GRAPE & WINE ROADSHOW

McLaren Vale Seminar

Tuesday 3rd September, 2013

AWRI

Vine balance – how does it affect yield and quality?
Mark Krstic

Does soil and vine nutrient status affect wine quality?
Marcel Essling

Morning Tea

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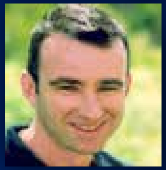
Importance of sampling for quality parameters in the vineyard
Mark Krstic

Berry sensory assessment in the vineyard for Fruit grading – does it work?
Marcel Essling



Rainfall redirection for managing soil salinity in the vineyard
Tim Pitt, SARDI

Lunch

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Managing stuck fermentation and rescue procedures

Paul Henschke

Afternoon Tea

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Pepper and spice in Shiraz: what influences rotundone levels in wines?
Tracey Siebert

The origin of eucalyptol and minty flavour in red wines
Dimi Capone

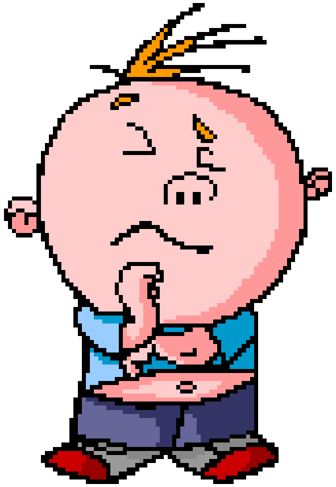
Features of the AWRI website and closing comments
Mark Krstic

Vine balance – how does it affect yield and wine quality?

Mark Krstic

Case study

The Australian Wine
Research Institute



Which block would your winemaker choose?

The Australian Wine Research Institute

- Cabernet Sauvignon/cool climate

A: 8 t/ha

B: 3 t/ha

Cabernet Sauv./cool climate

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Research Institute

Which block would your winemaker choose?

A

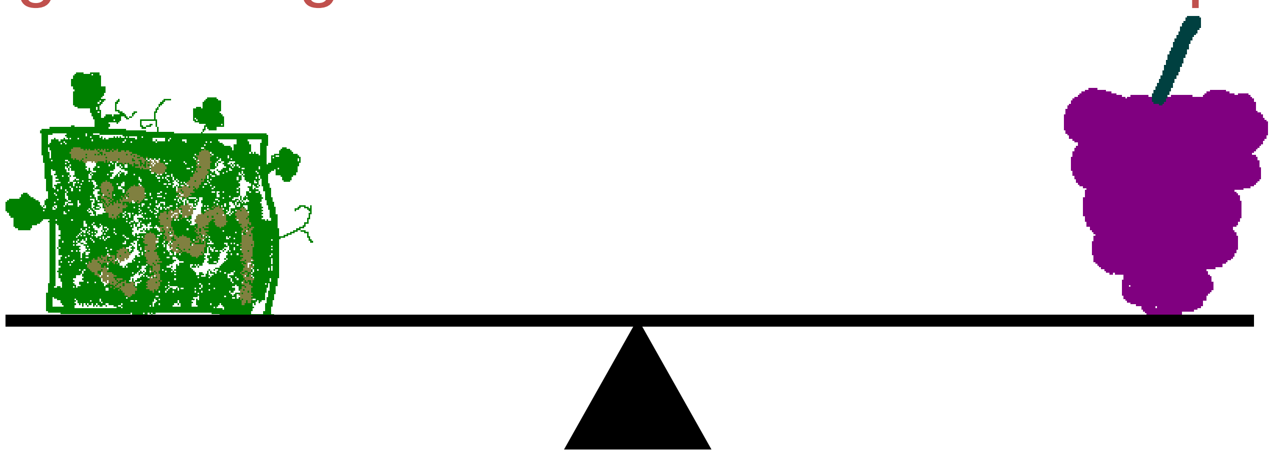
B

‘Balance is achieved when vegetative vigour and fruit load are in equilibrium and consistent with high fruit quality’

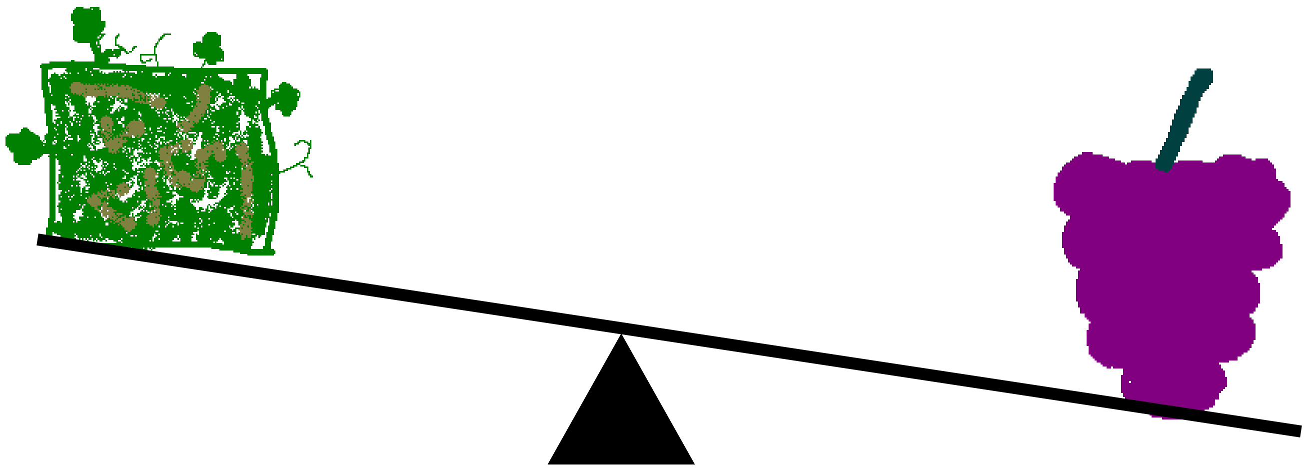
Gladstones (1992) Viticulture and Environment

Vegetative growth

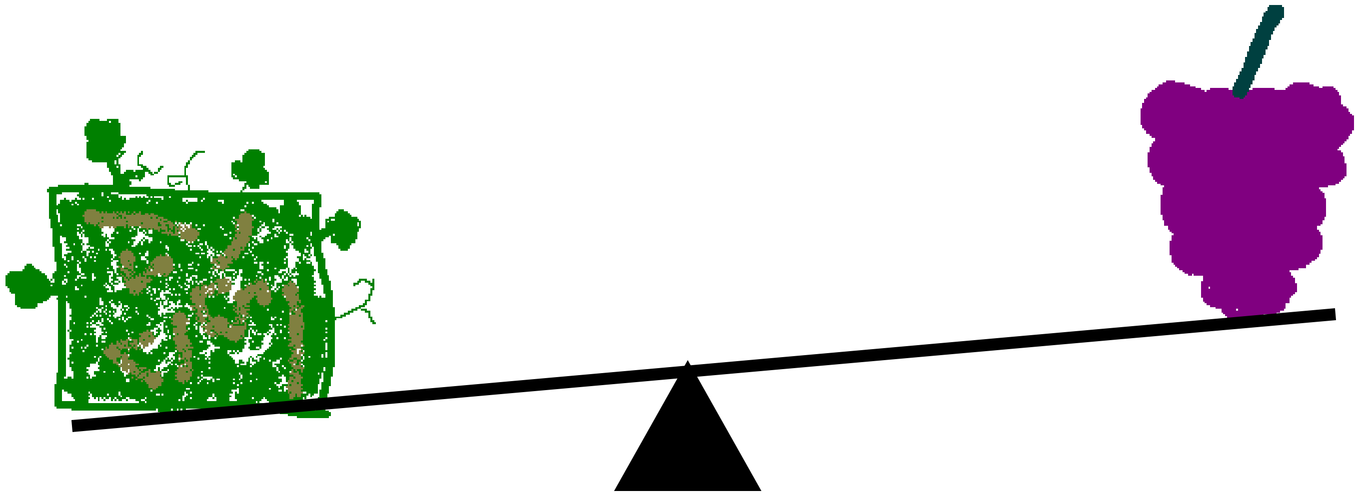
Fruit production



‘overcropping’



excessive vigour; undercropping



The Indices of Vine Balance

The Australian Wine Research Institute

1. Fruit yield to pruning weight

(Y/P, Ravaz Index)

- Recommended range for Y/P is generally between 5 and 10

Cool climates

Hot climates

This is easy to calculate

Fruit yield to pruning weight contd

The Australian Wine
Research Institute

Y/P = 6

Y/P = 2

2. Leaf Area to Fruit Yield ratio (LA/Y)

- Recommended range:

0.5 to 1.5 m^2/kg

Hot climates

Cool climates

Divided canopies

Single canopies

Measuring leaf area

- Sampling and counting
- Measure pruning weight
  - LA (m2) = PWT (kg) x 6.6

What else can you use to estimate balance?

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- Cessation of shoot growth by veraison

Can this be quantified?

A diversion to Bordeaux

Source: van Leeuwen et al. (2004)

- Terroir study
- 3 soil types
  - 'dry' = gravelly
  - 'moist' = clay subsoil
  - 'wet' = sandy + roots in contact with high water table
- Cab Sauv, Cab Franc, Merlot

What were the seasonal factors most closely associated with vintage rating?

The Australian Wine Research Institute

- Yield?
- Berry size?
- Sunshine?
- Temperature?
    - mean or day degrees
- Length of ripening period?
- Rainfall?

What were the seasonal factors most closely associated with vintage rating?

The Australian Wine Research Institute

- ~~Yield?~~
- ~~Berry size?~~
- ~~Sunshine?~~
- ~~Temperature?~~
- ~~Length of ripening period?~~
- Rainfall? – flowering to harvest yes

What were the seasonal factors most closely associated with vintage rating?

- Best vintages where water supply to vine from flowering to harvest was most limiting
- Either soil effect or seasonal effect or both
- Water deficit prior to veraison →
  early cessation of shoot growth

Cessation of shoot growth by veraison

- Why is this significant?
- Diversion of resources to fruit?
  - Or some other factor?
- Diversion of resources to roots?
  - ® increased supply of hormones from roots to ripening fruit?

Vine balance

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Research Institute

- Berry weight/size
- Yield

Are these good indicators of vine balance?

Yield and vine balance

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Research Institute

C grade
20 t/ha

A grade
5 t/ha

Bunch thin to 5 t/ha
Improved balance?

Bunch thin to 5 t/ha
Improved balance? No
Same wine quality as B? No

Yield

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Research Institute

- low yielding vineyards MAY produce better wine than high yielding

- However, it is not necessarily the low yield *per se* — rather it is where the vines are grown and the way that they are managed that determines the quality.

Yield reduction

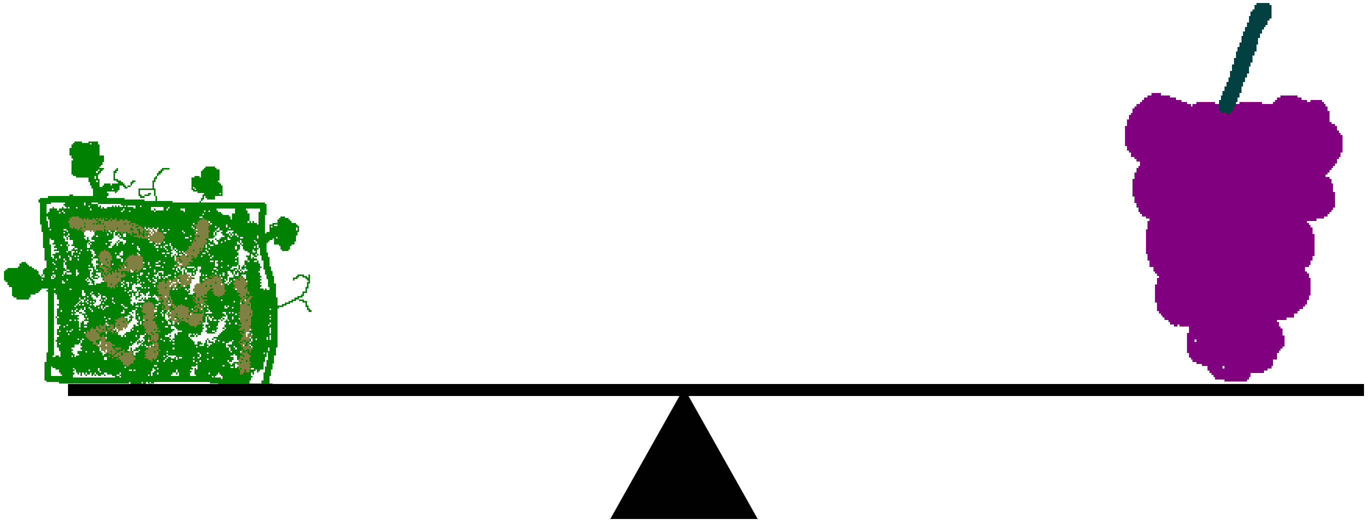
The Australian Wine Research Institute

- Yield reduction (e.g. bunch thinning) does not automatically ensure good wine quality
  - And it may decrease quality

