



The Effect of Rootstock and Water Stress on the Reproductive Performance  
of *Vitis vinifera* L.

by  
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Thesis submitted to School of Agriculture, Food and Wine  
of the University of Adelaide  
in fulfillment of the requirements for the degree of

**Doctorate of Philosophy**

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## Abstract

The reproductive process in grapevines could arguably be the most important, as its success determines the yield for the current season and sets the potential crop for the coming season. In regions where poor reproductive performance exists, for example, poor fruitset in cool climates or in environments where water restrictions are likely, reproductive performance of grapevines may potentially be managed through the use of American *Vitis* rootstocks. The aim of this research was to assess the effect of American *V.* rootstocks on the reproductive performance of *V. vinifera* scions.

Three scion cultivars commonly used in Australian viticulture, Cabernet Sauvignon, Shiraz and Merlot were investigated. The research identified that cultivars differ in their reproductive performance when grafted to the same rootstock. For Cabernet Sauvignon, rootstocks improved fruitfulness, for Merlot, rootstocks improved fruitset, while for Shiraz, the incidence of coulure— (an abnormal condition of fruitset), was more pronounced in rootstocks than for own-roots.

A detailed investigation of rootstocks which incorporated analysis of carbohydrates, pollination, fertilisation, fruitfulness and fruitset on the cultivar Shiraz— (the most commonly planted red cultivar in Australian viticulture) was performed. Results showed that the quantity of pollen grains present on the stigma was important for successful fertilisation. As such, rootstocks associated with higher quantities of pollen grains on the stigma had higher percentage fruitset and seeded berry number. In addition, the levels of carbohydrates in roots and trunk were greater in rootstocks associated with greater vegetative growth. This research highlighted the importance of balance between vegetative and reproductive growth, as an imbalance in favour of reproductive growth was at the expense of carbohydrate accumulation which affected fruitfulness in the following season.

The absence of irrigation affected reproductive development through yield losses which were attributed more to weight loss in bunches and berries through effects on berry size and dehydration,

rather than low fruitset. A detailed analysis of the three cultivars enabled classification of rootstocks and cultivars based on their reproductive performance which will help identify reproductive traits for rootstock and cultivar combinations.

In addition, there was an opportunity to assess the effect of rootstock and irrigation on grape and wine composition and wine sensory attributes of Shiraz. A novel sensory analysis technique enabled the discrimination of wine attributes between treatments and correlation with traditional wine quality assessments. For example, in one season, 1103 Paulsen with wine colour density, wine pH and the attributes "rich" and "black fruit". 110 Richter with grape TA, wine phenolics and alcohol % and the attributes "astringent" and "black fruit" in the other season. In addition, low quality rootstocks Ramsey and 99 Richter were associated with 'light' and 'simple' attributes used by the expert winemaker panel. These findings have implications for rootstock selection management decisions and how we assess research wines for commercial application.

This study has led to a greater understanding of how rootstocks impact reproductive performance and will help the Australian and international wine industries make decisions on rootstock selection, especially for sites and cultivars where reproductive development could be limited.

## Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any University or any other tertiary institution and, to the best of my knowledge and belief contains no material previously published or written by another person, except where due reference has been made in the text.

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.....14/3/2014.....

Catherine Mary Kidman

Date

**Journal of Papers Published as part of this Research:**

**Kidman, C.M., Dry, P.R., McCarthy, M.G. and Collins, C. (2013)**

Reproductive performance of Cabernet Sauvignon and Merlot (*Vitis vinifera* L.) is affected when grafted to rootstocks.

Australian Journal of Grape and Wine Research 19 (3): 409:421

Presented in Chapter 3

**Kidman, C.M., Olarte Mantilla, S.M., Dry, P.R., McCarthy, M.G. and Collins, C. (2014)**

The effect of water stress on the reproductive performance of Shiraz (*Vitis vinifera* L.) grafted to rootstocks.

American Journal of Enology and Viticulture In publication Vol 65 (1) March 2014.

Presented in Chapter 4

**Kidman, C.M., Dry, P.R., McCarthy, M.G. and Collins, C. (2014)**

Effect of rootstock on nutrition, pollination and fertilisation in Shiraz (*Vitis vinifera* L.).

Vitis In publication Vol 53, July 2014

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**Cox, C.M., Favero, A.C., Dry, P.R., McCarthy, M.G. and Collins, C. (2012)**

Rootstock effects on bud fertility, primary bud necrosis and carbohydrate storage in Shiraz.

American Journal of Enology and Viticulture 63 (2): 277-283

Presented in Chapter 6

**Kidman, C.M., Olarte Mantilla, S.M., Dry, P.R., McCarthy, M.G. and Collins, C.**

Assessment of grape and wine chemical composition and sensory differences with rootstock and irrigation treatments in Shiraz (*Vitis vinifera* L.)

[prepared manuscript]

Presented in Chapter 7

*Each of these manuscripts is displayed in the thesis in either published or submitted form according to the instructions to author of the specific journal*

*This Thesis has been prepared according to the University of Adelaide's specifications for "PhD by publications" format*

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## Conference Proceedings and Industry Publications

Cox, C.M, Dry, P.R., McCarthy, M.G. and Collins, C. (2008)

**Maintenance of grafted vine health and productivity under forced zero irrigation.**

In poster proceedings 8<sup>th</sup> International symposium on grapevine physiology and biotechnology, 23-28<sup>th</sup> November, Adelaide, Australia

Cox, C (2010)

**The effect of water stress on the performance of grafted vines with an emphasis on wine quality.**

Australian Viticulture **14 (1) 19-22.**

Cox, C.M, Dry, P.R., McCarthy, M.G. and Collins, C. (2010)

**Reproductive development changes when Merlot and Cabernet Sauvignon are grafted to**

**rootstocks in a cool climate region** In poster proceedings 14<sup>th</sup> Australian Wine Industry Technical Conference, 3-8<sup>th</sup> July, Adelaide, Australia

Kidman, C.M., Olarte Mantilla, S.M., Dry, P.R., McCarthy, M.G. and Collins (2013)

**The effect of water stress on the reproductive performance of Shiraz (*Vitis vinifera* L.) grafted to**

**American *Vitis* rootstocks.** In poster proceedings 18<sup>th</sup> International symposium GiESCO, 7-11<sup>th</sup> July, Porto, Portugal.

Kidman, C.M., Olarte Mantilla, S.M., Dry, P.R., McCarthy, M.G. and Collins (2013)

**The effect of water stress on the reproductive performance of Shiraz (*Vitis vinifera* L.) grafted to**

**American *Vitis* rootstocks.** In poster proceedings 15<sup>th</sup> Australian Wine Industry Technical Conference, 14-18<sup>th</sup> July, Sydney, Australia

## Abbreviations

ABA	Abscisic acid
ANOVA	Analysis of Variance
BOM	Bureau of Meteorology
CI	Coulure Index
CO <sub>2</sub>	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
cv	Cultivar
cvs	Cultivars
GWRDC	Grape and Wine Research and Development Corporation
IP	Inflorescence primordia
LGO	live green ovary
MI	Millerandage Index
PBN	primary bud necrosis
PGIBSA	Phylloxera and Grape Industry Board of South Australia
$\Psi_l$	Midday leaf water potential
$\Psi_{pd}$	Pre-dawn leaf water potential
$\Psi_s$	Midday stem water potential