



Flavonoids in grapes

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PLANT INDUSTRY
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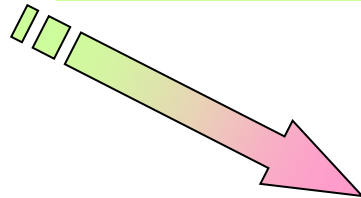


Grapes to wine – a 2° metabolic zoo



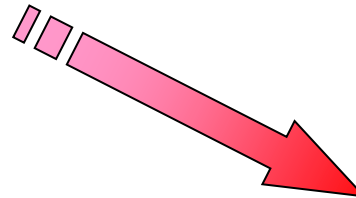
Grapevines

- Grape variety
- Soil, climate etc
- Vineyard management
- Seasonal influences
- Harvest timing



Grapes

- Transport & storage
- Processing
- Fermentation
- Pressing
- Added tannin, oak etc
- Ageing



Wine



Consumer

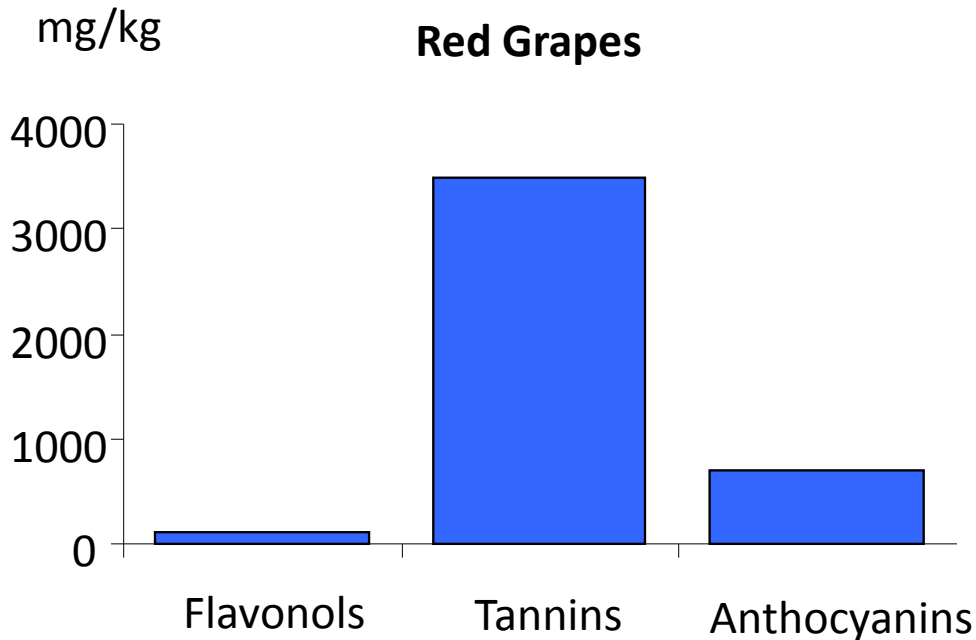


Hundreds of different metabolites determine 'Wine Quality'

Many of these compounds are synthesised in the grape berry

Flavonoids in grapes

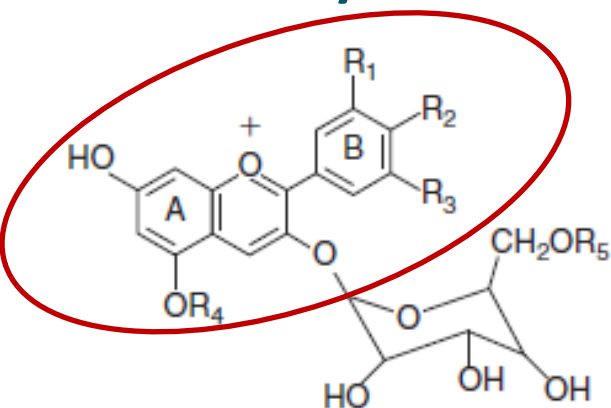
- Flavonoids are important for the colour & taste of wine
- Tannins are the major flavonoid present in grapes and wine
- Tannins plus anthocyanins form pigmented polymers



Flavonoids – a diverse range of compounds



Basic anthocyanin structure



- Complex metabolic pathway
- 1,000's of different flavonoids
- Pathway can be manipulated

NAME	R1	R2	R3
Cyanin	OH	OH	H
Peonin	OCH ₃	OH	H
Delphinin	OH	OH	OH
Petunin	OCH ₃	OH	OH
Malvin	OCH ₃	OH	OCH ₃

DERIVATIVES

R4 – H: monoglucoside; glucose: diglucoside

R5 – acetyl, *p*-coumaroyl, caffeoyl



*'Moon' series carnations :
on sale since 1996*

Flavonoid biosynthetic pathway in grape



Good knowledge of this pathway in grapes

Coumaroyl-CoA

CHS

Chalcones

CHI

Flavanones

F3H

F3'H

F3'5'H

Dihydroflavonols

Dihydroflavonols

FLS

FGT

Flavonols

DFR

Leucoanthocyanidin

DFR

Leucoanthocyanidin

LAR

Catechin

LDOX

Anthocyanidin

LDOX

Anthocyanidin

ANR

Epicatechin

UFGT

Anthocyanins

Malvidin-3-glucoside

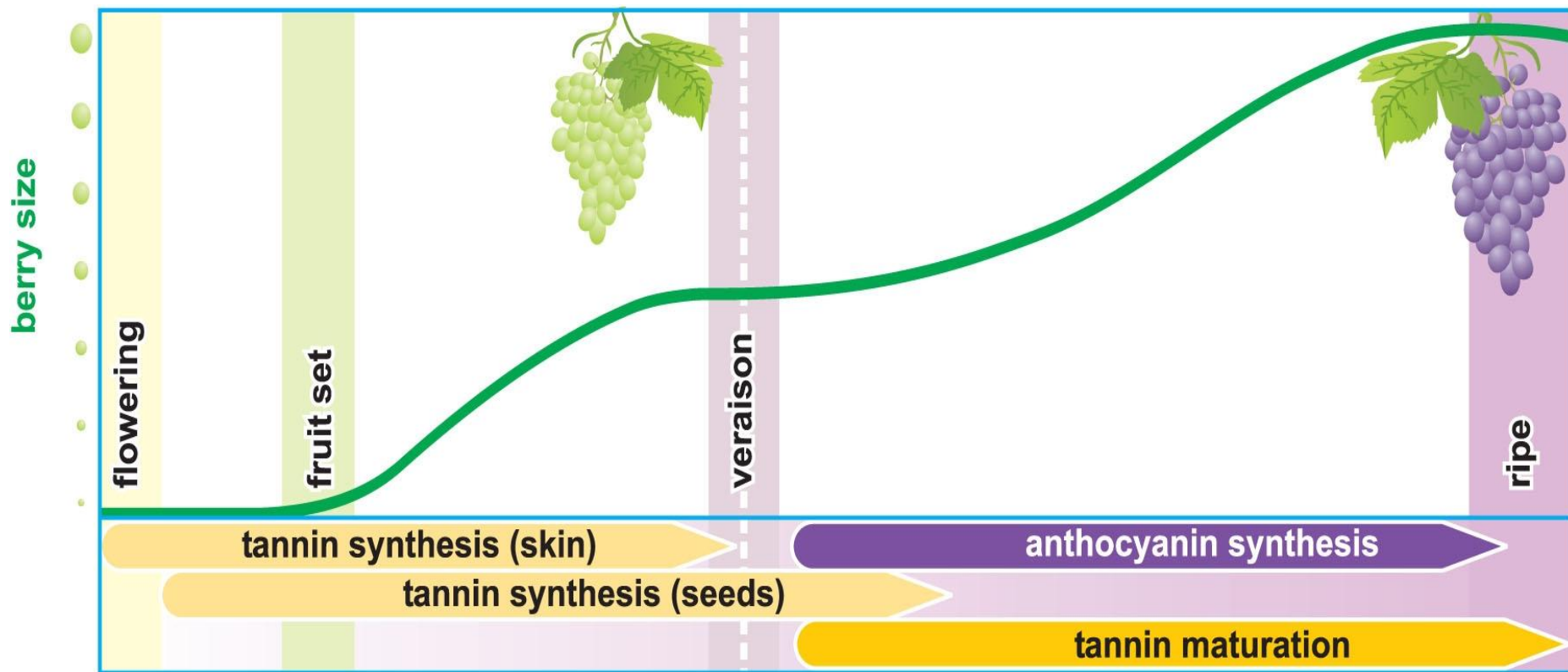
UFGT

Anthocyanins

?