- But there may be a yield limit above which quality decreases
  - Perhaps root system is involved

How to Achieve Balance

The Australian Wine Research Institute



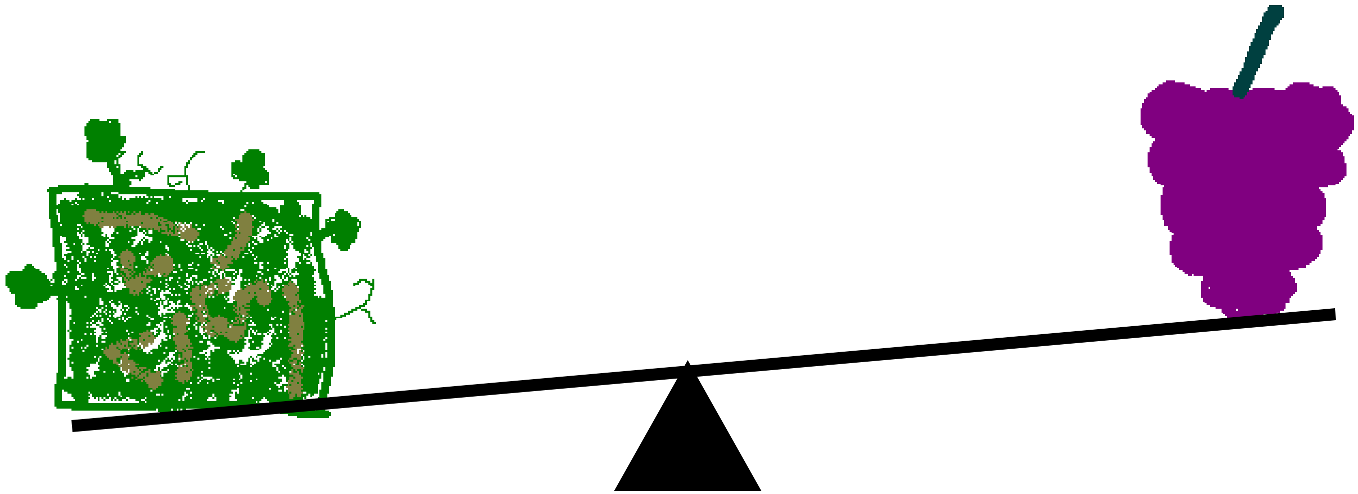
How to Achieve Balance: some principles

The Australian Wine Research Institute

- Need to achieve balance prior to veraison
- Need to develop adequate LA for ripening
- Avoid excessive shoot vigour

The Australian Wine Research Institute

What do you do if vineyard is like this?



- control vegetative growth by inducing mild to moderate water stress

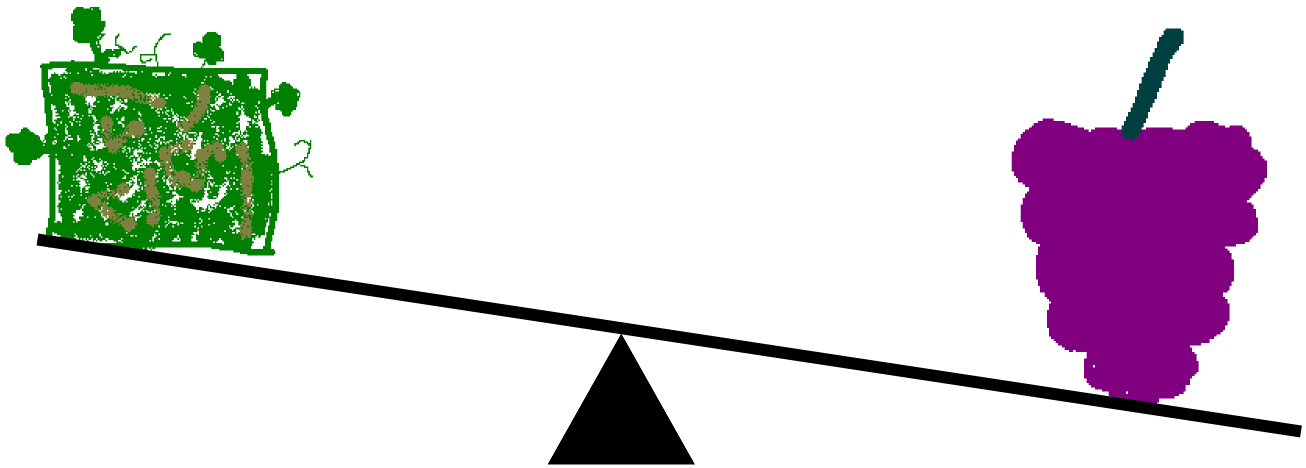
Irrigation management

Soil management

How to switch off shoot growth by veraison

- Limit water (and to lesser extent N) supply
  - Relatively easy in low rainfall climate
- In high rainfall must have low capacity soils

What do you do if vineyard is like this?



- Yield control
  - Pruning level
  - Bunch thinning

Does yield regulation lead to improved wine quality?

Perhaps – but it depends on:

- The starting point
- How and when it is done
- May only be effective if it improves vine balance
  - It will be ineffective if it disrupts vine balance
  - and causes sugar ripening to be too advanced relative to flavour ripening

Does FW/PW correlate with wine quality?

The Australian Wine Research Institute

- Cab Sauv, single vineyard, Calif (Dokoozlian et al. 2011)
- Bunch thinning 3 weeks after fruitset

Treatment	Yield t/ha	FW/PW	Days to reach 24° Brix (relative to BA)
‘Undercropped’ UC	4	3	-12
‘Balanced’ BA	15	8	0
‘Overcropped’ OC	30	14	+11

Does FW/PW correlate with wine quality?

The Australian Wine Research Institute

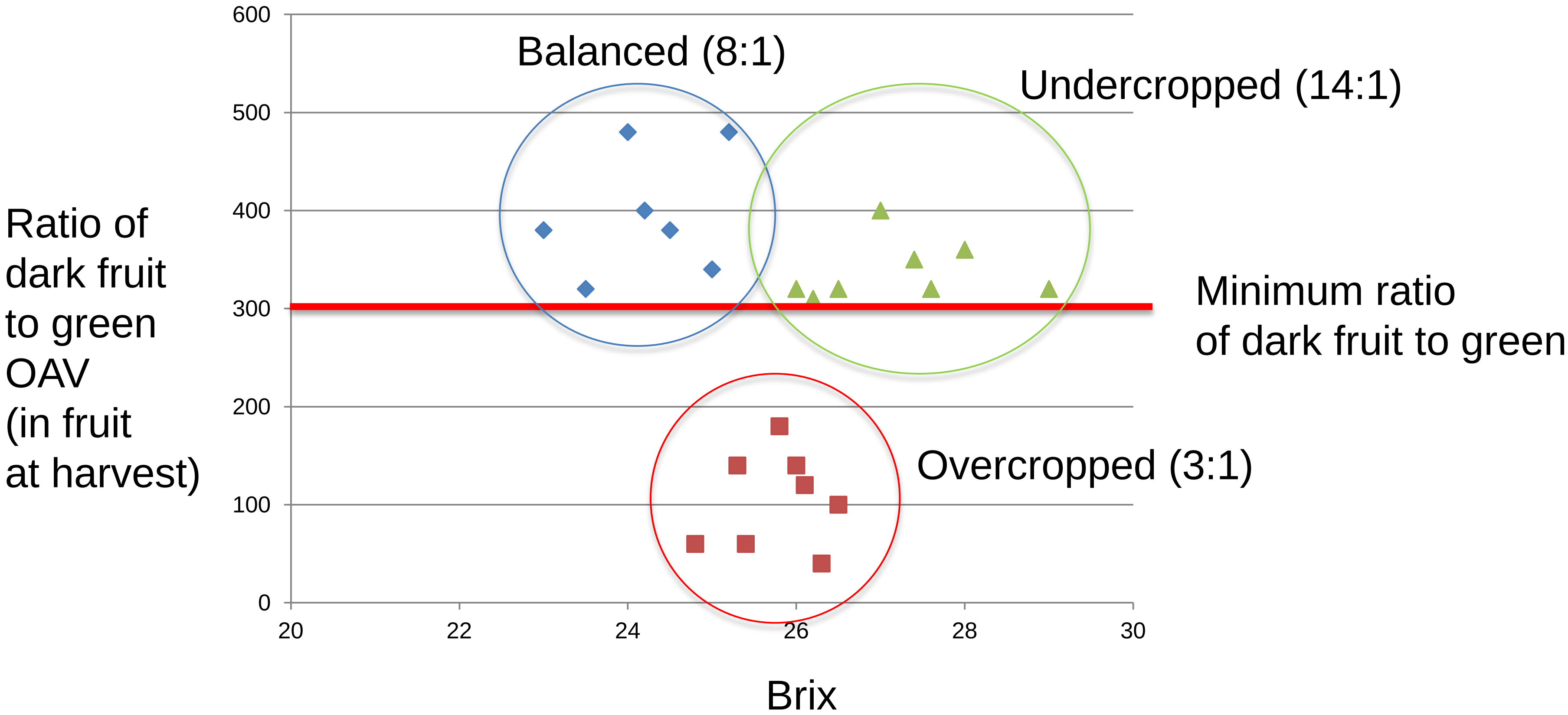
- Cab Sauv, single vineyard, Calif (Dokoozlian et al. 2011)
- Bunch thinning 3 weeks after fruitset

Treatment	Yield t/ha	FW/PW	Days to reach 24° Brix	OAV damascenone at 24° Brix
‘Undercropped’	4	3	-12	200
‘Balanced’	15	8	0	380
‘Overcropped’	30	14	+11	160

Does FW/PW correlate with wine quality?

(Dokoozlian et al. 2011)

