Berry heterogeneity, spatial distribution and maturation within single bunches (CV. Shiraz)

Elena KRAEVA-DELOIRE[a], Alain DELOIRE[a], Leigh M. SCHMIDTKE[a,b]

[a] *National Wine and Grape Industry Centre, Charles Sturt University, Locked Bag 588, Wagga Wagga, NSW 2678, Australia.*
[b] *School of Agricultural and Wine Sciences, Charles Sturt University, Locked Bag 588, Wagga Wagga, NSW 2678, Australia,*

Karl Briullov. The Italian midday. 1827.

Introduction

Berry growth and morphology are characterised by asynchrony between berries within a single bunch posing an important research question with potential practical implications for vineyard management and wine making processes. The goal of this study is to assess the spatial and temporal differences in individual fruit from single bunches at two developmental stages: veraison and mid ripening (CV Shiraz, *Vitis Vinifera* L.). Wide ranging research has been reported during the last few years on berry size and sugar content, berry position and maturity, resource competition between berries during their development, the effect of bunch heterogeneity on wine composition, etc. [1,2,3,4,5,6]. But still, this topic remains as a matter of debate.

Materials and Methods

The study was done in Griffith and Orange regions NSW, Australia; very different in climate and cultural practices.

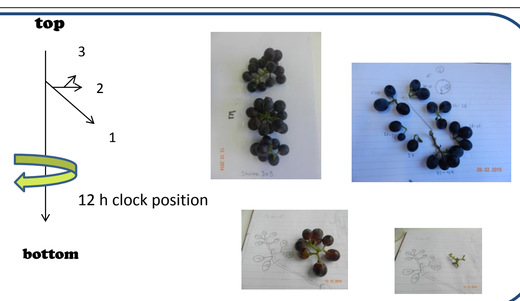
Mechanical pruning
Number of shoots: 92
Double cordon, open sprawling canopy
Yield/vine 18.6 kg
Flowering conditions: From the 15th of Oct to the 1st of Nov
Temperature min ave 10.9 °C
Temperature max ave 30.3 °C
Rain 0 mm

Griffith

Orange

Manual pruning
Number of shoots: 21
Double cordon, VSP
Yield/vine 4.3 kg
Flowering conditions:
From the 15th of Nov to the 1st of Dec
Temperature min ave 12.1 °C
Temperature max ave 28.3 °C
Rain 14.6 mm

607 berries from 4 different bunches sampled at veraison and mid ripening harvest were analysed. Each single berry was removed from the stem according to the position on the rachis including ramification. Clock wise position corresponds to the exposed and shadowed sides.



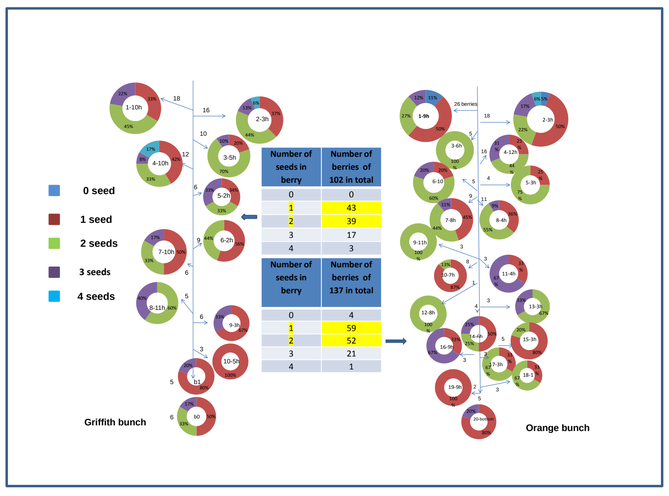
Twenty parameters, for each single berry were measured and calculated.

11533 values in total...

- Number-Position
- Fresh mass berry, seeds, pericarp
- Dry mass berry, seeds, pericarp
- Seed content and seed weight
- Colour
- Total Soluble solids (Brix),sugar concentration per g of berry
- Water concentration
- Seed/berry ratio (SB) [7]
- Others

Results

A " map" of spatial distribution of the berries on the primary side branches within the bunch at harvest.



Number of seeds in berry	Number of berries of 102 in total
0	0
1	43
2	39
3	17
4	3

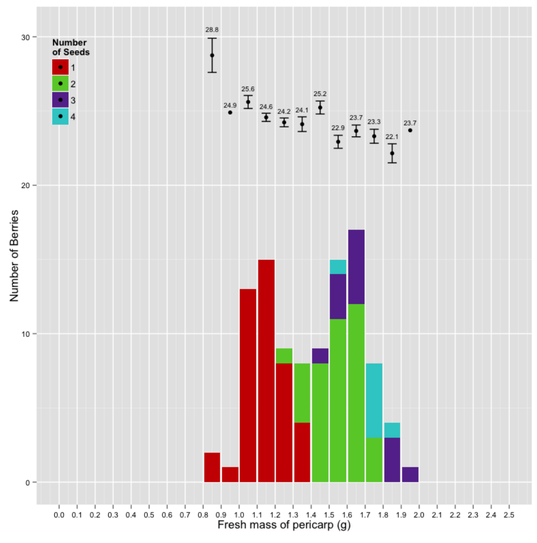
Number of seeds in berry	Number of berries of 137 in total
0	4
1	59
2	52
3	21
4	1

The arrows show the rachis and small branches with the number of berries on each. Circles are the groups of berries on each side branch regarding the number on the rachis and a clock position. The colours correspond to percentage of one, two, three and four seeded berries in the group.