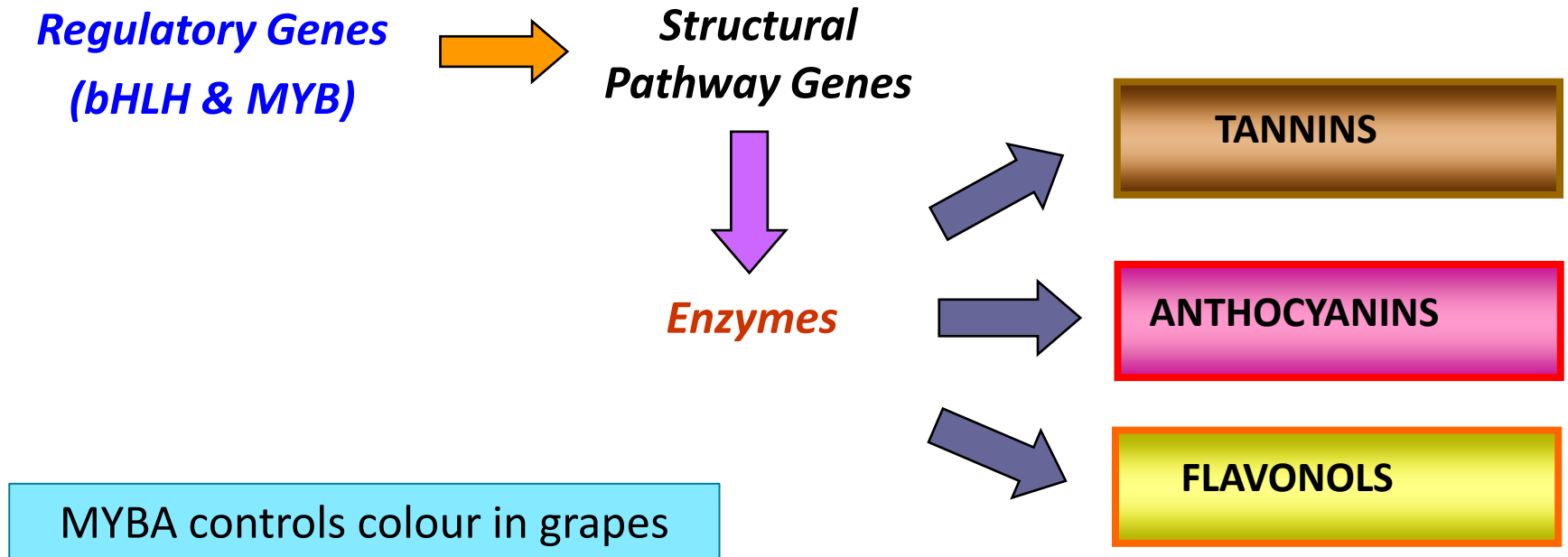
Tannins

Tannin synthesis and maturation



- Anthocyanins are synthesised after veraison
- Tannins and flavonols are made between flowering & veraison
- Tannin maturation occurs from veraison to harvest