The Australian Wine Research Institute



Each point = single rep

Hypothetical Undercropped

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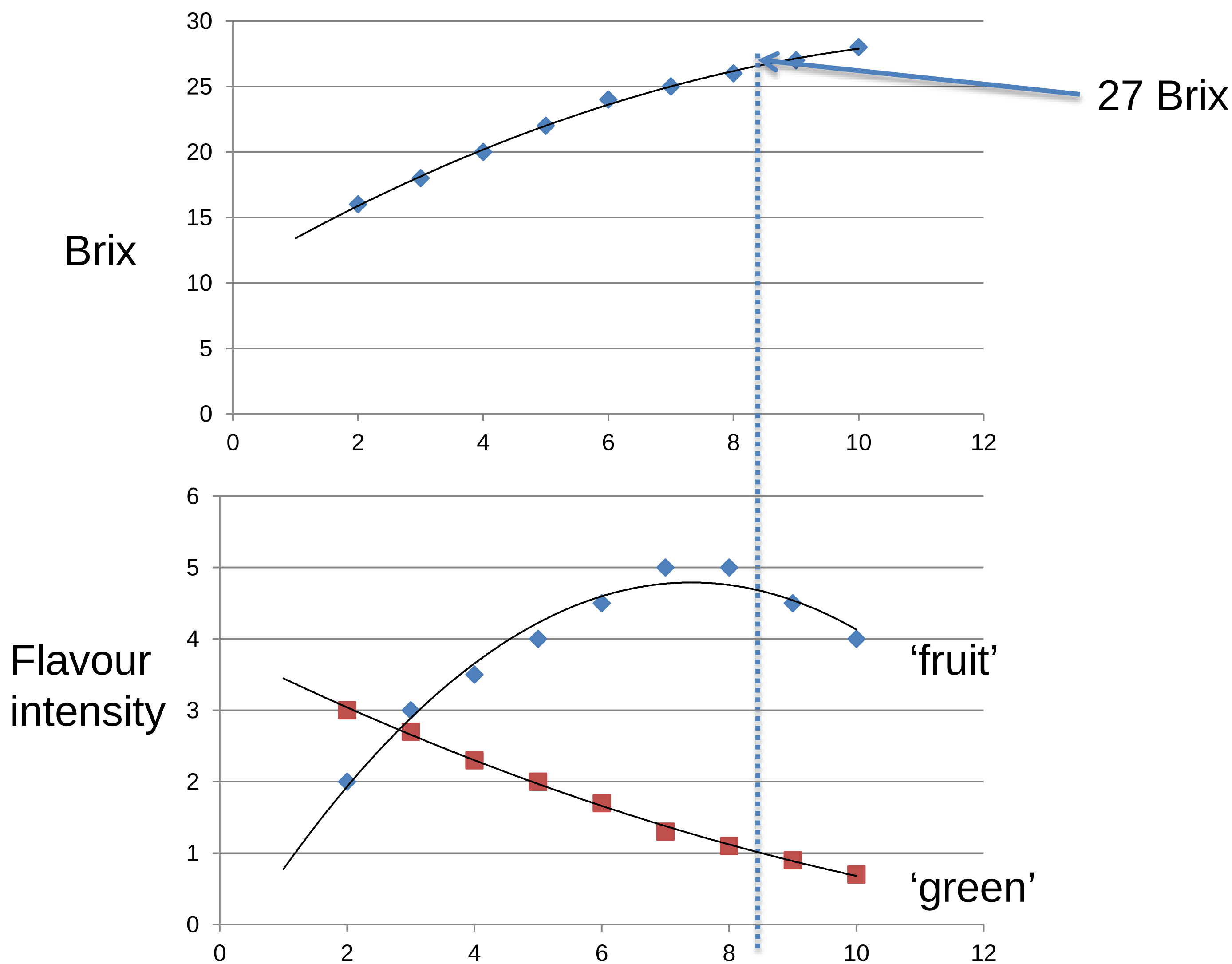
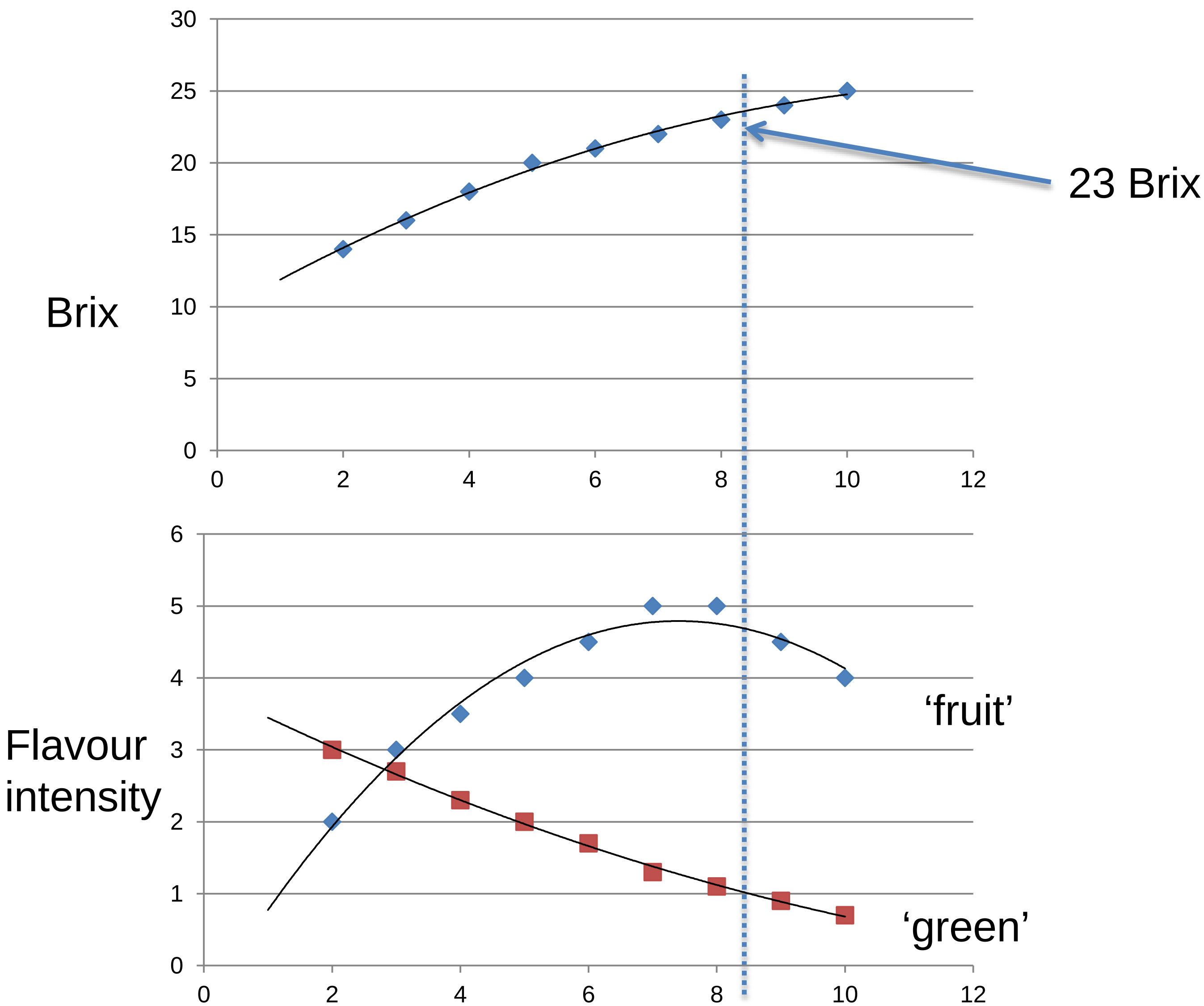
Research Institute



Hypothetical ‘Balanced’

The Australian Wine
Research Institute



Take home messages

The Australian Wine Research Institute

- Indices of vine balance are useful guide
- But use other indicators as well
- Low yield does not mean good balance
- Control of shoot growth before veraison is important
  - It is better to achieve vine balance earlier in season rather than later
- The timing and method of yield control must be appropriate for the site

Further reading

The Australian Wine
Research Institute

- Bindon et al. (2008a) Aust J Grape and Wine Res. 14, 91-103
- Dokoozlian, N. et al. (2011) Some new perspectives on the impact of vine balance on grape and wine flavour. Proc. 17th GIESCO meeting, Asti-Alba Italy: 407-409
- Dry et al. (2005) What is vine balance? Proc.12th Aust Wine Ind Tech Conf, Melbourne, 2004; pp. 68-74
- Poni et al. (2009) Aust J Grape Wine Res 15, 185-193
- Roby and Matthews (2004) Aust J Grape Wine Res 10, 74-82
- Scheiner et al. (2010) Amer. J Enol. Vitic. 61(3), 358-64
- Van Leeuwen et al. (2004) Am J Enol Vitic 55, 207-217

A novel method of yield control

- Leaf removal in bunch zone just before flowering (E-L 19)
  - Approx 8 basal leaves
  - Manual or mechanical
  - No lateral shoots removed
- Yield reduced by 20 to 70% mainly due to fewer berries/bunch
- Varieties used: Semillon, Tempranillo, Graciano, Carignan, Sangiovese, Barbera, Trebbiano, Ciliegiolo
  - Mostly warm climates

Poni et al (2009), Scheiner et al. (2010)

A novel method of yield control

The Australian Wine Research Institute

- Positive effects:
  - Reduced bunch compactness
  - Reduced Botrytis
  - No detrimental effect on Brix
  - Increased concentration anthocyanin and other phenolics
  - Partial recovery of LA to give later bunch protection

Why does it work?

Early vs late bunch thinning?

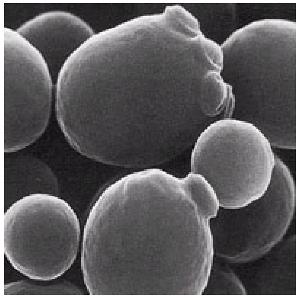
- Early is more economical than later
- But if too early may stimulate shoot vigour
- In a high rainfall climate,
  - leave high bud number to reduce shoot vigour
  - then bunch thin relatively late e.g. at veraison
- In dry climate can use severe pruning to reduce bunch load knowing that water stress will control shoot vigour

AWRI

The Australian Wine Research Institute

Does soil and vine nutrient status affect wine quality?

Marcel Essling



Does soil nutrient status affect wine aroma and flavour?

The Australian Wine Research Institute

- in popular press, the ‘terroir effect’ is often attributed to specific minerals that are alleged to confer typicity to wine
- soils with rock appear to elicit allusions of minerality

Geological influence as a fantasy of the taster

“ But what separates Beechworth from so many other regions, …., is minerality. It’s there, you can see it, with minerals glistening in the sun—slate and shale and great boulders of granite…..

While some disagree, you can taste minerality and it’s there in the wines”

Jeni Port, The Age

Feb 2012

What are the facts?

- Geological minerals are complex chemical compounds that are mainly tasteless
- Vine roots can only take up ions in solution
- Membranes only allow certain ions to be taken up
- Even then not all ions taken up by roots will end up in fruit

What are the facts?

- Some wine is said to be reminiscent of smell of wet rocks following rain
- Actually is scent of organic compounds released from plants during dry periods and ‘captured’ by rocks (= petrichor) (Bear and Thomas 1964)

What are the facts?

§ What about 'minerality' in wine?
- probably a descriptor for acidity

What are the facts?

The Australian Wine Research Institute

- Rocks affect physical structure of soil and water relations

Does soil nutrient status affect wine aroma and flavour?

- Many studies – no correlation between wine quality and soil content of any nutritive element with exception of N (and salt)

Response to N: summary

Red wine quality: negatively correlated with vine N

- particularly when water not limiting

§ low soil N best for red wine quality

White wine: moderate soil N best for quality

§ Low N ® decreased aromatic precursors and increased tannin

§ High N ® increased Botrytis

NITROGEN

- Of all mineral nutrients, N has greatest effect on growth, yield and fruit composition
  - ↑ soil N → ↑ photosynthesis → ↑ sugar
- As for water, excess N can have negative effect
  - eg increased canopy size

NITROGEN

- Demand for N greatest from budburst to flowering
  - But most uptake from soil after flowering
  - Overwintering reserves thus very important (like starch)
- Storage reserves are lowest at flowering
  - Therefore plant is vulnerable to deficiency if insufficient N in soil after flowering

Total berry NITROGEN

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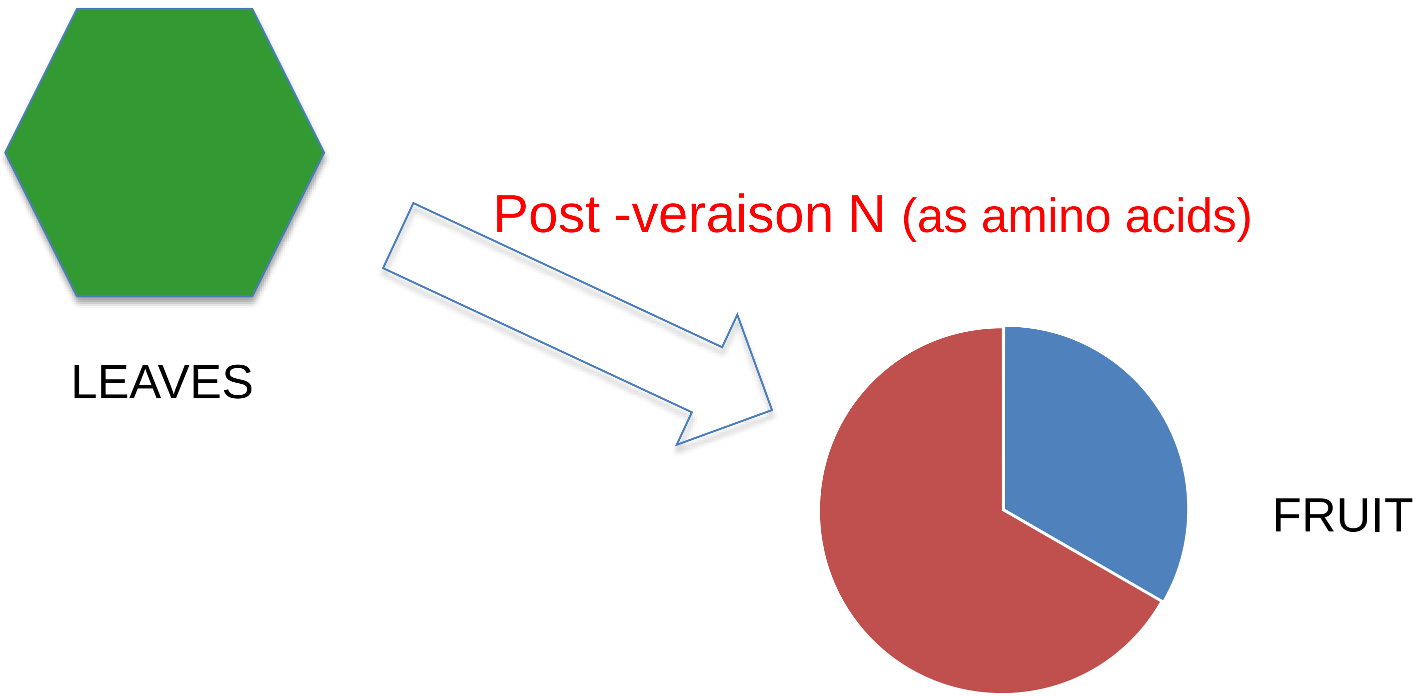


