

# **The Role of Abscisic Acid in Grape Berry Development**

**Susan Faith Wheeler  
BSc (Auckland University)**

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## Abstract

Hormones control plant development by coordinating changes in the expression of numerous genes at crucial times in a tissue and organ-specific manner. They have been implicated in controlling various aspects of grape berry development, in particular, the important process of ripening and are used in some crops to control growth and ripening. Abscisic acid (ABA), is associated in grapevine with the response to water stress but may also have a role in berry ripening.

We have shown over three seasons that ABA levels in Cabernet Sauvignon berries increase dramatically at veraison, consistent with it being involved either as a trigger for ripening or as a response to the increase in sugars that occurs at this time. Net ABA accumulation doesn't occur until veraison, the decrease in ABA concentration in the first phase of berry development being due to berry expansion. The decrease in ABA that occurs later in development is likely to be due to a combination of catabolism and sequestration into the bound form. The genes crucial to ABA synthesis, 9-cis-epoxycarotenoid dioxygenase (*NCED*) and zeaxanthin epoxidase (*ZEP*), were expressed throughout berry development and no clear correlation was found between their levels and that of ABA.

Laboratory studies have shown that isolated berries respond to the presence of sucrose through an increase in ABA biosynthesis pathway gene expression (*NCED* and *ZEP*). This resulted in *de novo* synthesis of ABA as inhibition of the carotenoid synthesis pathway by a phytoene desaturase inhibitor prevented ABA accumulation.

Replicated field trials clearly showed that ABA treatments can be effective in significantly enhancing ripening when applied in at or near the end of the first period of berry expansion. Colour accumulation in the skins commenced earlier in ABA-treated fruit as did the increase in sugar levels. ABA treatment also advanced the timing of the second phase of berry expansion as it appeared to eliminate the lag phase of berry growth. Taken together these data demonstrate that ABA is likely to play some part in the control of berry ripening and can be used to advance the timing of ripening. Further investigation into the characteristics of ABA-treated fruit will be needed to investigate the compositional

character of treated fruit and to gauge its suitability for winemaking. An ability to control the timing of ripening may provide considerable benefits to the wine industry in terms of wine style/quality and for winery scheduling.

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## **Declaration**

This work contains no material that has been accepted for the award of any other degree or diploma in any university or 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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*Susan Wheeler*

*October 2006*

## Abbreviations

1-MCP	1-methylcyclopropene
A <sub>520</sub>	absorbance at 520nm
AAO	AB aldehyde oxidase
ABA	abscisic acid
ABA2	ABSCISIC ACID DEFICIENT2
ACO	1-aminocyclopropane-1-carboxylic acid oxidase
ASR	abscisic, stress and ripening
BLAST	basic local alignment search tool
bp	base pairs
cDNA	complementary DNA
DNA	deoxyribonucleic acid
DPA	dihydrophaseic acid
dNTP	deoxynucleotide triphosphate
dsDNA	double-strand DNA
EDTA	ethylenediamine- <i>tetra</i> -acetic acid
EST	expressed sequence tag
Fruc	fructose
FW	fresh weight
g	gram(s)
<i>g</i>	relative centrifugal force
GA	gibberellin
GC/MS	gas chromatography/mass spectrometry
GE	glucosyl ester
Glu	glucose
<i>GRIP</i>	grape ripening induced protein
h	hour(s)
HPLC	high performance liquid chromatography
IAA	indole-3-acetic acid
IPTG	<i>Iso</i> -propyl- $\beta$ -D-thiogalactopyranoside
kb	kilobase pairs
L	litre(s)

