PRODUCTION

CHANGEMENT GLOBAL, DURABILITÉ ET DÉFIS POUR LA PRODUCTION VITICOLE

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Abstract
Grapevines are cultivated on 6 out of 7 continents, between latitudes 4° and 51° in the Northern Hemisphere and between 6° and 45° in the Southern Hemisphere across a large diversity of climates (oceanic, warm oceanic, transition temperate, continental, cold continental, Mediterranean, subtropical, attenuated tropical, and arid climates). Accordingly, the range and magnitude of environmental factors differ considerably from region to region and so do the principal environmental constraints for grape production. The type, number and magnitude of environmental constraints are currently undergoing changes due to shifts in climate patterns already observed for the past and predicted for the future. These changes are already affecting grape composition with observed changes in sugar and acid concentrations. As with other components such as polyphenols or aroma compounds, their relationships to environmental changes are more difficult to quantify. In general, one can divide the expected climatic changes during the grape ripening period into two scenarios; warmer and dryer, and warmer and moister with different responses for red and white grape varieties. The production challenges within this broad separation are vastly different and the strategies to ensure sustainable production need to be adapted accordingly.

6. Society of Experimental Biology (SEB) annual meeting

The aim of SEB is to “promote and increase the influence of experimental biology within the scientific community and society” by:

- Developing the field of, and scientific careers in, experimental biology;
- Developing education and public awareness in experimental biology
- Developing collaborative partnerships
- Maintaining transparency, ethical and environmental sensitivity in every sphere of activity
- Ensuring financial viability of the society.

The SEB annual meeting is one of the Society’s biggest events and it brings together about 1000 delegates from around the world. The meeting’s activities included nine simultaneous sessions in plants, animals and cell biology. I attended four sessions: i) ecophysiology, ii) plant roots, iii) plants biotechnology and iv) innovations and best practices in undergraduate education.

The Society carries out “career development workshops” and I attended one of them during the meeting. The workshop was run by successful senior scientists and focused on helping early career researchers achieve their career goals. Not surprisingly, all speakers stressed the importance of publishing (quality and not quantity) however, many other important topics were discussed and the workshop saw a great involvement of the whole audience. One of the main discussions point was the importance of making connections and networking to build collaborations hence all senior scientists highly encouraged active participation to conferences.

7. IX In Vino Analytica Scientia

The 9th In Vino Analytica Scientia conference was held at the MezzoCorona winery in Trento, Italy. The conference attracts highly recognised researchers in enology but also viticulture and it focuses on the latest advances in analytical wine chemistry but also wine sensory science.

This year’s conference saw more than 250 participants from 27 countries and a total of 36 oral communications and 225 posters were discussed.

The topics of discussion for the 2015 meeting were:

- Chemical analysis and composition of grapes, wines and spirits
- Chemical and biochemical reactions
- Metabolomics, Chemometrics and Authenticity of products
- Sensory analysis

This was the first time I attended this meeting and it was interesting to notice the emphasis on sensory science, with 10 out of 36 oral presentation dedicated to it. It appeared that sensory is becoming more important in all of our wine and viticulture research. I believe that, even if sensorial analysis cannot replace the chemical-physical analysis of grape and wine, it should be added to all our research. It is important to assess how the characteristics of the product interact with the consumer's senses, so it is necessary to make more use of sensory analysis as a method of verification and evaluation of the results and I was glad to see the space given to it at this conference.

Many Australian scientists participated to the conference however only two papers were

presented as oral presentation: Joanna Gambetta (Creation of a wine quality prediction index) and Sigfredo Fuentes (Development of a novel App for sensory analysis…).



All the Australian scientists present at the IX In Vino Analytica Scientia conference.

8. Outcomes and conclusions

Participating at international conferences is always a great privilege and opportunity for meeting some of the best researchers in the area of interest. The GiESCO symposium has been a good occasion to renew contacts and make new collaborations. I had a chance to discuss my research with colleagues working in similar field and I have been able to gather important feedback that will certainly be taken into account in my future research. My presentation about the development of VitiCanopy and the App in itself have generated a lot of curiosity amongst scientists who were all interested in starting using the App for their experiments. Numerous questions were asked on its use, accuracy and avenues for possible collaborations arose. Many scientists have emailed me to receive a copy of the App which is now available for download on the iTunes store:
https://itunes.apple.com/au/app/viticanopy/id1042914901?mt=8 .
Thanks to the visibility these conferences have given to my work I have a good network of contacts with fellow scientists around the world.

Also, Mr Pietro Bertanza, editor of “L’Informatore Agrario”, one of the most respected and widespread Italian farming magazines, has asked for an article about VitiCanopy.

I thank Wine Australia and the University of Adelaide for giving me this opportunity.