The reproductive biology of grapevines — factors that affect flowering and fruitset

by

Mardi Louise Longbottom

Bachelor of Agricultural Science (Viticultural Science)
Masters of Viticulture
The University of Adelaide, South Australia

Discipline of Wine and Horticulture
School of Agriculture, Food and Wine
Faculty of Science
The University of Adelaide

A thesis submitted to The University of Adelaide in fulfilment of the requirement for the degree of Doctor of Philosophy

February, 2007

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Abstract

Molybdenum experiments

In Australia young Merlot vines sometimes suffer from vegetative disorders such as slow, zigzagged growth and leaf distortion. Merlot is also particularly known as a low- and inconsistent-yielding grape variety. Previous research showed that when foliar applications of molybdenum (Mo) were applied to Merlot vines the vegetative symptoms improved. More recently, when sodium molybdate was applied to Mo-deficient Merlot, yield improved; a function of increased bunch weight brought about by bigger berries. It has also been reported that at high concentrations, molybdenum might be detrimental to yield. Experiments were conducted on own-rooted Merlot (clone D3V14) vines in commercial vineyards in the Adelaide Hills (Hills) and at McLaren Vale, South Australia.

Effects of molybdenum deficiency on the vegetative growth and yield of *Vitis vinifera* cv. Merlot

The aims of the current study were to: a) elucidate the mechanism by which molybdenum affects yield of Merlot; b) to monitor the effects of Mo-treatment on the balance between vine reproductive and vegetative growth; c) to monitor the residual effects of Mo-treatment on growth and yield of Merlot and; d) to determine whether high concentrations of molybdenum are detrimental to yield.

Three rates of sodium molybdate were applied to vines in springtime (control = 0g, rate 1 = 0.101g and rate 2 = 0.202g sodium molybdate per vine). Vine molybdenum status was measured prior to treatment and again at flowering time using petiole, shoot tip and inflorescence analysis. The effects on vegetative growth were monitored at veraison, during dormancy and at budburst in the seasons following Mo-treatment. At flowering time, pollen vitality, pollen tube growth and flower structure were examined. Bunch number per vine, fruitset, berry weight and berry composition were measured at harvest.

In the Hills, the controls had adequate molybdenum however, at McLaren Vale petiolar molybdenum concentration fell within the suggested deficiency range of 0.05-0.09 mg/kg in the petioles at flowering time. No visual symptoms of Mo-deficiency were observed on the experimental vines. At McLaren Vale, Mo-treatment reduced pruning weight and improved vine balance. Mo-treated vines in the Hills and at McLaren Vale were affected by delayed

budburst in the season following Mo-treatment irrespective of their Mo-status. However, no seasonal carryover of molybdenum could be detected in tissue analysis at flowering time.

Juice total soluble solids, pH and titratable acidity were not affected by Mo-treatment at McLaren Vale or in the Hills. However, juice from Mo-treated vines in the Hills had a significantly higher concentration of molybdenum than the controls. At McLaren Vale there was no significant difference in juice molybdenum concentration between treatments.

In the Hills, yield was not affected by Mo-treatment. However, Mo-treated vines at McLaren Vale had significantly higher yields (approximately double) than the Mo-deficient controls. Bunch number per vine was not affected by Mo-treatment, either in the year that treatments were applied or in the following season. However, bunches from Mo-treated vines had significantly better fruitset resulting in more berries per bunch. Berry weight was affected by Mo-treatment in one season only. Yield was not detrimentally affected on vines that received the higher rate of sodium molybdate.

In the Hills, Mo-treatment did not affect pollen numbers, pollen vitality or pollen tube growth. At McLaren Vale, where the controls were Mo-deficient, pollen vitality was not affected by Mo-treatment. However, pollen tube growth was significantly enhanced by Mo-treatment. Significantly more pollen tubes penetrated the ovules from Mo-treated vines and a higher proportion of ovaries had at least one penetrated ovule. Structural observations revealed that a significantly higher proportion of ovules from Mo-deficient vines were defective. The absence of an embryo sac in those ovules is probably the cause of pollen tube growth inhibition and subsequent poor fruitset.