LB	Luria broth
M	molar
Man	mannitol
min	minute(s)
MOPS	3-N-morpholinopropanesulfonic acid
mRNA	messenger RNA
Nor	norflurazon
NAA	naphthaleneacetic acid
NCED	9-cis-epoxycarotenoid dioxygenase
nt	nucleotide
PA	phaseic acid
PCR	polymerase chain reaction
qRT-PCR	quantitative Real-Time PCR
RACE	rapid amplification of cDNA ends
RNA	ribonucleic acid
rpm	revolutions per minute
RT-PCR	reverse transcription-PCR
s	second(s)
suc	sucrose
SDS	sodium dodecyl sulphate
TBE	tris-borate-EDTA
T <sub>m</sub>	temperature of DNA disassociation (melt)
Tris	tris(hydroxymethyl)aminomethane
V	volt(s)
w/v	weight per volume
Wpf	weeks postflowering
ZEP	zeaxanthin epoxidase

# Table of contents

Abstract.....	ii
Acknowledgements .....	iv
Declaration .....	v
Abbreviations .....	vi
List of figures .....	xi
List of tables .....	xiii
Chapter 1: Introduction.....	1
1.1 Preamble.....	1
1.2 Physiology of fruit ripening .....	1
1.3 Role of plant growth regulators.....	2
1.4 Grape berry ripening .....	3
1.4.1 Physiology of grape berry ripening .....	3
1.4.2 Role of plant hormones during grape berry ripening.....	6
1.4.3 ABA biosynthesis and mechanism of action.....	13
1.5 Conclusion.....	23
Chapter 2: ABA Accumulation During Grape Berry Development.....	24
2.1 Introduction .....	24
2.2 Materials and methods .....	25
2.2.1 Plant tissue.....	25
2.2.2 Free abscisic acid analysis.....	27
2.2.3 Bound abscisic acid analysis .....	28
2.3 Results .....	29
2.3.1 Abscisic acid purification method development .....	29
2.3.2 Grape berry development .....	29
2.3.3 Free ABA accumulation during berry development.....	33
2.3.4 Comparison of free and bound abscisic acid levels.....	37
2.3.5 Abscisic acid levels in grape berry skin, flesh and seed.....	39
2.4 Discussion .....	41
Chapter 3: qReal-Time PCR Analysis of Grape Berry Developmental Series.....	48
3.1 Introduction.....	48
3.2 Materials.....	50
3.2.1 Solutions .....	50
3.2.2 Oligodeoxyribonucleotides.....	50
3.2.3 Bacterial strains .....	50
3.2.4 Plant tissue.....	50
3.3 Methods.....	50
3.3.1 Restriction enzyme digestion of DNA.....	50
3.3.2 Agarose gel electrophoresis.....	50
3.3.3 Purification of DNA from agarose gel slices.....	51
3.3.4 DNA amplification by the polymerase chain reaction (PCR) .....	51
3.3.5 Purification of DNA samples following enzymatic reactions .....	51
3.3.6 DNA ligation .....	51
3.3.7 Transformation of bacteria with recombinant plasmids .....	51



3.3.8	Preparation of electro competent <i>E. coli</i> cells .....	52
3.3.9	Preparation of chemical competent <i>E. coli</i> cells.....	52
3.3.10	Growth of bacteria in liquid cultures .....	52
3.3.11	Preparation of bacterial plasmid DNA .....	53
3.3.12	Preparation of DNA samples for sequencing .....	53
3.3.13	Preparation of bacterial glycerol stocks.....	53
3.3.14	Preparation of grape RNA .....	53
3.3.15	RNeasy purification of grape RNA .....	54
3.3.16	DNA synthesis.....	54
3.3.17	Degenerate oligo PCR .....	54
3.3.18	Quantitative real-time PCR amplification .....	55
3.3.19	Preparation of SYBR green reagent for quantitative real-time PCR amplification.....	55
3.4	Results .....	56
3.4.1	Degenerate oligo PCR .....	56
3.4.2	qRT-PCR .....	56
3.5	Discussion .....	69
3.5.1	Degenerate oligo PCR .....	69
3.5.2	qReal-time PCR, justification of technique .....	71
3.5.3	Changes in the expression of ABA biosynthesis genes, and genes involved in berry development, in Cabernet Sauvignon berries and the implications for transcriptional control .....	72
Chapter 4: Grape Tissue <i>In vitro</i> Experiments .....		77
4.1	Introduction .....	77
4.1.1	Hormones in fruit ripening .....	77
4.1.2	Sugar signalling .....	77
4.1.3	<i>In vitro</i> experimental techniques .....	79
4.1.4	Experimental outline .....	79
4.2	Materials and methods .....	80
4.2.1	Plant tissue.....	80
4.2.2	ABA measurement by Phenomenex strata-X column purification .....	81
4.2.3	Oligodeoxyribonucleotides.....	81
4.2.4	Preparation of grape RNA .....	81
4.2.5	RNeasy purification of grape RNA .....	81
4.2.6	cDNA synthesis .....	81
4.2.7	Real-time PCR amplification .....	82
4.3	Results .....	82
4.4	Discussion .....	94
Chapter 5: ABA Field Experiments.....		103
5.1	Introduction .....	103
5.2	Materials.....	105
5.2.1	2004 ABA field experiment .....	105
5.2.2	2005 ABA field experiment .....	106
5.2.3	Berry development analysis .....	107
5.2.4	Abscisic acid analysis.....	107
5.2.5	Anthocyanin extraction .....	107