Regulatory 'Master Genes' control the pathway



MYBA controls anthocyanin synthesis

'Black' Chardonnay
– gain of *VvMYBA* gene expression



Chardonnay



MYBA
promoter



35S
promoter

'Pink' and 'White' Shiraz
– reduction of *VvMYBA* gene expression



Shiraz

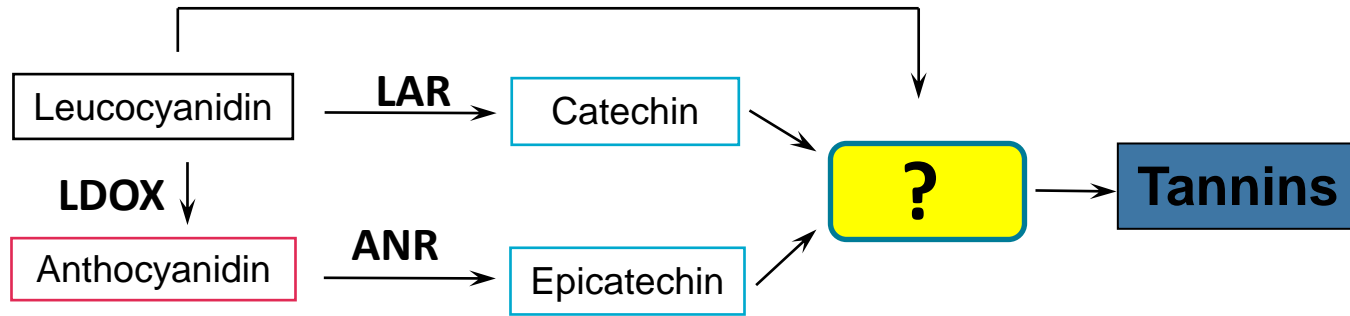


Pink



White

Formation of tannin polymers



Leucocyanidin

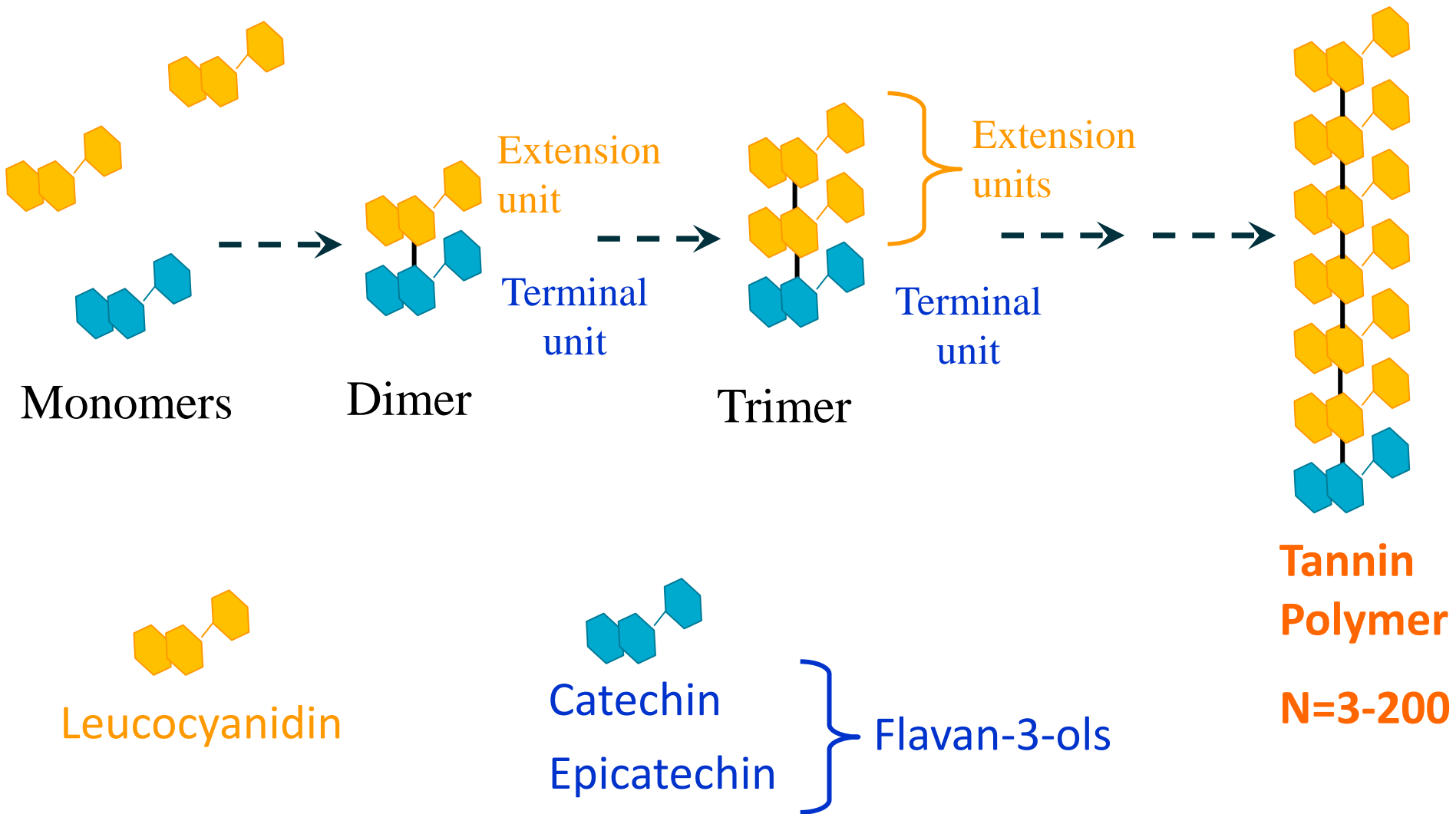


Catechin

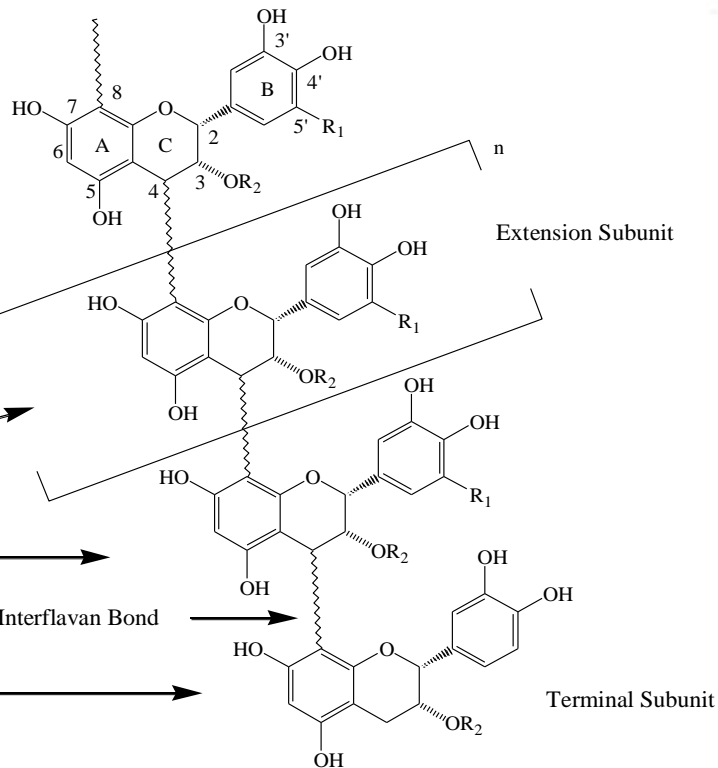
Epicatechin

} Flavan-3-ols

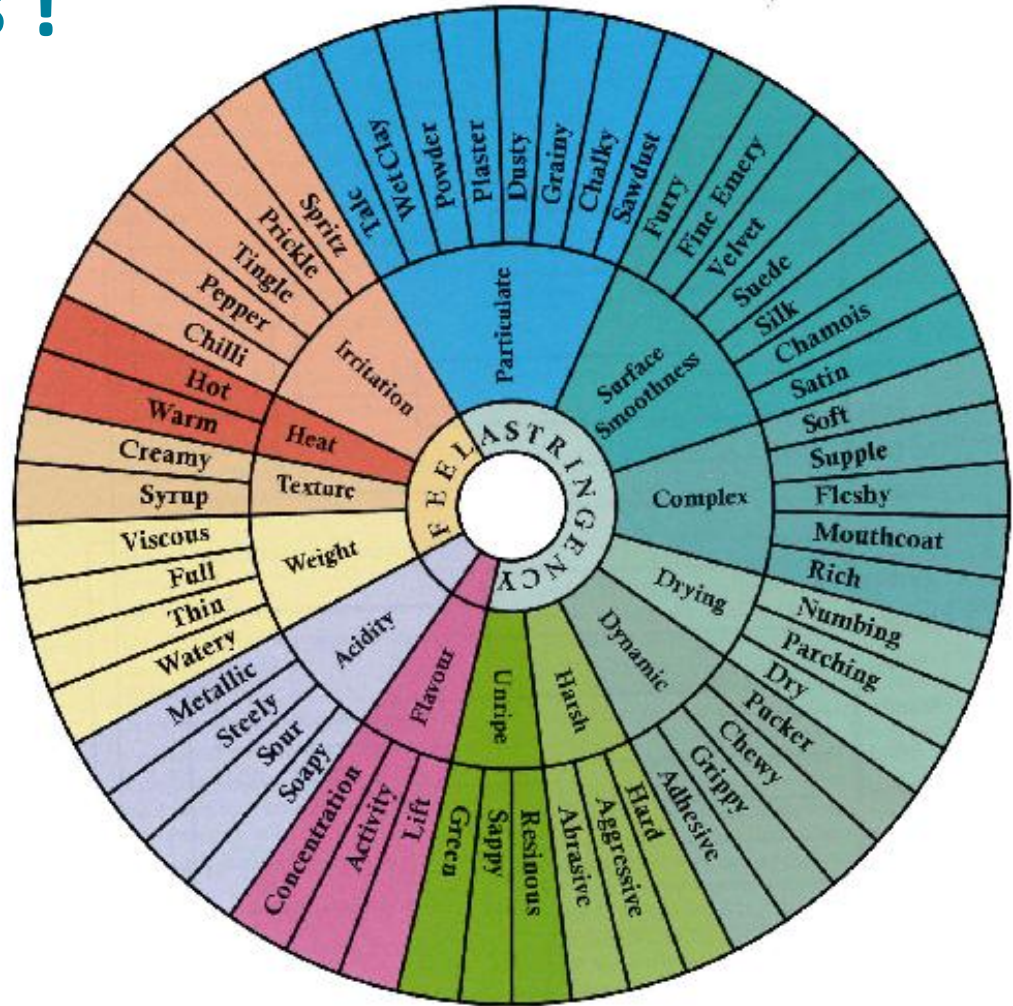
Formation of tannin polymers



Tannins ain't tannins !



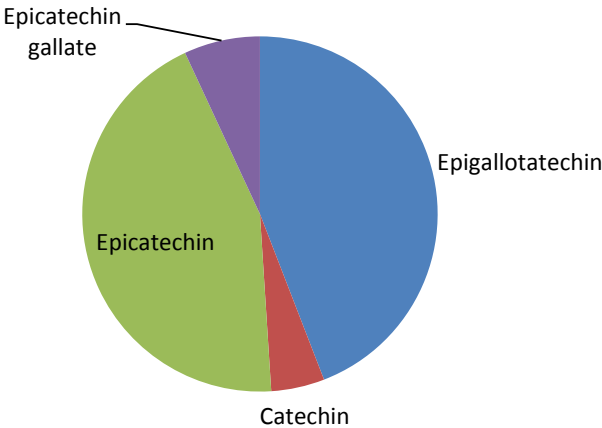
- Seed tannins mdp ≈ 5 units
- Skin tannins mdp ≈ 25 units
- Different polymer composition



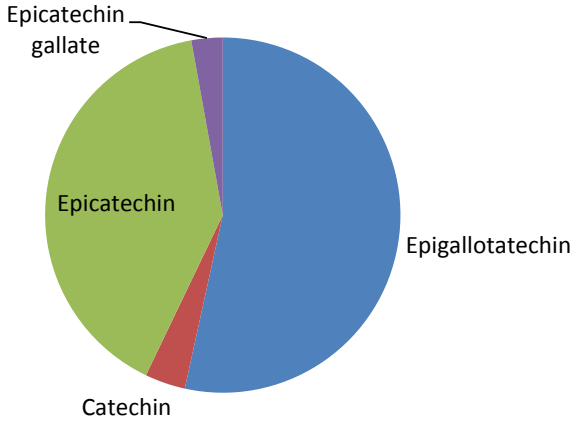
We need to know about tannin composition, as well as the total amount

