The Role of Abscisic Acid in Grape Berry Development

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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.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Susan Wheeler
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Abbreviations

1-MCP	1-methylcyclopropene
A_{520}	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-*tetra*-acetic acid
EST	expressed sequence tag
Fruc	fructose
FW	fresh weight
g	gram(s)
g	relative centrifugal force
GA	gibberellin
GC/MS	gas chromatography/mass spectrometry
GE	glucosyl ester
Glu	glucose
GRIP	grape ripening induced protein
h	hour(s)
HPLC	high performance liquid chromatography
IAA	indole-3-acetic acid
IPTG	*Iso*-propyl-β-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
Tm	temperature of DNA disassociation (melt)
Tris	tris(hydroxymethyl)aminomethane
V	volt(s)
w/v	weight per volume
Wpf	weeks postflowering
ZEP	zeaxanthin epoxidase

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