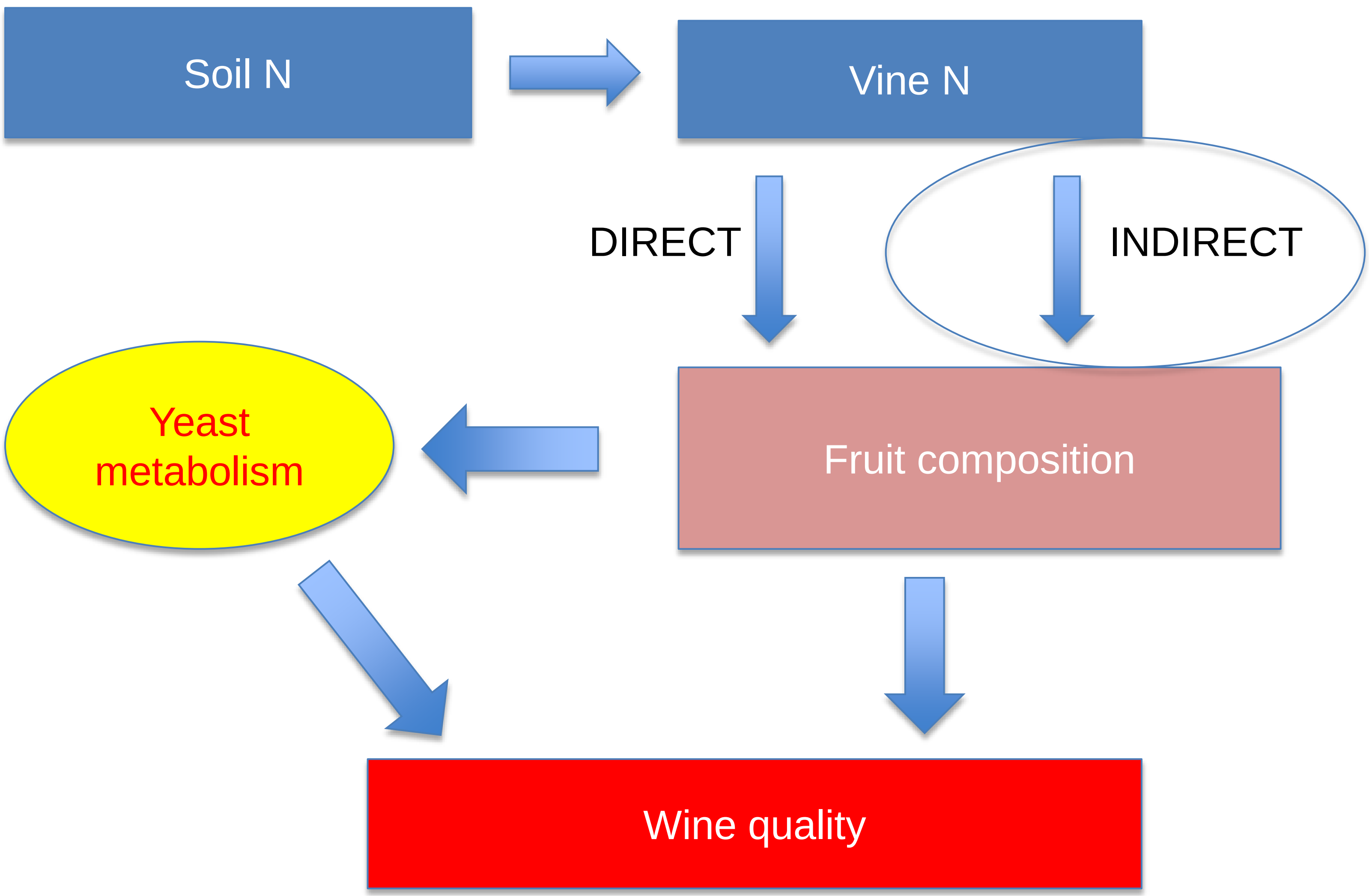
What is effect of N fertilisation on vine performance?

The Australian Wine Research Institute

- Deficit to marginal status (based on tissue analysis)
  - N fert. generally has a positive effect
- Adequate to high status (based on tissue analysis)
  - N fert. may have negative effect
    - Disrupt balance
    - Increases vegetative growth
    - Increases shading
    - Decreases net photosynthesis
    - assimilates diverted from fruit to shoots

Nitrogen effect on fruit composition and wine quality

The Australian Wine Research Institute



N impact on wine quality: Indirect effect

The Australian Wine Research Institute

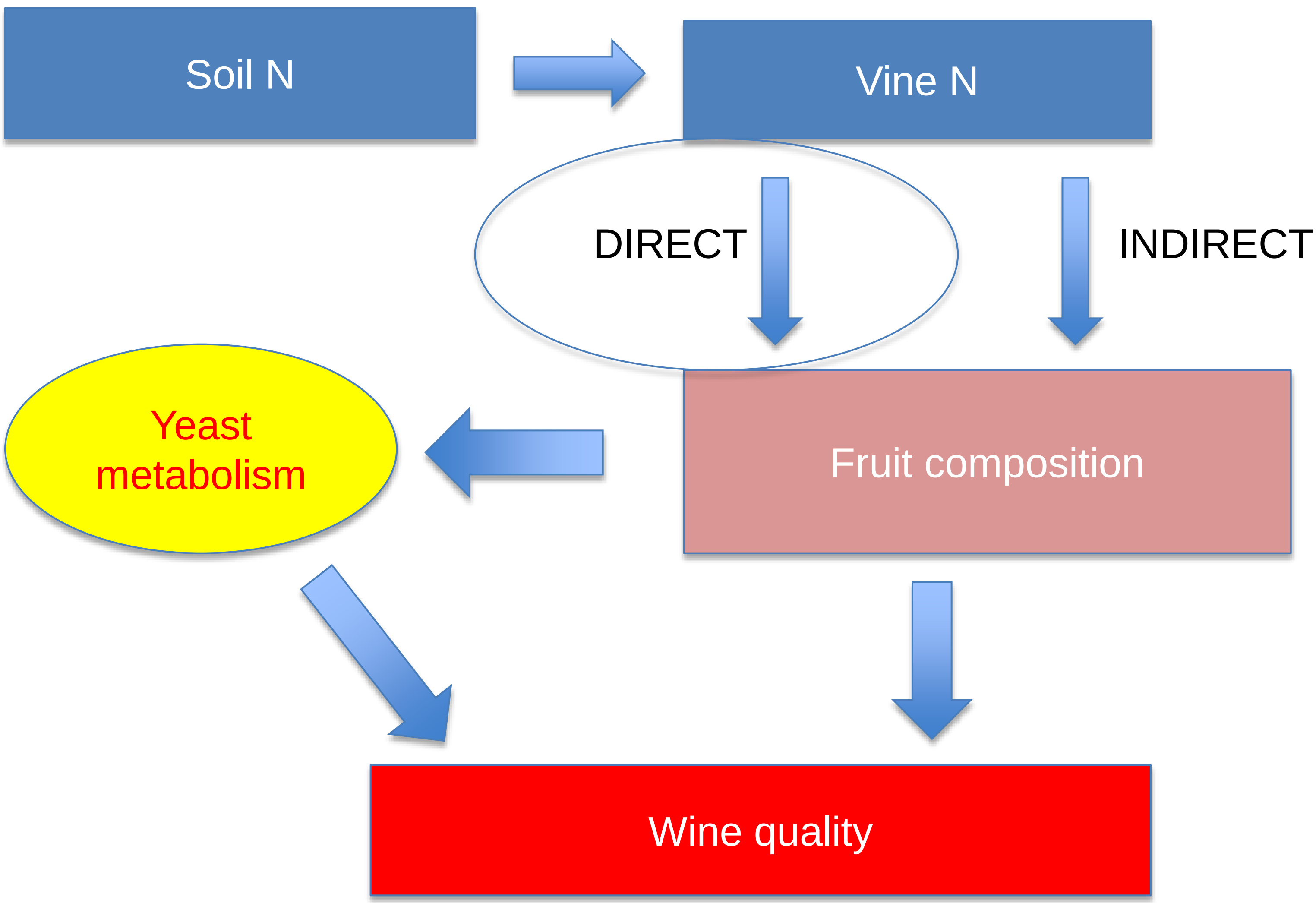
- Excess → ↑ vegetative growth ↑ canopy density
  - More bunch zone shading → fruit composition
    - e.g. increased methoxypyrazine concentration in Cab Sauv in response to N fertilization

N impact on wine quality: Indirect effect

- Excess → ↑ vegetative growth ↑ canopy density
  - More bunch zone shading → fruit composition
    - generally decreased monoterpenes in response to N fert.
  - **More disease**
  - **Growing tips compete with fruit for assimilate**

Nitrogen effect on fruit composition and wine quality

The Australian Wine Research Institute



N impact on wine quality: Direct effect

- Nitrate uptake → reprogramming of gene expression
- High nitrate suppresses genes involved in phenolic production
- Also high nitrate → ↑ organic acid production
  ↑ amino acid

Overall effect is decreased phenolics

N fertilisation and grape anthocyanins

- Response to N fertilisation depends on starting point
  - less than adequate level:
    - Ø may increase anthocyanins
  - adequate or more:
    - Ø may decrease anthocyanins

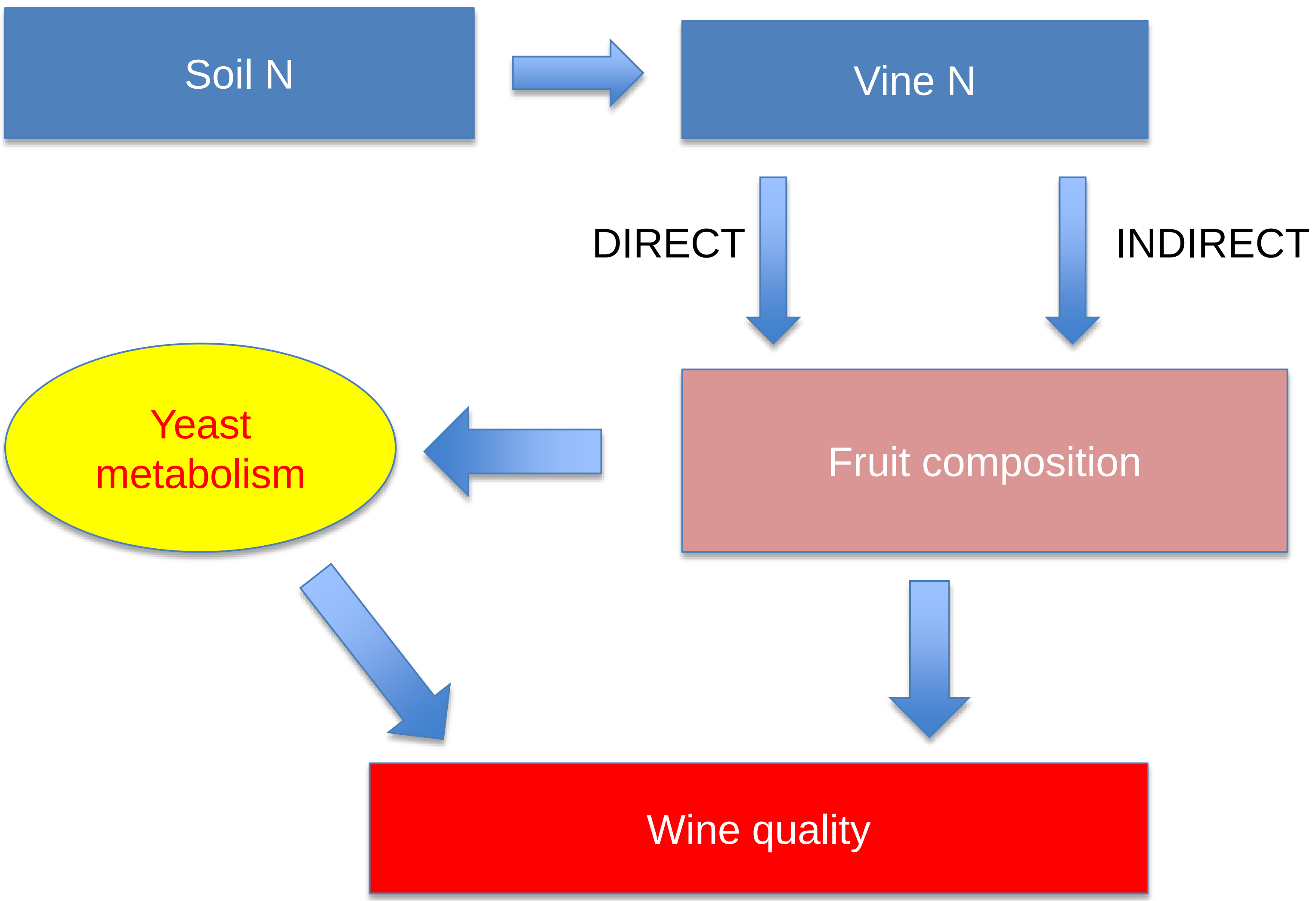
N impact on wine quality

- Can the negative effect of shading caused by high N be overcome by leaf removal in bunch zone etc?
  - Not necessarily – high N and low flavonol make berries more susceptible to sunburn