Tannin composition

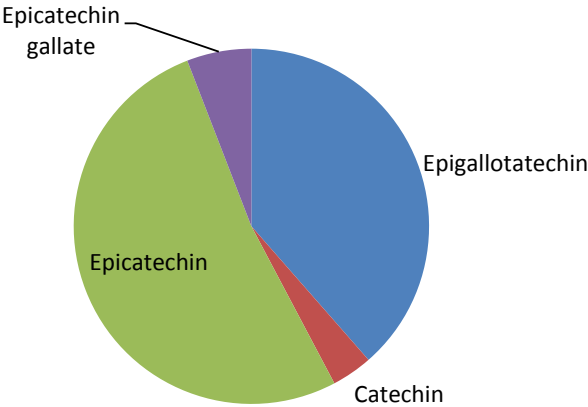
Sunraysia Shiraz 2008



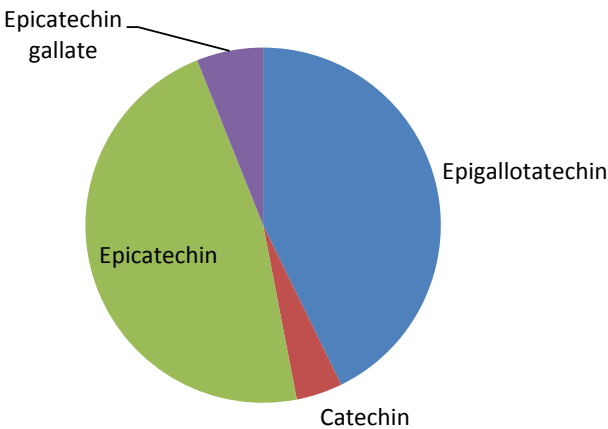
Sunraysia Cabernet Sauvignon 2008



Sunraysia Shiraz 2009

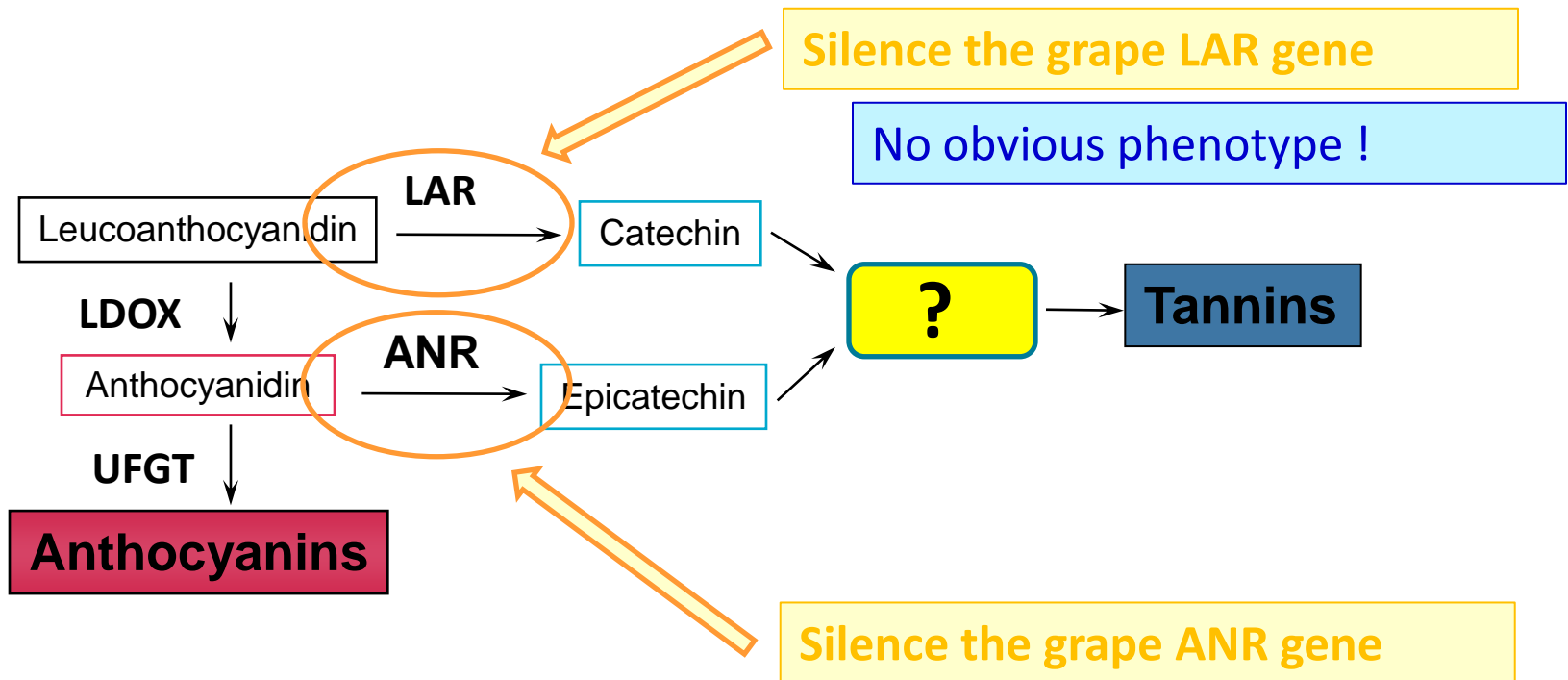


Glenrowan Shiraz 2009



Role of ANR & LAR in tannin synthesis using transgenic grapevines

Silence the genes for ANR & LAR to decrease their enzyme activity and determine the effect on tannin synthesis and grape tannin composition



Silencing tannin genes



Shiraz



VvANR Si

Anthocyanin

Flavonol

Tannin

	VvANR Si
leaves	More cyanidin
roots	normal
berries	More cyanidin
leaves	More flavonols
seeds	Lots of flavonols
skins	More flavonols
skins	Less tannin
seeds	Same tannin ?
leaves	Less tannin

- Less tannin in leaves & grape skins from ANR Si lines (10-30% Controls)
- Changes in composition – extension units have less epicatechin, more catechin & epigallocatechin
- Seed tannin slightly lower (70-85% Controls)
- Impact on wine?

How do you manage colour in the vineyard?

Where are you now?

Where do you want to be?

- More grape colour ?
- Better colour extraction & stability ?
- Better anthocyanin composition ?



- Season & site are the biggest drivers of variation
- Day and night temperatures
- Practices that effect colour include:
 - Yield / vigour / vine balance
 - Rootstocks
 - Irrigation
 - Canopy management / bunch exposure
 - Vineyard variability

**Based on grape or
wine observations?**



How do you manage tannin in the vineyard?

Where are you now?

Where do you want to be?

- More tannin
- Less tannin
- Different tannin
- Better tannin
 - Smooth tannin
 - Soft tannin
 - Persistent tannin