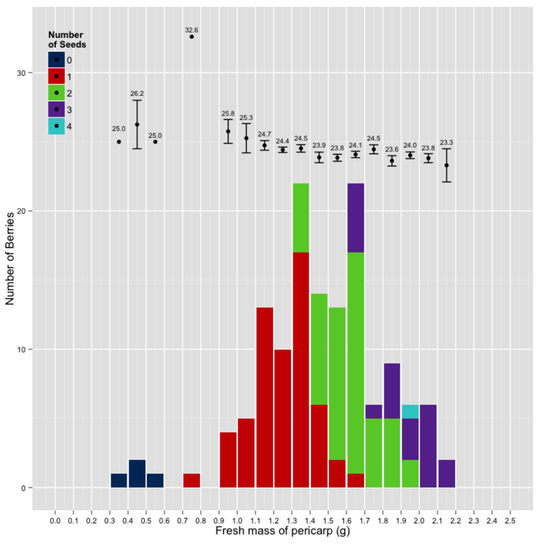
The majority of berries have one and two seeds randomly situated within the bunch. There is no gradient or apparent continuity in distribution. We didn't find any influence of berry position on the physiological parameters studied.

Heterogeneity of berry pericarp fresh mass within single bunch.

Griffith bunch at harvest

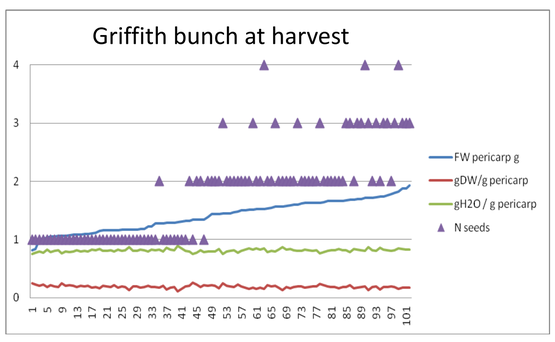


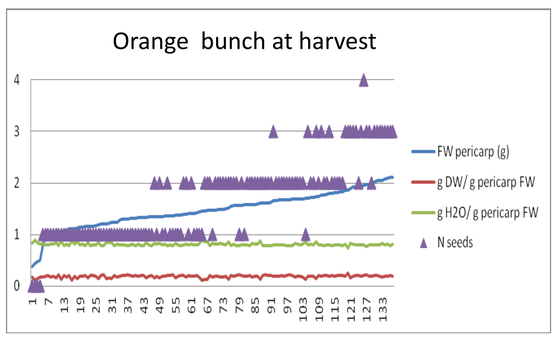
Orange bunch at harvest



The histograms show the berry distribution per class within the bunch and how the seed content changes from small to large berries. Colour corresponds to the number of one, two, three and four seeded berries within each class. This could be interesting and useful for grouping and sampling strategies. For example, two major classes within the same cluster are very different in Brix and seed content, which can have an important consequences for final wine style.

How different are the berries within the bunch?



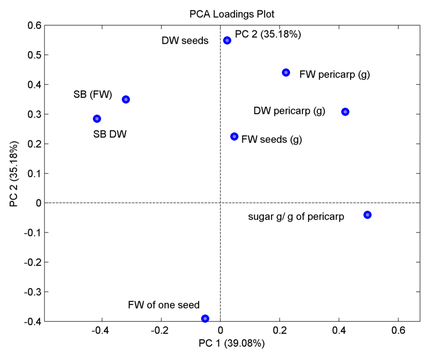


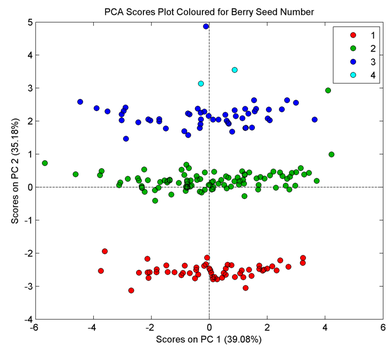
	Ave of 10% lowest FW (g) pericarp	Ave of 10% highest FW (g) pericarp	Difference %
FW pericarp g	1.0	1.8	+80
DWg [C] / pericarp FW g	0.212	0.174	-17.9
H2O %	79%	83%	+5.01
Brix	26.3	23.4	-11
Seed content N	1	2.9	+190

	Ave of 10% lowest FW(g) pericarp	Ave of 10% highest FW(g) pericarp	Difference %
FW pericarp g	1.02	2.03	+99
DWg [C] per g pericarp FW	0.180	0.199	+10.5
H2O %	82.1%	80.2%	-2.3
Brix	25.9	23.9	-7.7
Seed content N	1	3	+200

The berries of each bunch were classified from the lowest to highest pericarp fresh mass. We found that the difference of almost 100% in fresh mass is correlated with a seed content but not with a water or carbon (dry weight) concentration.