- Or hedging?
  - This may waste resources because removes young leaves and retains old inefficient leaves
  - Also diversion of assimilates away from fruit

Nitrogen effect on fruit composition and wine quality

The Australian Wine Research Institute



N and fermentation

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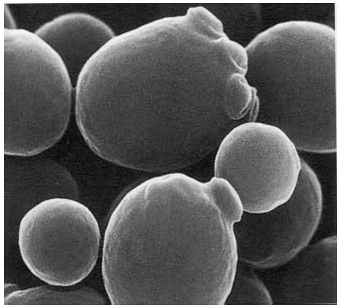
Nitrogen affects



- Yeast growth
- Metabolic activity
  - Fermentation rate
  - Flavour active compounds (fermentation bouquet)

Grape nitrogen: effect on yeast

The Australian Wine Research Institute

- Total Nitrogen in juice is mainly
  - Ammonia
  - Free Amino Acids
- Yeast assimilable N (YAN)
  = free amino N (FAN) + ammonia N (NH_3-N)
- Yeast will use ammonium N initially,
  then most assimilable amino acids
- If YAN too low → stuck or slow ferments

Does N fertilization affect YAN in grapes?

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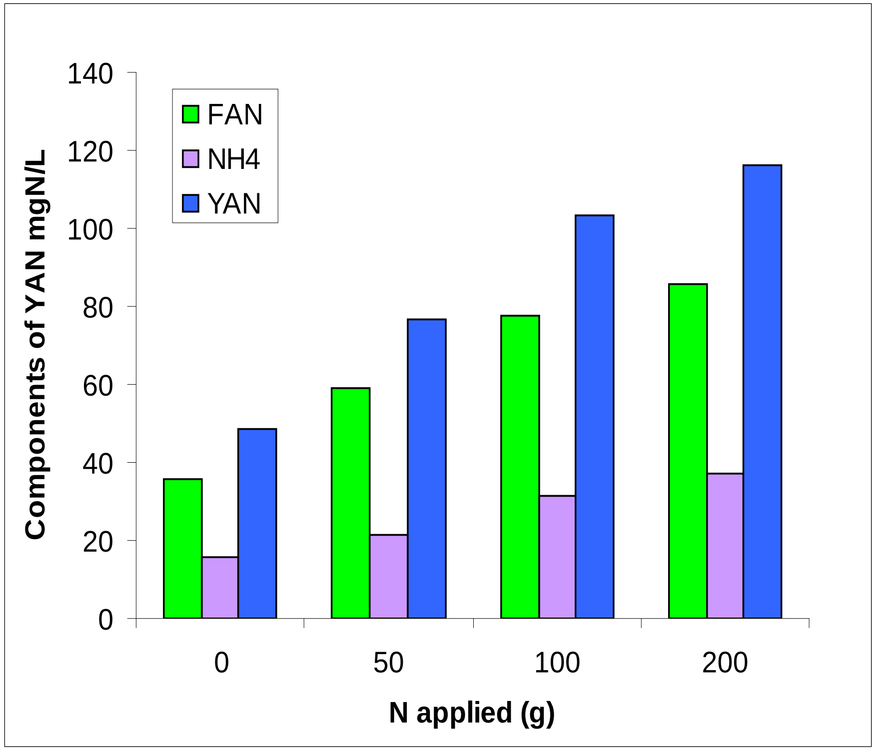


Grape N that yeast can use

Fermentation and sensory

The Australian Wine Research Institute

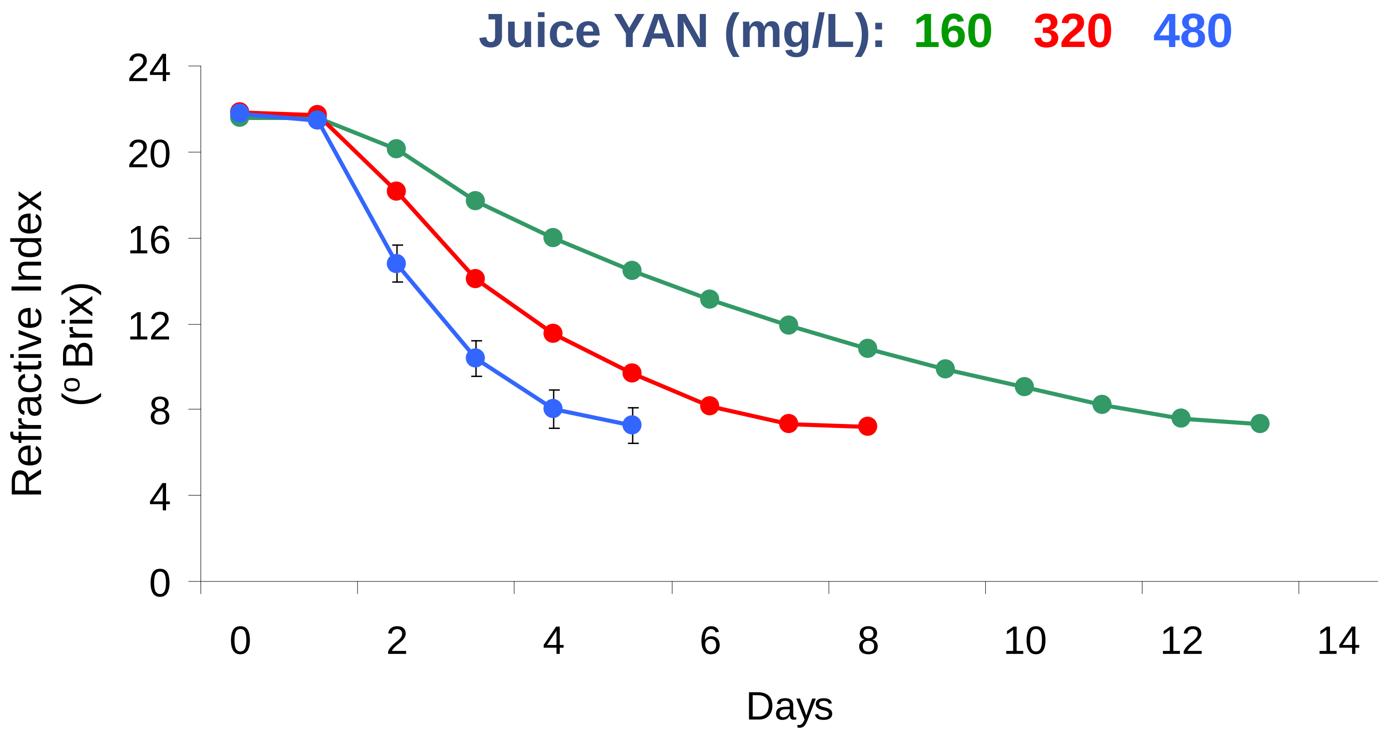
AWRI fermentation study


Diego Torrea

- Filtered Chardonnay juice
- Low N (YAN = 160 mg/L)
- High N demand yeast (AWRI 796)
- Wine analysis and descriptive sensory analysis

Effect of Juice N on Fermentation

The Australian Wine Research Institute



Juice YAN affects: i) yeast growth,
ii) fermentation, and
iii) fermentation duration

Effect of juice N concentration on wine aroma profile

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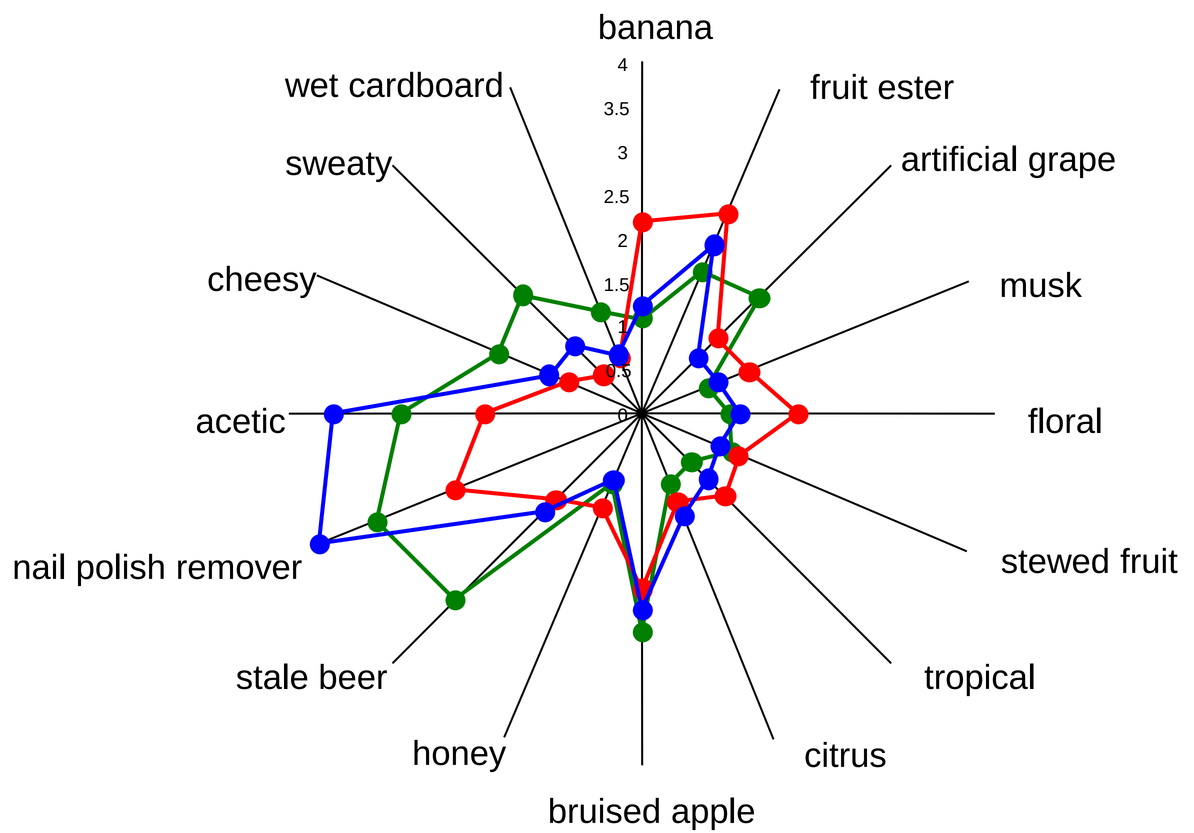

Low & High N: Negative effects
Moderate N: Positive effects

Juice YAN (mg/L): 160 320 480

NITROGEN

- increased PR proteins with increased plant N
  - → haze and increased need for bentonite fining

Potassium

The Australian Wine Research Institute

- High K in juice
  - → decreased concentration of free acids ??partic. tartaric (and ↑ pH)
  - → may decrease rate of degradation of malic acid

What factors determine how much K ends up in juice?

Potassium

- No evidence for direct effect of soil K on wine quality
  - Except K deficiency may impair sugar accumulation
- K fertilisation effect on juice K concentration?
  - No consistent results
- Factors such as rootstock type, irrigation, canopy management etc much more influential than K status of soil
  - Reduced irrigation → reduced juice K concn
  - Shoot trimming → increased leaf blade K concn

Impact of K movement from leaves to fruit

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EXPOSED CANOPY
Less potassium moves from leaves to the berries

Shading→ ↑ K in leaves at veraison
→ ↑ K in berries at maturity
Therefore more K in wine, higher pH

SHADED CANOPY

More potassium moves from leaves to the berries

Potassium: rootstock effect

The Australian Wine Research Institute

- Direct or indirect effect?
- Direct
  - Rootstock type affects:
    - a) uptake by roots Ö
    - b) transport from roots to shoots Ö
    - c) transport from leaves to fruit ?
- Indirect
  - Rootstock type affects shoot vigour, canopy shading

Take home messages

The Australian Wine Research Institute

- Minerality of wine is unlikely to be related to soil nutrient status
- N is the only soil nutrient that has a significant impact on wine quality
- N has both direct and indirect effect s on fruit composition and wine quality
- Only use N fertiliser to correct a deficiency or to maintain adequate levels (timing is important)
- Measure must YAN before fermentation

Can DAP addition make up for N deficient grapes?