**Based on grape or
wine observations?**



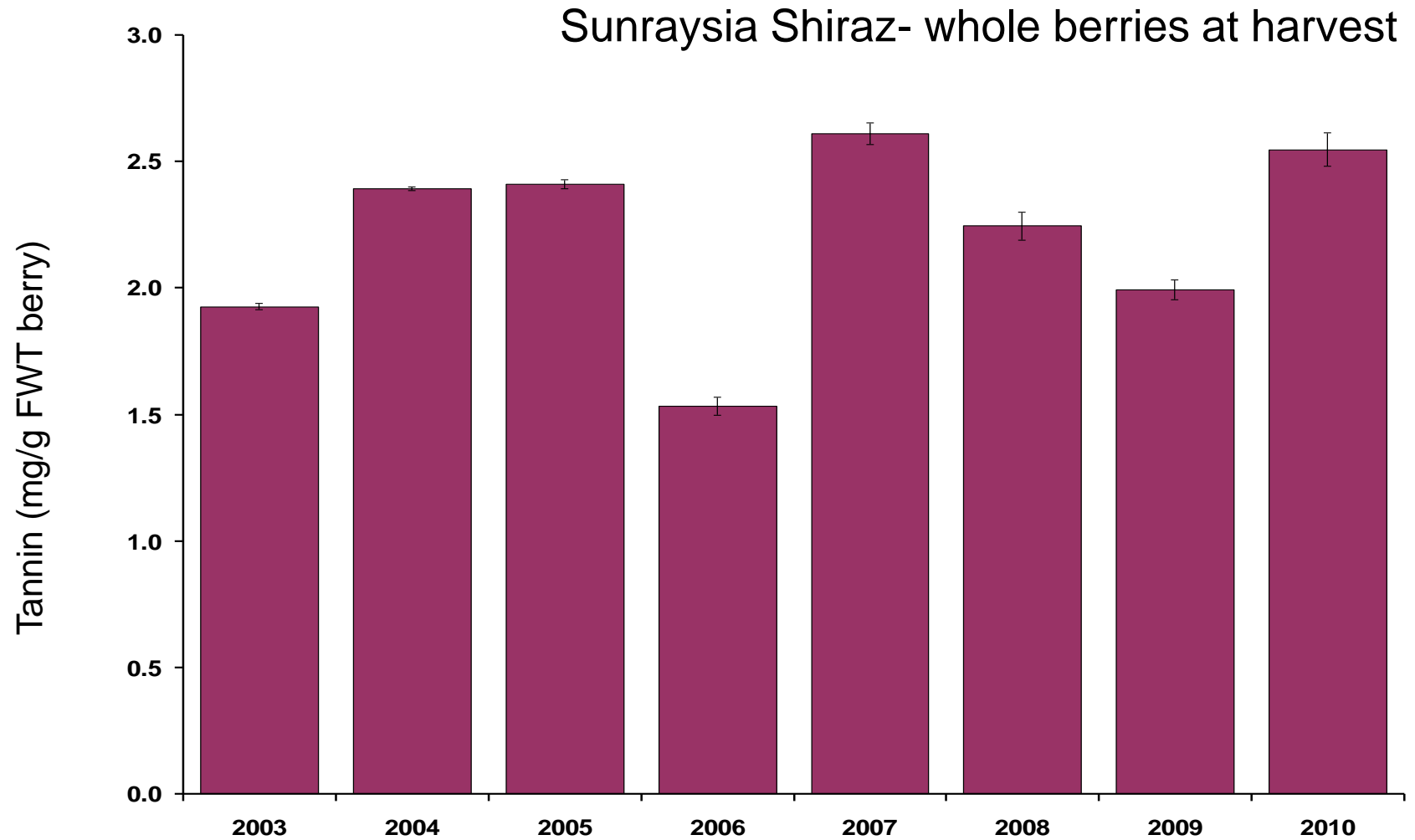
Grape tannin versus wine tannin

- How much tannin is in the grapes ?
- How much of that tannin is extracted into must ?
- How stable is the tannin in the wine ?

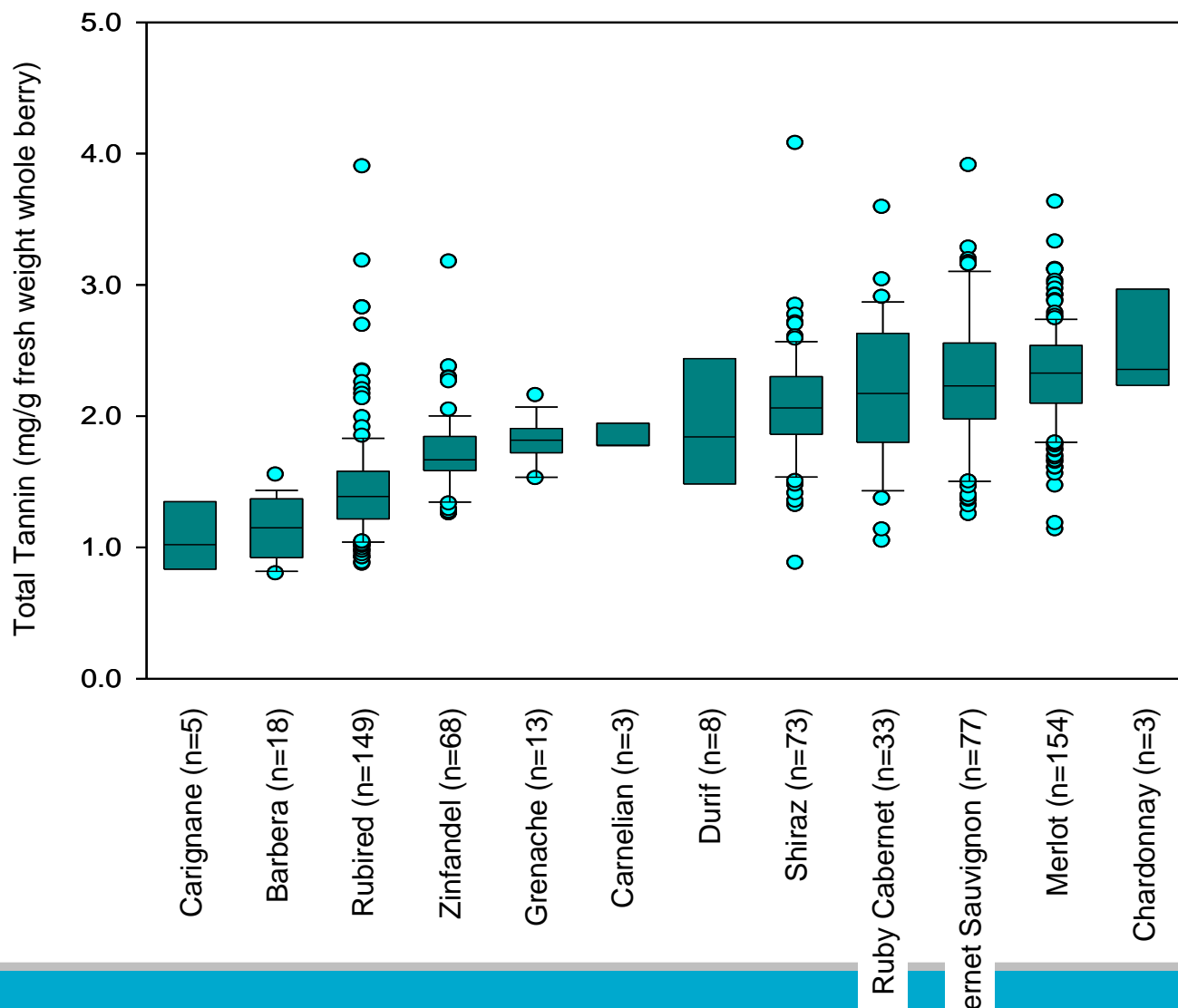
Wine Tannin = Grape Tannin x Extractability x Stability

If the tannin isn't extracted during winemaking, there's no point trying to get more into the grapes.