5.3	Results .....	108
5.3.1	Treatment of Cabernet Sauvignon fruit with exogenous ABA: 2003/04 experiment.....	108
5.3.2	Treatment of Cabernet Sauvignon fruit with exogenous ABA: 2004/05 experiment.....	116
5.4	Discussion .....	124
Chapter 6: General discussion .....		132
6.1	Introduction .....	132
6.2	ABA accumulation in Cabernet Sauvignon berries.....	133
6.3	ABA biosynthesis gene expression in Cabernet Sauvignon berries and the role of ABA in berry development.....	134
6.4	Implications for grape growing and winemaking.....	137
6.5	Summary .....	138
References .....		139
Appendix 1: Primer sequences .....		160
Appendix 2: Sequence Alignment for Degenerate Oligo PCR.....		161

## List of figures

Figure 1.1: Grape berry structure .....	3
Figure 1.2: Grape berry development .....	4
Figure 1.3: ABA concentration in ripening 'Cabernet Sauvignon' grape berries. ....	11
Figure 1.4: Chemical structure of S-(+)-abscisic acid.....	13
Figure 1.5: ABA biosynthesis pathway .....	16
Figure 1.6: ABA catabolism.....	20
Figure 2.1: Comparison of ABA purification methods on a variety of starting material.....	30
Figure 2.2: Changes in absorbance at A <sub>520</sub> and average berry weight measured during the development of cv. Cabernet Sauvignon grape berries during three growing seasons.. ....	31
Figure 2.3: Changes in various ABA concentration and Brix measured during the development of cv. Cabernet Sauvignon grape berries during three growing seasons.. ....	32
Figure 2.4: Comparison of ABA levels in cv. Cabernet Sauvignon berry developmental series over three seasons.. ....	35
Figure 2.5: Comparison of ABA levels in cv. Cabernet Sauvignon berry developmental series over two seasons on a per berry basis. ....	36
Figure 2.6: Comparison of free and bound ABA levels in cv. Cabernet Sauvignon berry developmental series during the development and ripening during three growing seasons. ....	38
Figure 2.7: Comparison of ABA levels in cv. Cabernet Sauvignon berry skin, flesh and seed tissues for 2003-04 season.. ....	40
Figure 3.1: Relative gene expression of ABA biosynthesis genes measured during the development of cv. Cabernet Sauvignon grape berries during the 2000-01 season. ....	57
Figure 3.2: Relative gene expression of ripening associated genes measured during the development of cv. Cabernet Sauvignon grape berries during the 2000-01 season.. ....	58
Figure 3.3: Relative gene expression of ABA biosynthesis genes measured during the development and ripening of cv. Cabernet Sauvignon grape berries during the 2002-03 Berry Series. ....	59
Figure 3.4: Relative gene expression of ripening associated genes measured during the development and ripening of cv. Cabernet Sauvignon grape berries during the 2002-03 Berry Series.. ....	61
Figure 3.5: Relative gene expression of ABA biosynthesis genes measured during the development and ripening of cv. Cabernet Sauvignon grape berries during the 2003-04 Berry Series.. ....	63
Figure 3.6: Relative gene expression of ripening associated genes measured during the development and ripening of cv. Cabernet Sauvignon grape berries during the 2003-04 Berry Series.. ....	65