The Australian Wine Research Institute

- Perhaps
- But some evid that not entirely cos C backbone of AA is metab to higher alcs so AA not just source of N

A W R I

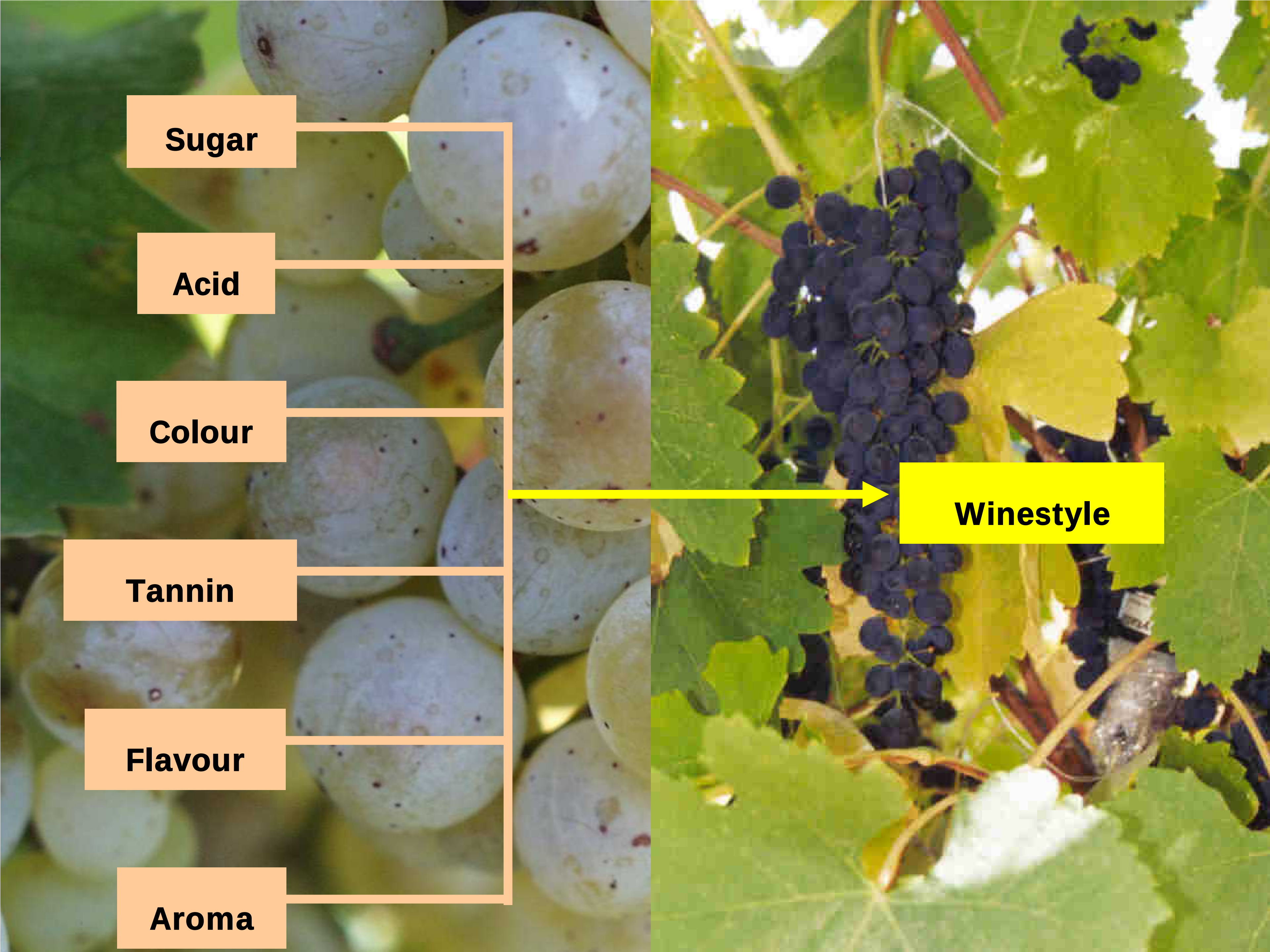
The Australian Wine Research Institute

Importance of sampling for quality parameters in the vineyard

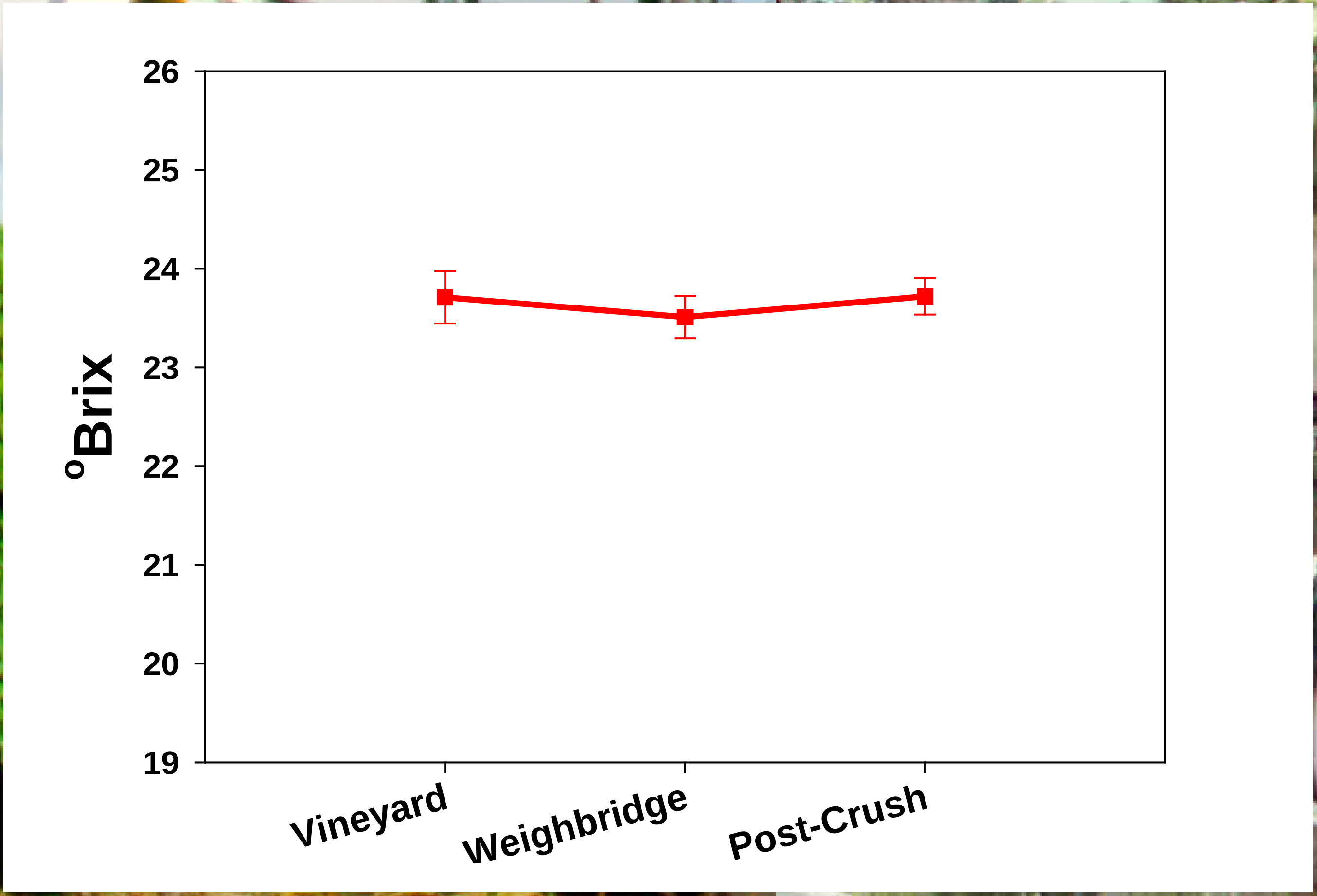
Dr Mark Krstic

AWRI - Extension Services Manager - Victoria

One of the most important decisions a grower, winery GLO or winemaker will make during the season is deciding when to harvest a parcel of grapes

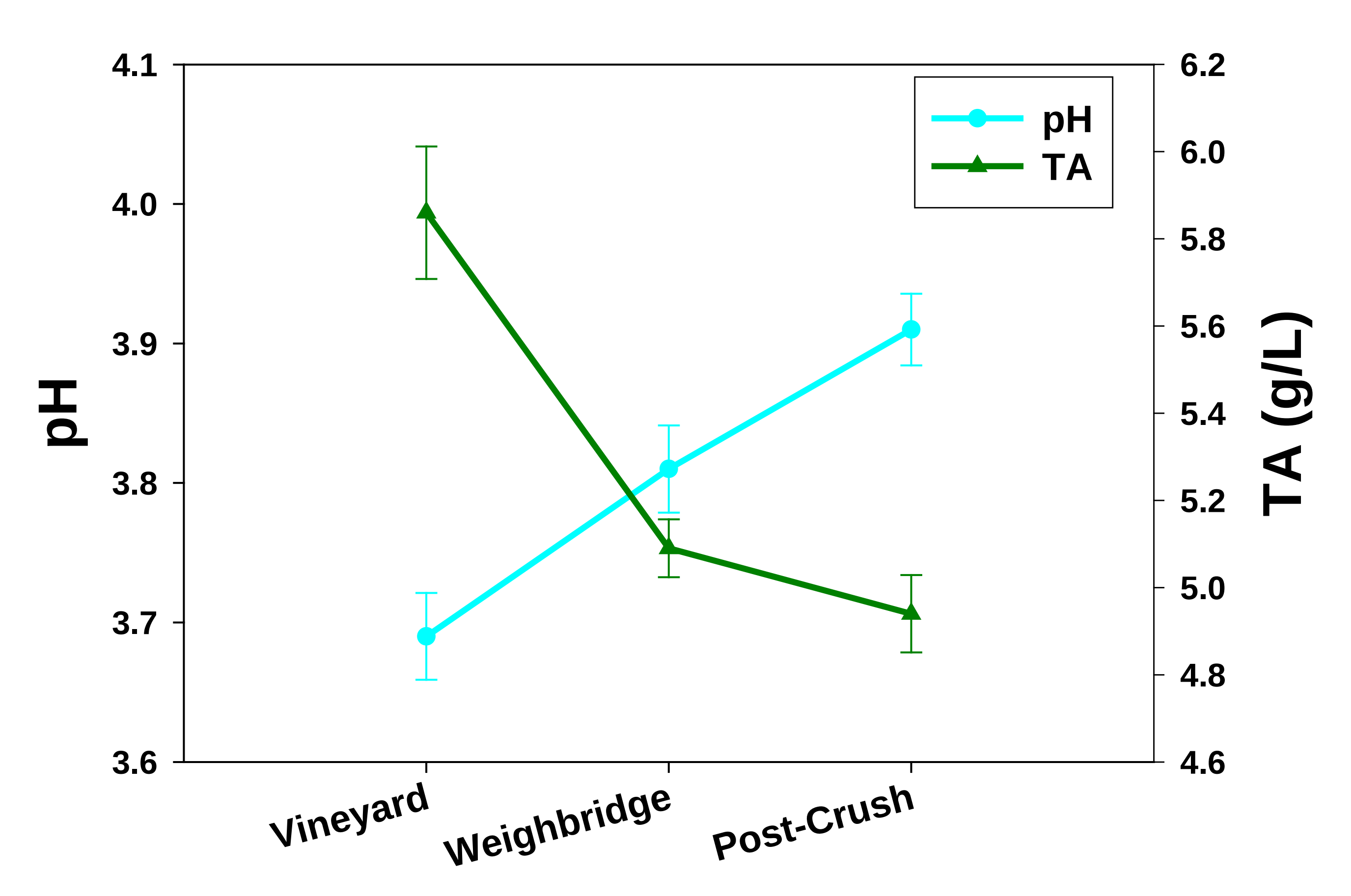

Sugar
Acid
Colour
Tannin
Flavour
Aroma
Winestyle

Differences observed between vineyard and winery - natural variability or 'special cause'