Season effects



Variation between varieties

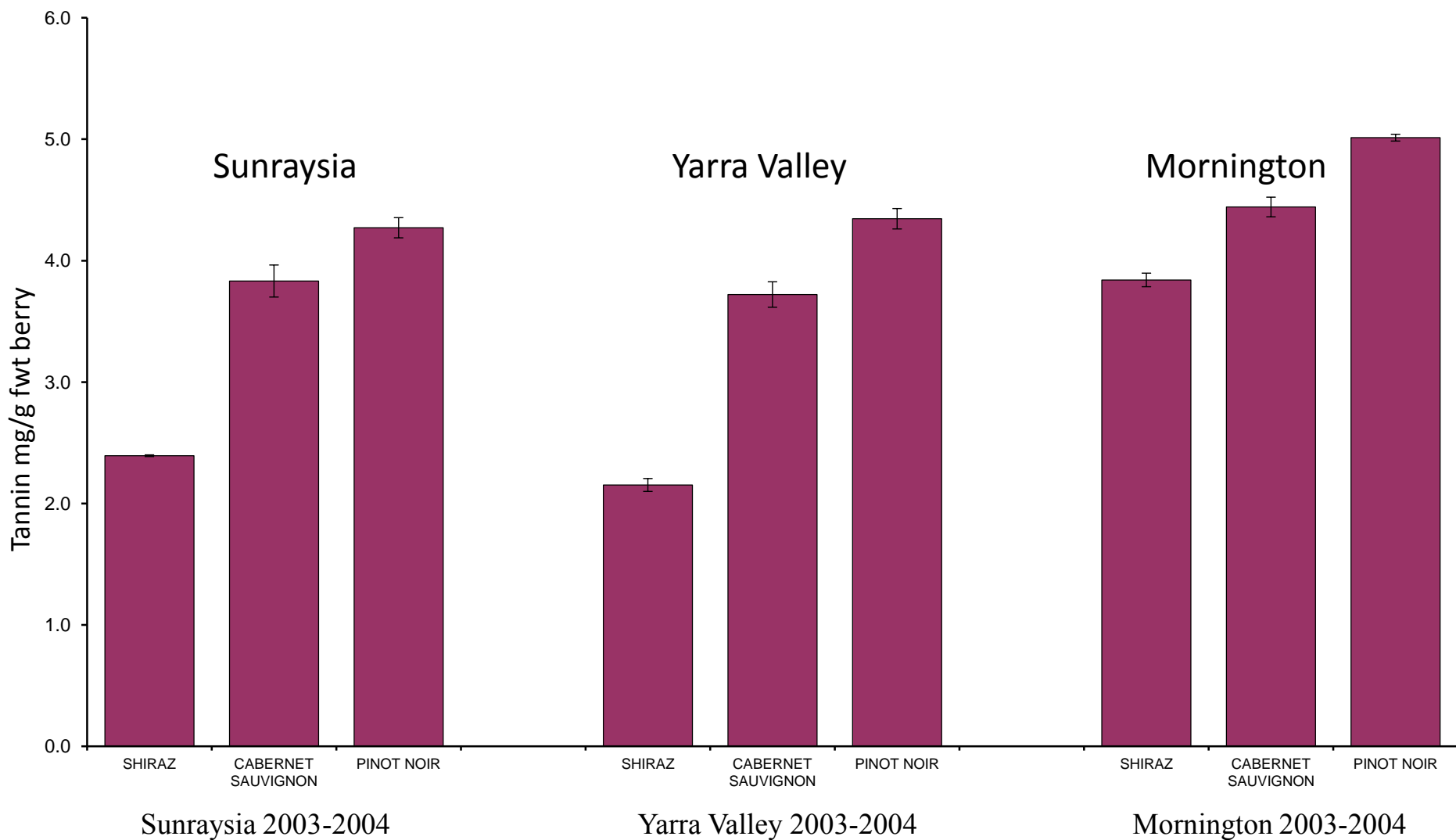


~600 grape samples

whole berry homogenate

Californian vineyards

Varietal differences and site effects



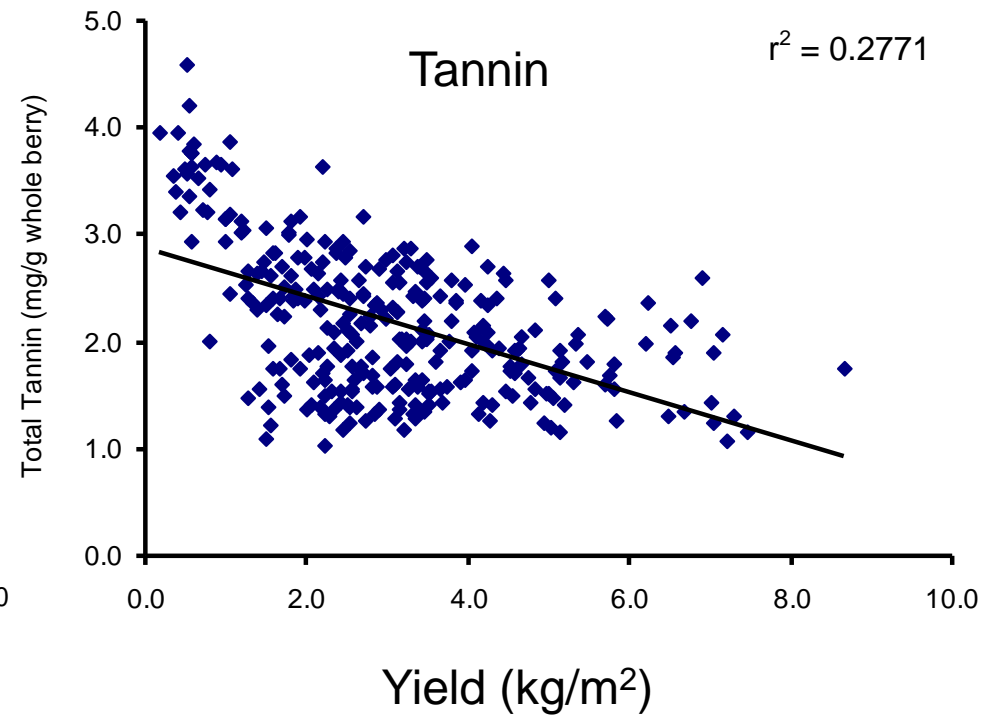
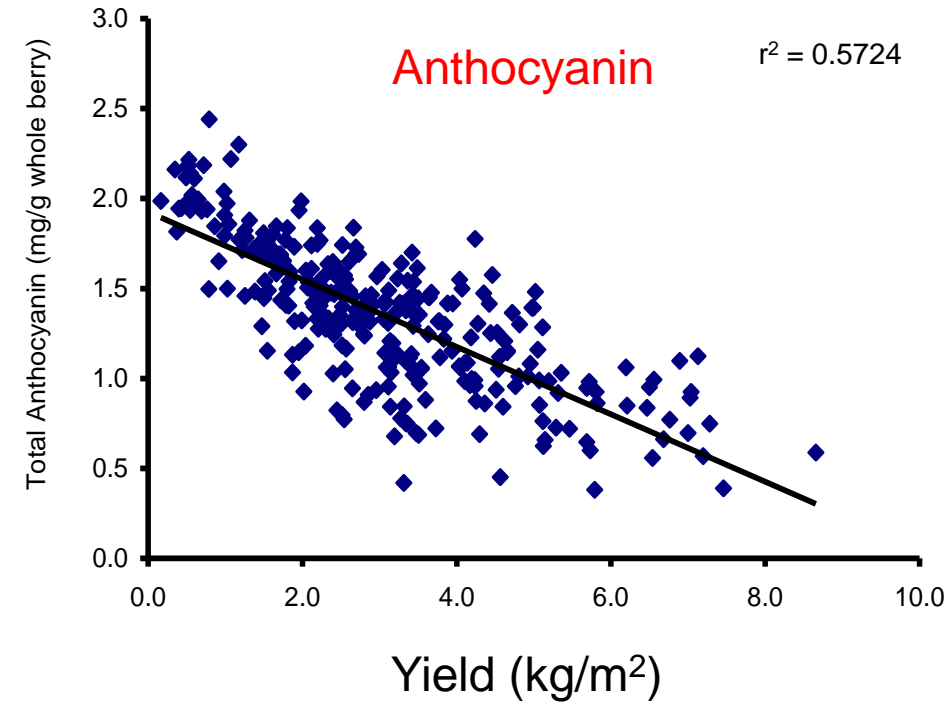
Viticultural management

- Season is the biggest driver of variation
- Understanding other drivers creates management strategies
- Practices that effect tannins might include:
 - Irrigation
 - Canopy management
 - Trellis design
 - Nutrient status
 - Pruning
 - Harvest date
 - Cover crop
 - Mulching
 - Rootstock