Figure 3.7: Relative gene expression of ABA biosynthesis genes measured during the development and ripening of cv. Cabernet Sauvignon grape berries skin, flesh and seed tissues during the 2003-04 Berry Series..	67
Figure 3.8: Relative gene expression of ripening associated genes measured during the development and ripening of cv. Cabernet Sauvignon grape berries skin, flesh and seed tissues during the 2003-04 Berry Series..	68
Figure 4.1: Comparison of free ABA levels measured during the 48 hour <i>in vitro</i> inductions of cv. Cabernet Sauvignon grape berries harvested on the 24-01-03.....	83
Figure 4.2: Comparison of free ABA levels measured during the 48 hour <i>in vitro</i> inductions of cv. Cabernet Sauvignon grape berries harvested on the 30-01-03.....	84
Figure 4.3: Comparison of free ABA levels measured during the 48 hour <i>in vitro</i> inductions of cv. Cabernet Sauvignon grape berries harvested on the 04-02-03.....	86
Figure 4.4: Comparison of free ABA levels measured during 24 hour <i>in vitro</i> inductions of cv. Cabernet Sauvignon grape berries harvested on the 09-01-04.....	88
Figure 4.5: Relative gene expression of ripening associated genes measured during the 24 hour <i>in vitro</i> inductions of cv. Cabernet Sauvignon grape berries harvested on the 09-01-04.....	89
Figure 4.6: Relative gene expression of ripening associated genes measured during the 24 hour <i>in vitro</i> inductions of cv. Cabernet Sauvignon grape berries harvested on the 09-01-04.....	91
Figure 4.7: Comparison of free ABA levels in Cabernet Sauvignon suspension cell cultures induced with various osmolites for 24 hours..	92
Figure 4.8: Comparison of free ABA levels in Riesling berry suspension cell cultures induced with various osmolites for 4 hours..	93
Figure 5.1: Nepenthe Lenswood Spray Experiment 05-02-2004.....	109
Figure 5.2: Nepenthe Lenswood Spray Experiment 10-02-2004.....	110
Figure 5.3: Nepenthe Lenswood Spray Experiment 19-02-2004.....	111
Figure 5.4: 2004 Nepenthe Lenswood Cabernet Sauvignon ABA Spray experiment..	113
Figure 5.5: 2004 Nepenthe Lenswood Cabernet Sauvignon ABA Spray experiment..	115
Figure 5.6: Nepenthe Charleston Spray Experiment 04-02-2005.....	117
Figure 5.7: Nepenthe Charleston Spray Experiment 11-02-2005..	<b>Error! Bookmark not defined.</b>
Figure 5.8: Nepenthe Charleston Spray Experiment 18-02-2005..	<b>Error! Bookmark not defined.</b>
Figure 5.9: 2005 Nepenthe Charleston Cabernet Sauvignon ABA Spray experiment.....	120
Figure 5.10: 2005 Nepenthe Lenswood Cabernet Sauvignon ABA Spray experiment..	122
Figure 5.11: 2005 Nepenthe Lenswood Cabernet Sauvignon ABA Spray experiment..	123

## List of tables

Table 2.1: Sampling dates for Cabernet Sauvignon berries Slate Creek Vineyard.....	26
Table 5.1: 2004 ABA spray and sampling regime Nepenthe Lenswood Vineyard.....	106
Table 5.2: 2005 ABA spray and sampling regime Nepenthe Charleston Vineyard .....	107