Cabernet Sauvignon

Differences observed between vineyard and winery - natural variability or 'special cause'

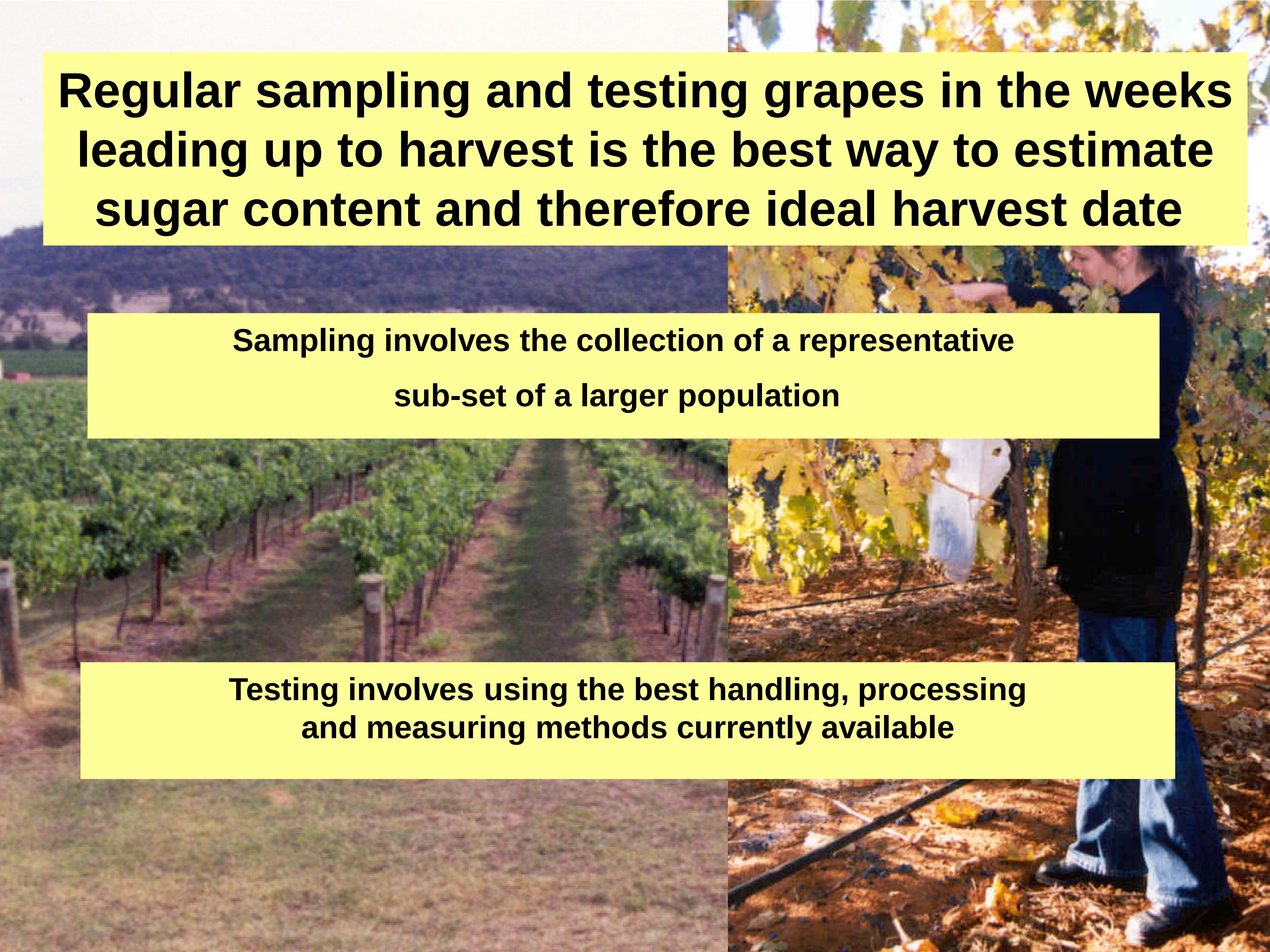


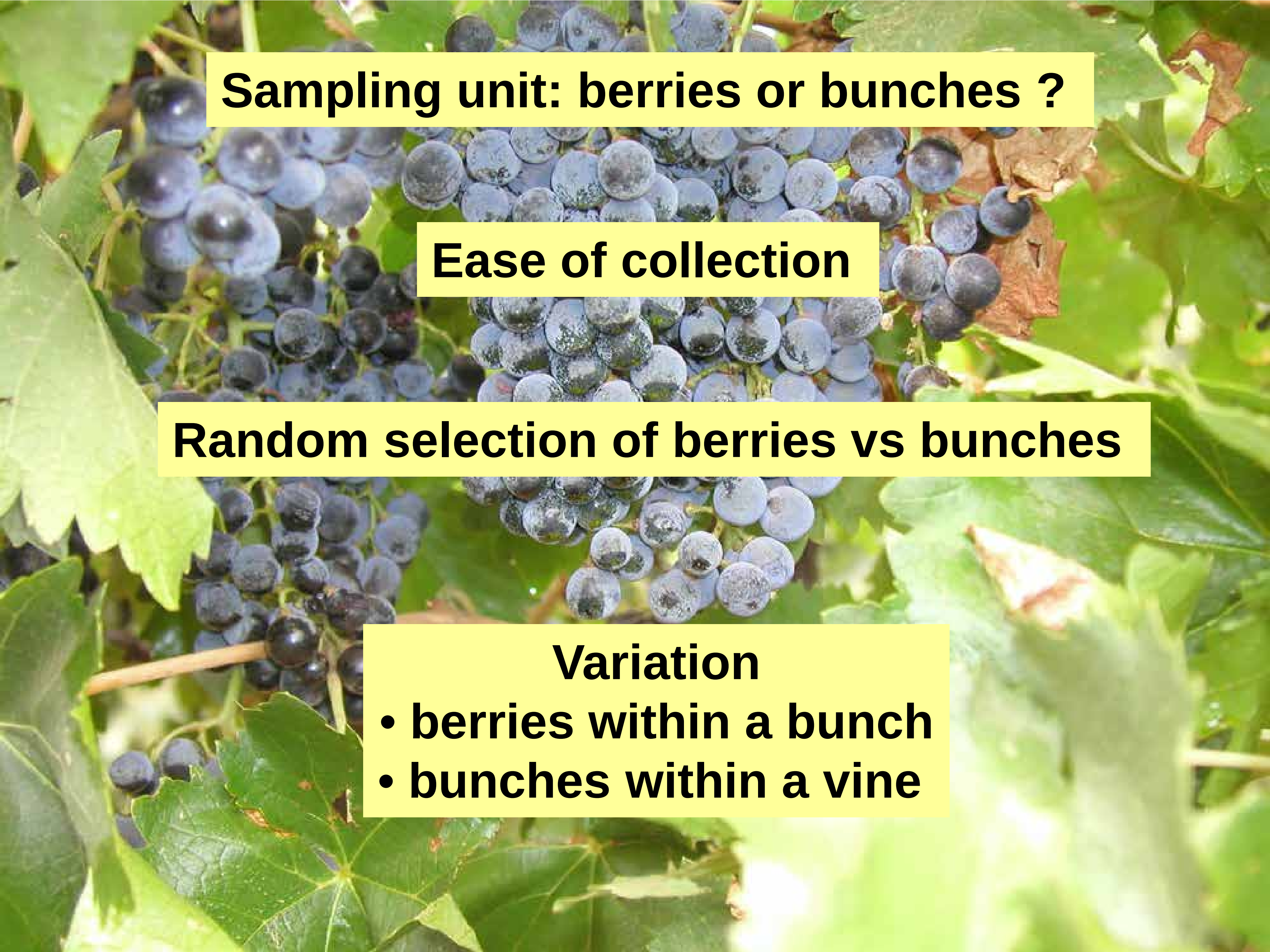
Cabernet Sauvignon

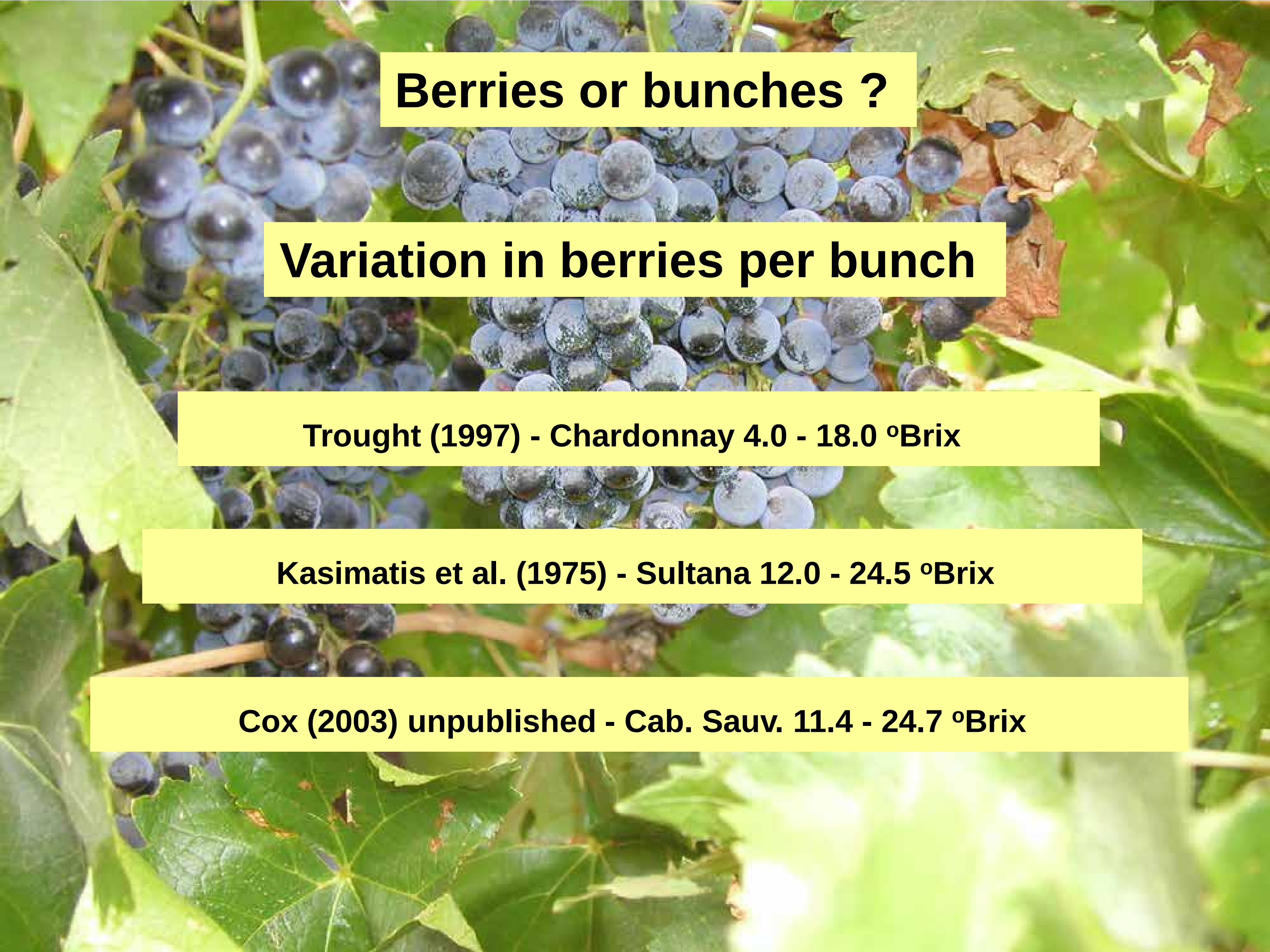

Sugar concentration will influence potential alcohol content
Anthocyanin levels in grapes may influence final wine colour ?