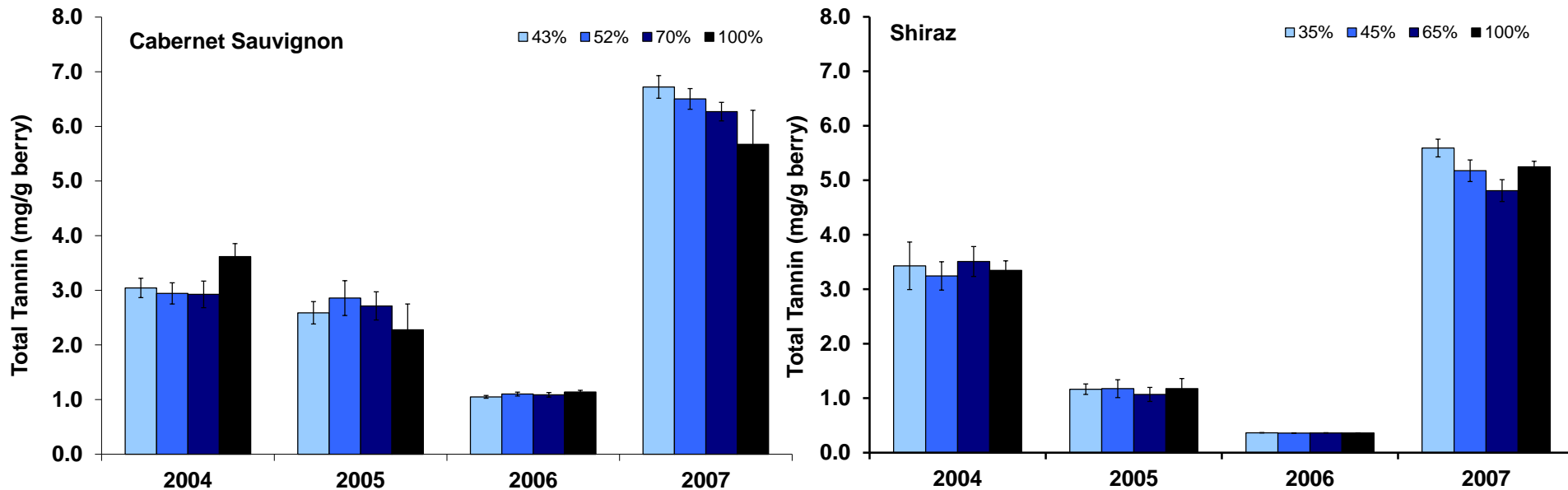
Yield

California



Sustained deficit irrigation

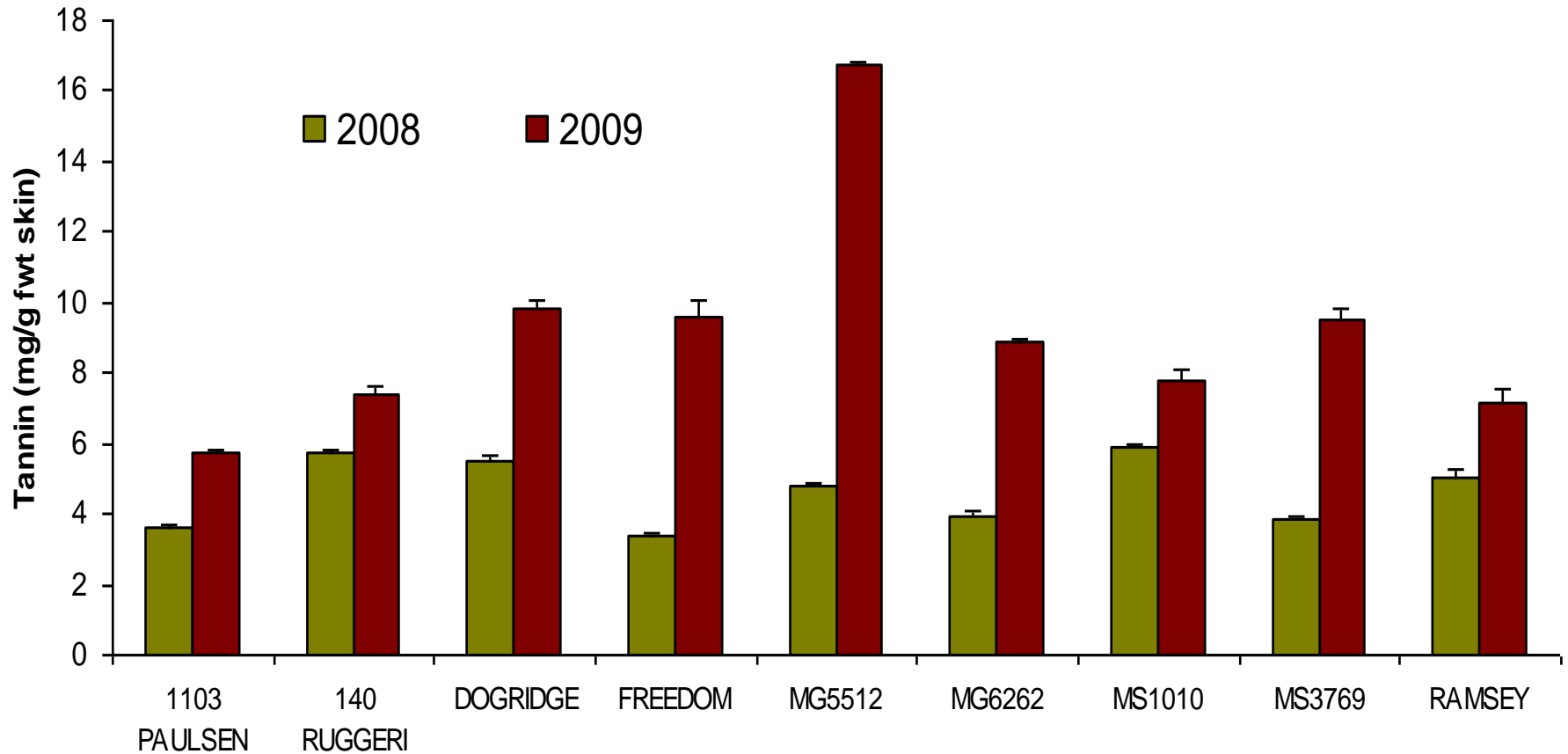
Sunraysia



- Large seasonal variation
- Irrigation has no major effect on tannin synthesis
- It may effect vigour, berry size and tannin extractability

Rootstocks

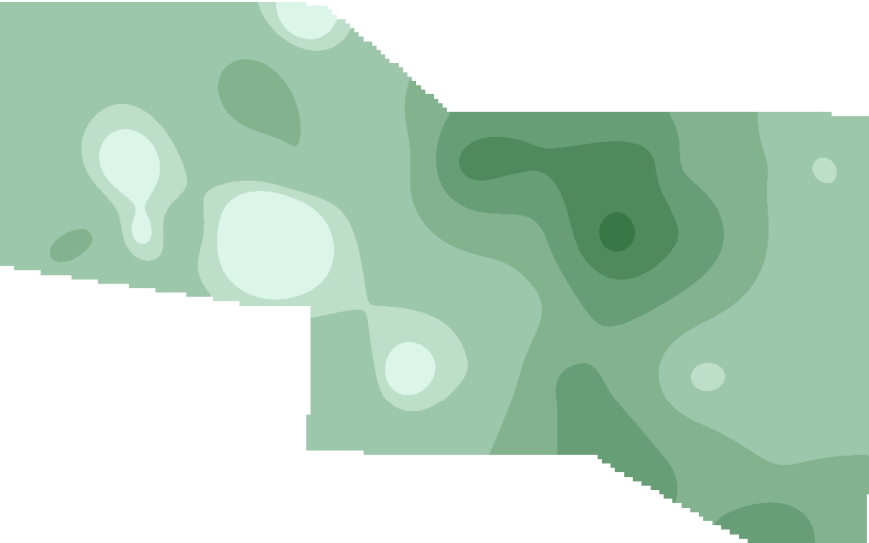
Sunraysia Shiraz



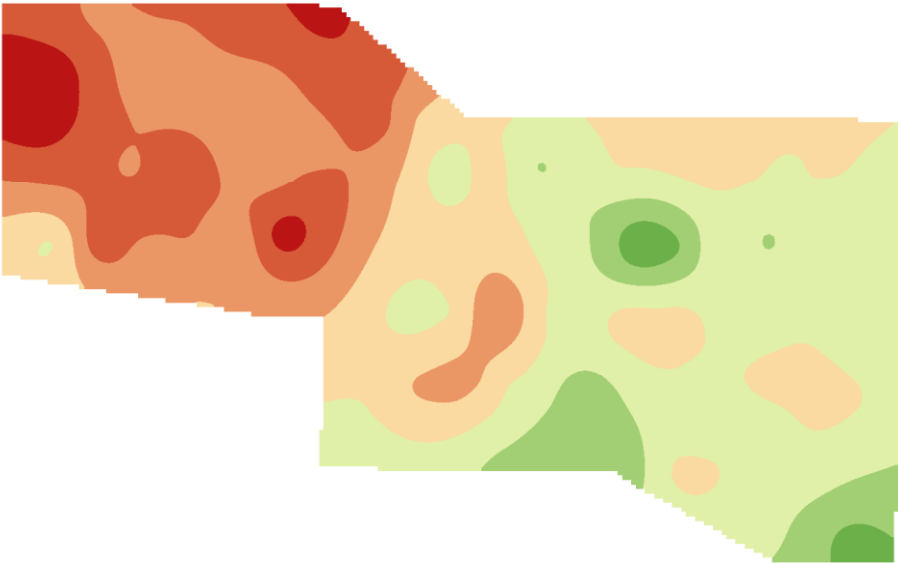
Vine vigour

Sunraysia Shiraz

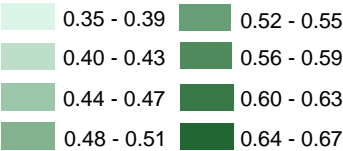
Averaged Verasion to Harvest 2007
Canopy Assessments