Effects of mode of pollination on yield of Merlot and the interacting effects of sodium molybdate sprays

Pollination experiments were conducted on field-grown own-rooted Merlot (clone D3V14) vines in commercial vineyards in the Adelaide Hills and at McLaren Vale in 2003-04 and in 2004-05. Inflorescences were supplied with supplementary Merlot pollen (self-pollination), with pollen from another variety (cross-pollination) or they were left to pollinate naturally (open pollination). In the Hills, mode of pollination did not affect fruitset or berry weight. In 2003-04 fruitset increased significantly at McLaren Vale when inflorescences were cross-pollinated with Semillon. Applying supplementary Merlot pollen also tended to improve fruitset, however none of the treatments affected berry weight. In 2004-05 there was no

significant difference between treatments. These results indicate that Merlot may be a poor producer of pollen and may suffer from self-incompatibility.

Given the significant improvements in yield gained by spring foliar applications of sodium molybdate to Mo-deficient Merlot vines, in 2005-06 a reciprocal experiment was conducted to separate the effects of Mo-treatment and mode of pollination on the male and female flower parts. The aims of this experiment were to: a) determine whether the male or female reproductive organs are more important in determining the success of fruitset of Merlot and; b) determine which remedial measure, Mo-treatment or pollination, is more effective at overcoming poor fruitset. Supplementary pollination treatments—cross-pollination (Semillon); self-pollination (Mo-deficient pollen); self-pollination (Mo-treated pollen) and; open-pollination—were applied to Mo-treated and Mo-deficient vines.

Cross-pollinating Mo-deficient vines with Semillon significantly improved fruitset of Merlot compared to other pollination treatments on those vines, however applying molybdenum to the vines in springtime was more effective at improving fruitset. Within the Mo-treated vines the effects of supplementary pollination on fruitset were not thought to be of any practical significance.

The results of this experiment provide further evidence that Mo-deficiency affects the female flower parts more than the male reproductive organs of Merlot.

The occurrence of 'star' flowers in Australia

In 2003 faulty flowers were discovered on Canada Muscat grown in the Coombe Vineyard at the University of Adelaide's Waite Campus. The Canada Muscat flowers opened from the top in 'star' formation in contrast to normal grape flowers, which shed the calyptra from its base. Star flowers were reported in French literature in the late 1800s. They were reported to as a symptom of a 'disease' that caused 'coulure', the cure for which was vine removal. The current report is the first known report of star flowers occurring in Australia.

Through dissemination of the news of this discovery, several star flower variants were found in other varieties in South Australia. The association of star flowers with poor berry development and the frequency of the occurrence of star flowers suggest that this flower aberration may be affecting yield to a greater extent than previously recognised.

This study provides a detailed description of two types of star flowers: those that occur in response to environmental conditions and those that occur every season. Other star flower variants are also documented.

Declaration

I HEREBY DECLARE that the thesis presented here has been carried out by myself and does not incorporate any material previously submitted for another degree in any university. To the best of my knowledge and belief, it does not contain any material previously published or written, except where due reference is made in the text.

I am willing to have this copy of my thesis available for loan and photocopying, once deposited in the university library.

MARDI LOUISE LONGBOTTOM

Acknowledgements

The completion of this study would not have been possible without the guidance and encouragement of my supervisors, Associate Professor Peter Dry and Professor Margaret Sedgley.

Financial contribution from the Adelaide Hills Wine Region and the Grape and Wine Research and Development Corporation are also gratefully acknowledged.

I would also like to thank:

- Nepenthe Viticulture, especially Murray Leake
- The Hardy Wine Company, especially Rodney Birchmore
- Dr Peter May for his guidance, encouragement and allowing me access to his literature collection
- Dr Robert Hallon for his fastidious translation of the foreign language papers referred to in this text
- Lyn Waterhouse and Dr Meredith Wallwork at Adelaide Microscopy
- Kate Dowley at Biometrics SA
- Technical laboratory assistance - Dr Cassandra Collins, Dr Pauline Glocke, Dr Michelle Wirthensohn, Dr Kate Delaporte and Dr Toby Knight
- Assistance in the field and laboratory – Heath Burzacott, Beau Burzacott, Jon Longbottom, Bill Longbottom, Neil Wellman, Sonali Mookerjee, Joanne Brady, Carrie McDonnell, Dylan Grigg, Rebecca Brooksby, Sarah Murray, Renata Ristic and Toby Tennent
- Students of the University of Adelaide who volunteered their time to assist with data collection in the field and laboratory
- My husband Heath, for giving me time, space and patience

List of Abbreviations

˚C	degrees Celsius
no.	number
p	probability for data
TA	titratable acidity
TSS	total soluble solids (˚Brix)