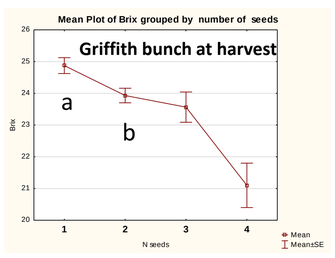
Principal component analysis.

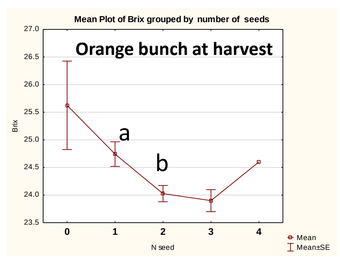




PCA was conducted on berry composition. We found that the seeds could play an important role for other berry characteristics. These plots shows well defined sample clusters for each group of berries with a different seed content.

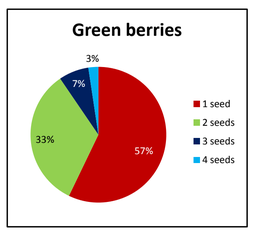
Seed content and sugar (Brix, g sugar per berry, g sugar per g pericarp)

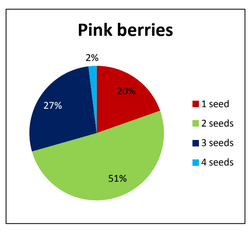


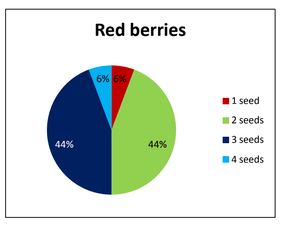


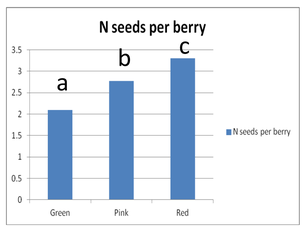
A significant difference in sugar concentration was up to 0.7 Brix = 7 g/L (0.3-0.4 % alc) between one and two seeded berries, which were the major classes within the bunch.

Seed content and berry colour at Veraison. Orange bunch. The most ripe berries had the highest seed content.



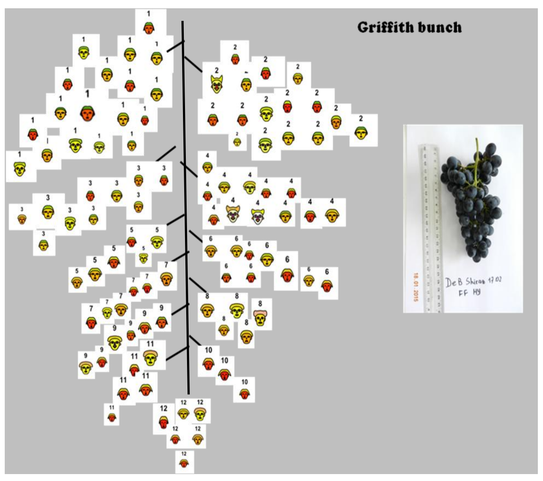






Seed content was well correlated with berry colour and could play a major role in the timing of ripening. The majority of berries with one seed were green, two seeded berries were pink or red, three and four seeded berries were mostly red. This may be the result of seeds triggering the earlier onset of veraison, however this needs to be confirmed.

Conclusion



Single bunch represented with Cheroff faces. Each face is one single berry. Each face characteristic corresponds to one of the berry parameters. Face color is an average of sets of variables.

Results showed that berry position within bunches and branches did not influence the targeted physiological parameters. Strong interrelationship between berry seed number and sugar concentration, fresh and dry mass of the pericarp were found. The study showed a correlation between the number of seeds per berry and skin colour at veraison, suggesting an important role of seeds in the timing of ripening. We hypothesize that berry seed number influences berry size by alteration of cell number in the pericarp at early stage of berry development. Flowering and early berry development stages could be partly responsible for bunch heterogeneity and this is discussed in the light of our original results.

[1]. Matthews M and Nuzzo V. (2007) Acta Hort. 423-435. [2]. Ferrer M. *et al*., (2014) S. Afr J. Enol Vitic, vol 35, No 1, 103-113.[3]. Dai ZW et al., (2009). Journal of Agricultural and Food Chemistry. [4]. Friend et al., (2009) Australian Journal of Grape and Wine research 15, 166-174. [5]. Torchio et al., (2014) S. Afr J. Enol Vitic,Vol 35, No 1. [6].Friendel et al., (2016) Australian Journal of Grape and Wine research.[7]. Gouthu S and Deluc L. (2015). BMC Plant Biology 15:46.

This project was partly funded by NWGIC and the Australian Grape and Wine Authority, with matching funding from the Australian federal Government.