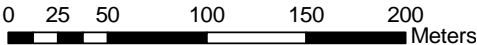
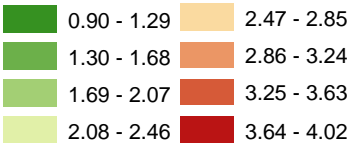
Tannins at Harvest 2007



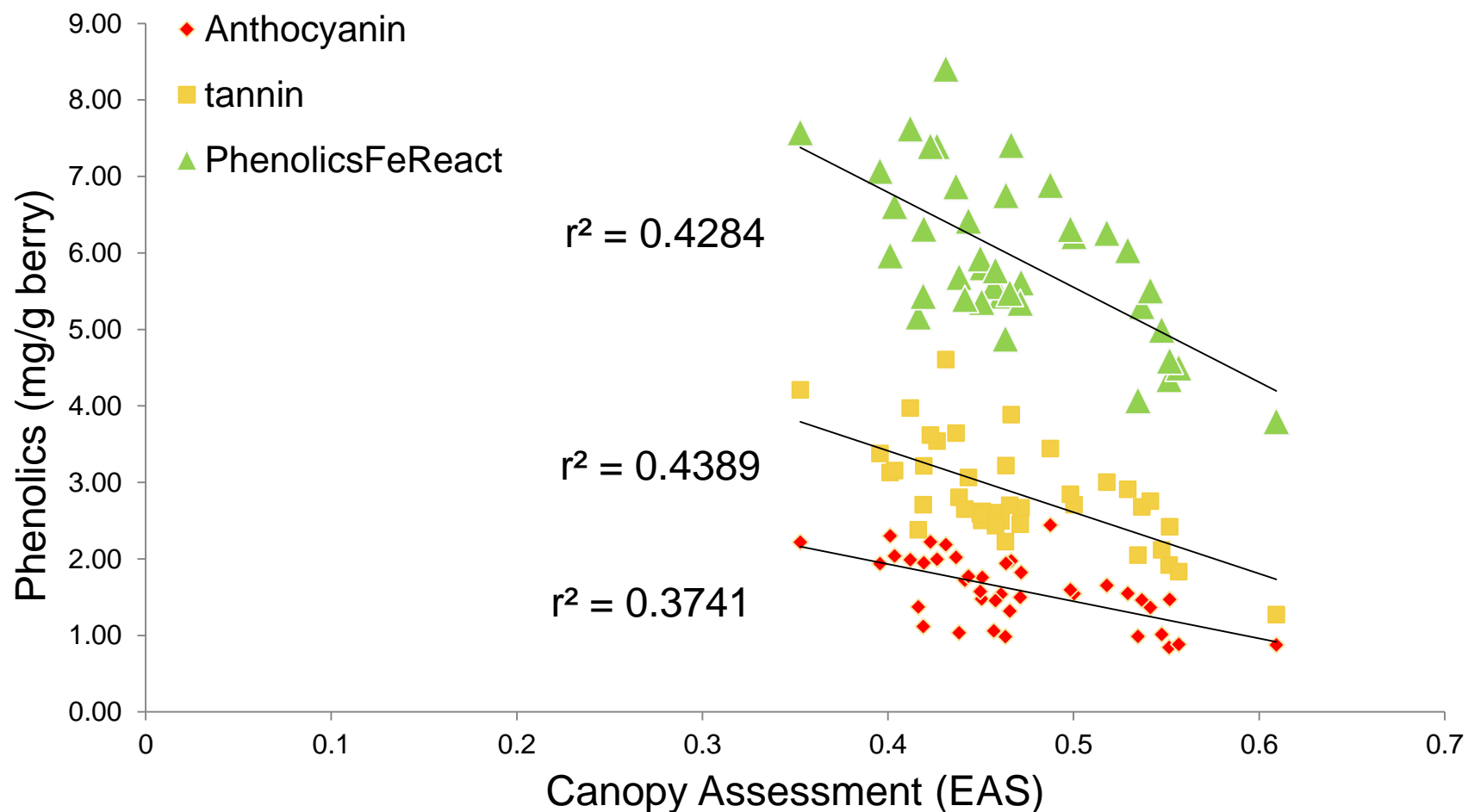
Canopy Assessments (EAS)



Tannins (mg/g berry CE)



Vine vigour

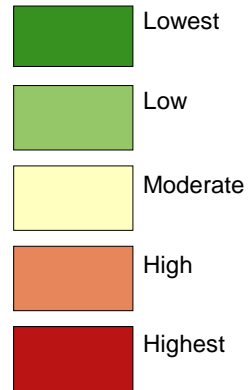


Vineyard variability

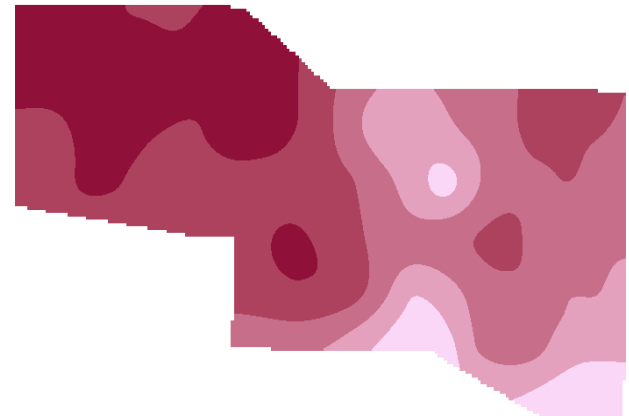
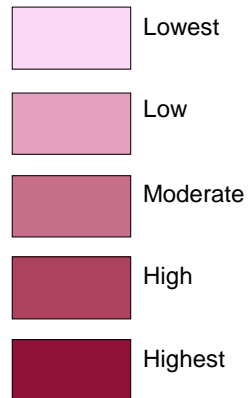
Sunraysia Shiraz



Sum of normalised Tannins

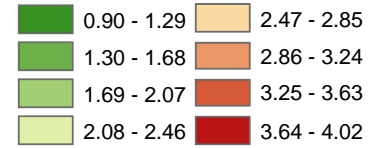


Sum of normalised anthocyanins



Vineyard variability

Tannins (mg/g berry CE)



0 25 50 100 150 200 Meters

2006

2007

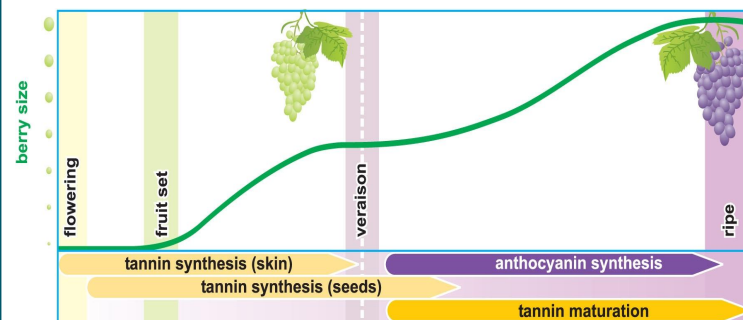
2008

2009

Tannins at Harvest

Summary

- Tannin synthesis to veraison
- Tannin maturation post-veraison
- Measurement
- Tannin composition & extractability



- ❖ Season & site
- ❖ Yield / vigour / vine balance
- ❖ Irrigation
- ❖ Rootstocks
- ❖ Vineyard variability



Thank you

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