Perennial arguments between viticulturists and winemakers about absolute levels of each compositional trait

‘I wanted them at 13.5 Baume, not 12.5’


Regular sampling and testing grapes in the weeks leading up to harvest is the best way to estimate sugar content and therefore ideal harvest date
Sampling involves the collection of a representative sub-set of a larger population
Testing involves using the best handling, processing and measuring methods currently available


Sampling unit: berries or bunches ?
Ease of collection
Random selection of berries vs bunches
Variation
• berries within a bunch
• bunches within a vine



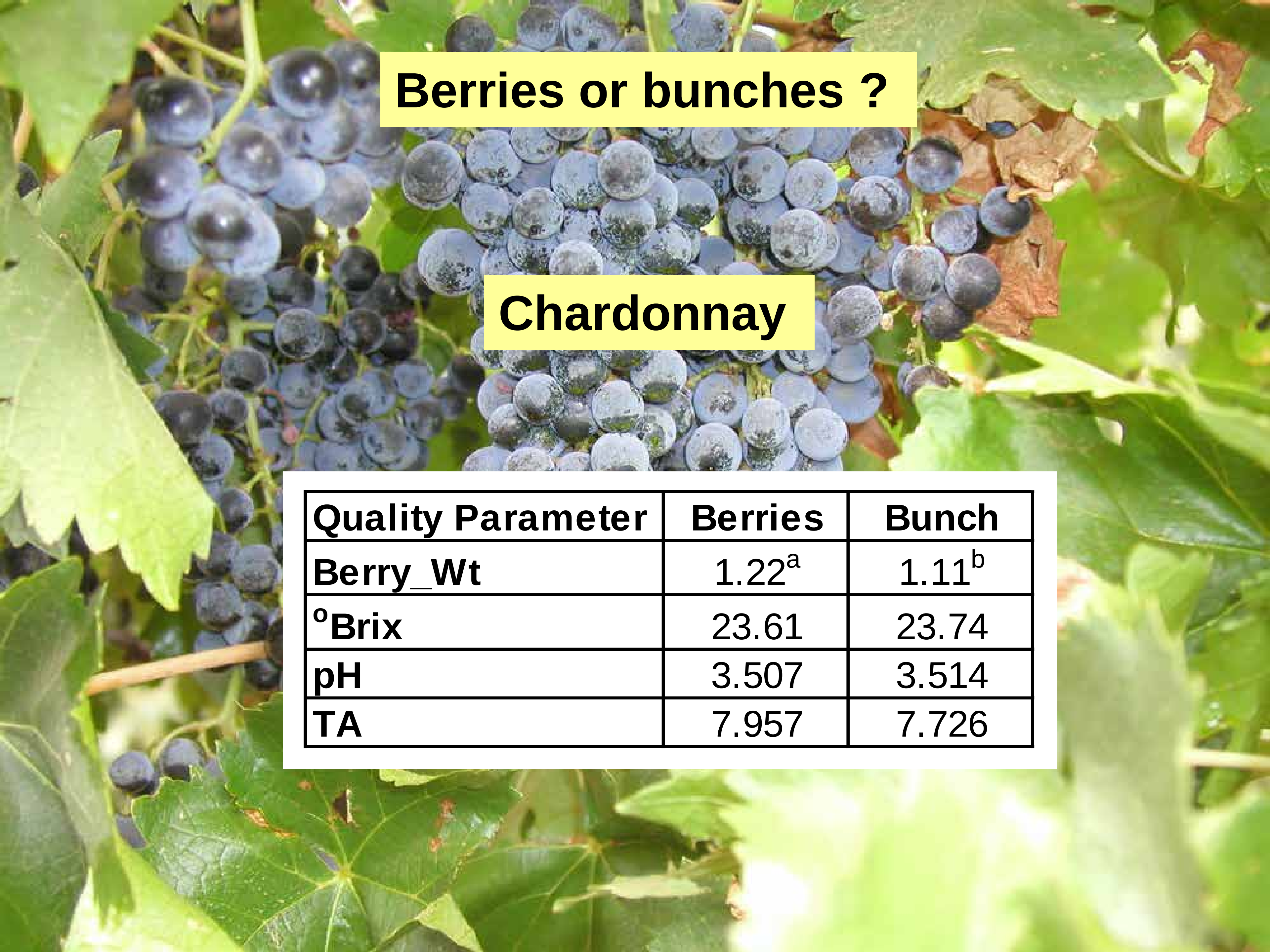
Berries or bunches ?

Variation in berries per bunch

Trought (1997) - Chardonnay 4.0 - 18.0 ºBrix

Kasimatis et al. (1975) - Sultana 12.0 - 24.5 ºBrix

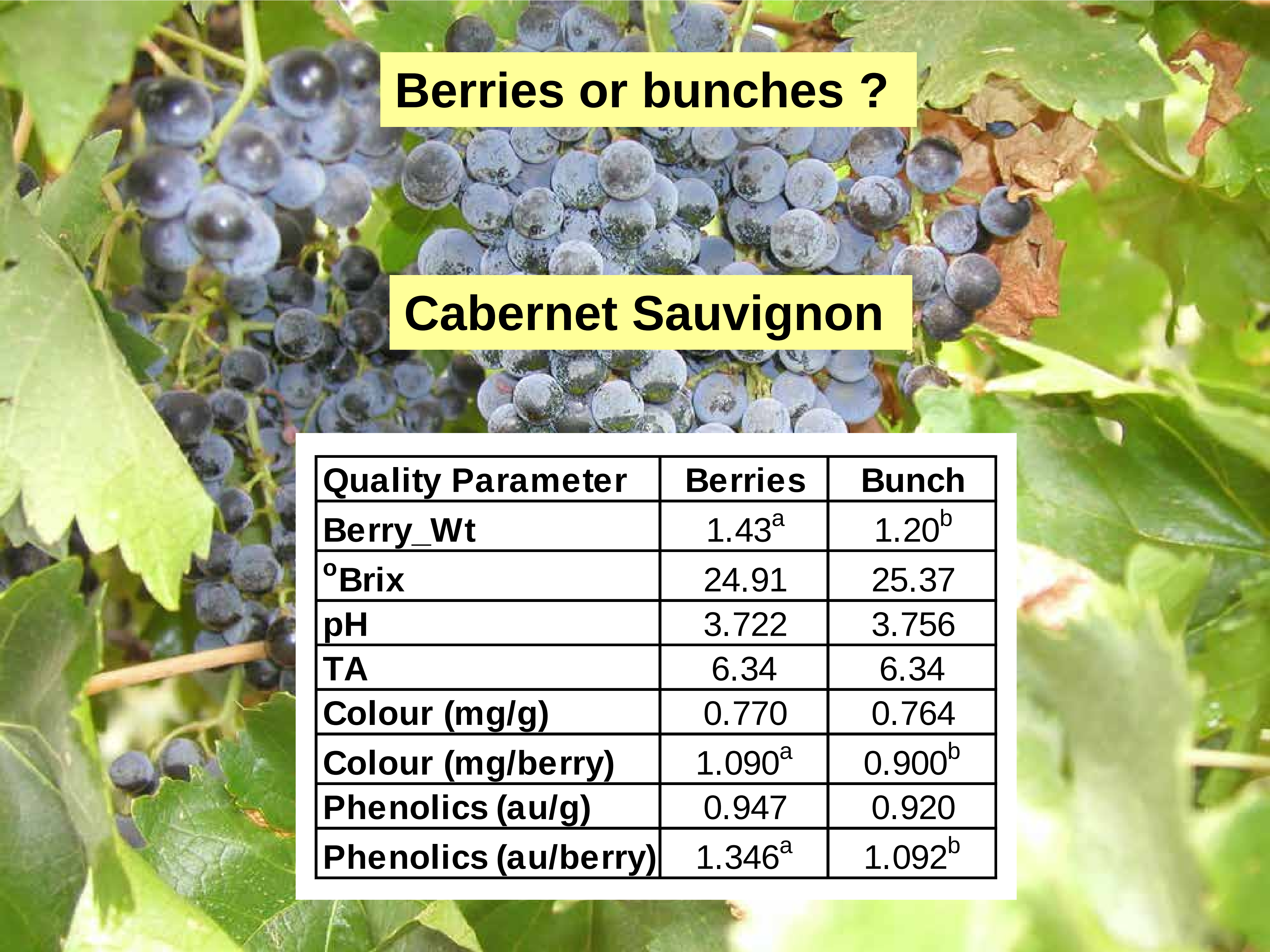
Cox (2003) unpublished - Cab. Sauv. 11.4 - 24.7 ºBrix



Berries or bunches ?

Chardonnay

Quality Parameter	Berries	Bunch
Berry_Wt	1.22[a]	1.11[b]
°Brix	23.61	23.74
pH	3.507	3.514
TA	7.957	7.726



Berries or bunches ?

Cabernet Sauvignon

Quality Parameter	Berries	Bunch
Berry_Wt	1.43^{a}	1.20^{b}
^{o}Brix	24.91	25.37
pH	3.722	3.756
TA	6.34	6.34
Colour (mg/g)	0.770	0.764
Colour (mg/berry)	1.090^{a}	0.900^{b}
Phenolics (au/g)	0.947	0.920
Phenolics (au/berry)	1.346^{a}	1.092^{b}

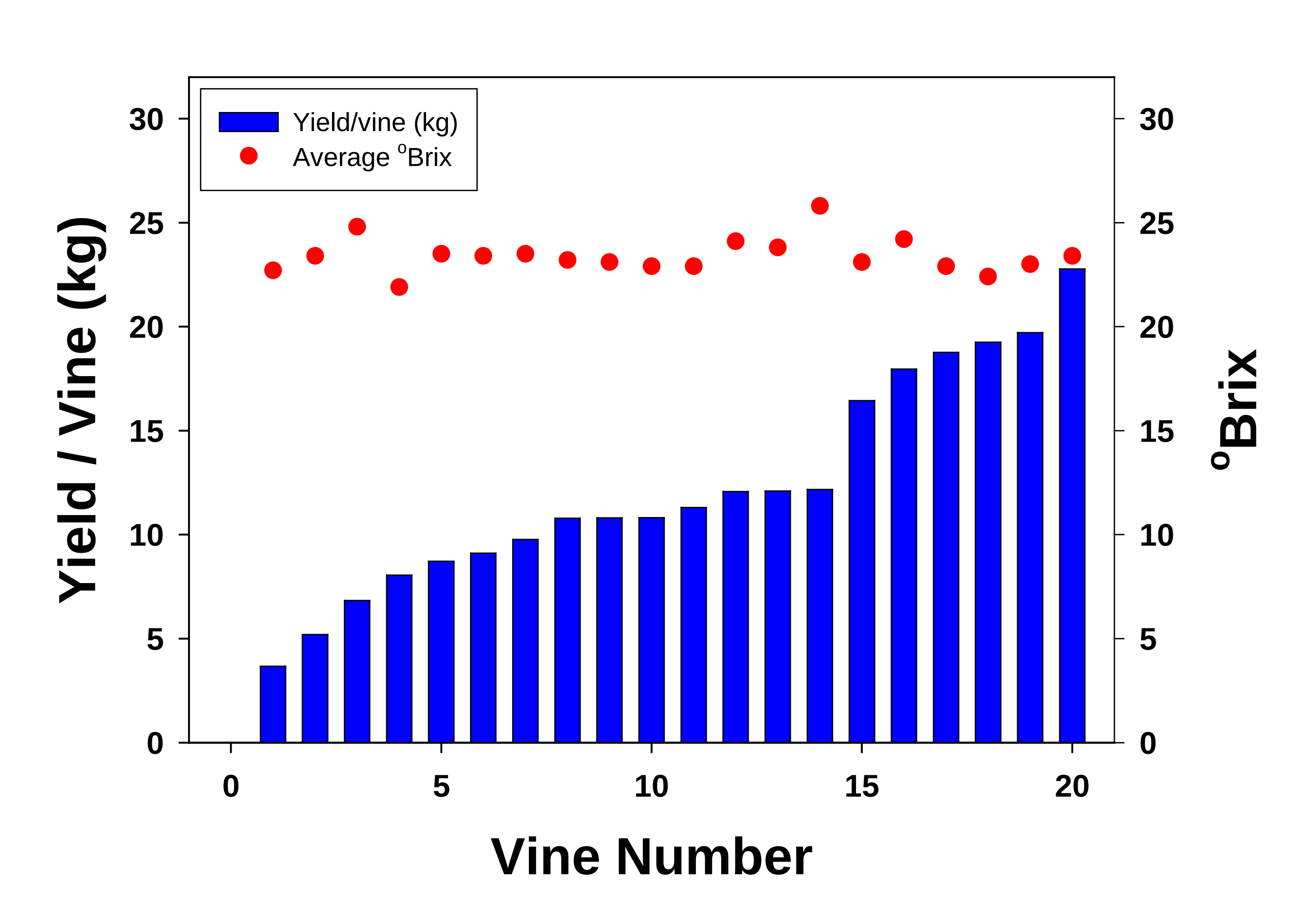
Berries or bunches ?

Shiraz

	Berries	Bunches
Mean ºBrix	17.83	18.1
Standard Deviation	2.26	1.64
95% confidence limit	0.58	0.42
% Coefficient of Variation	13	9
% Doubt	3.3	2.3
Best sample size (4% tolerance of doubt)	40	21

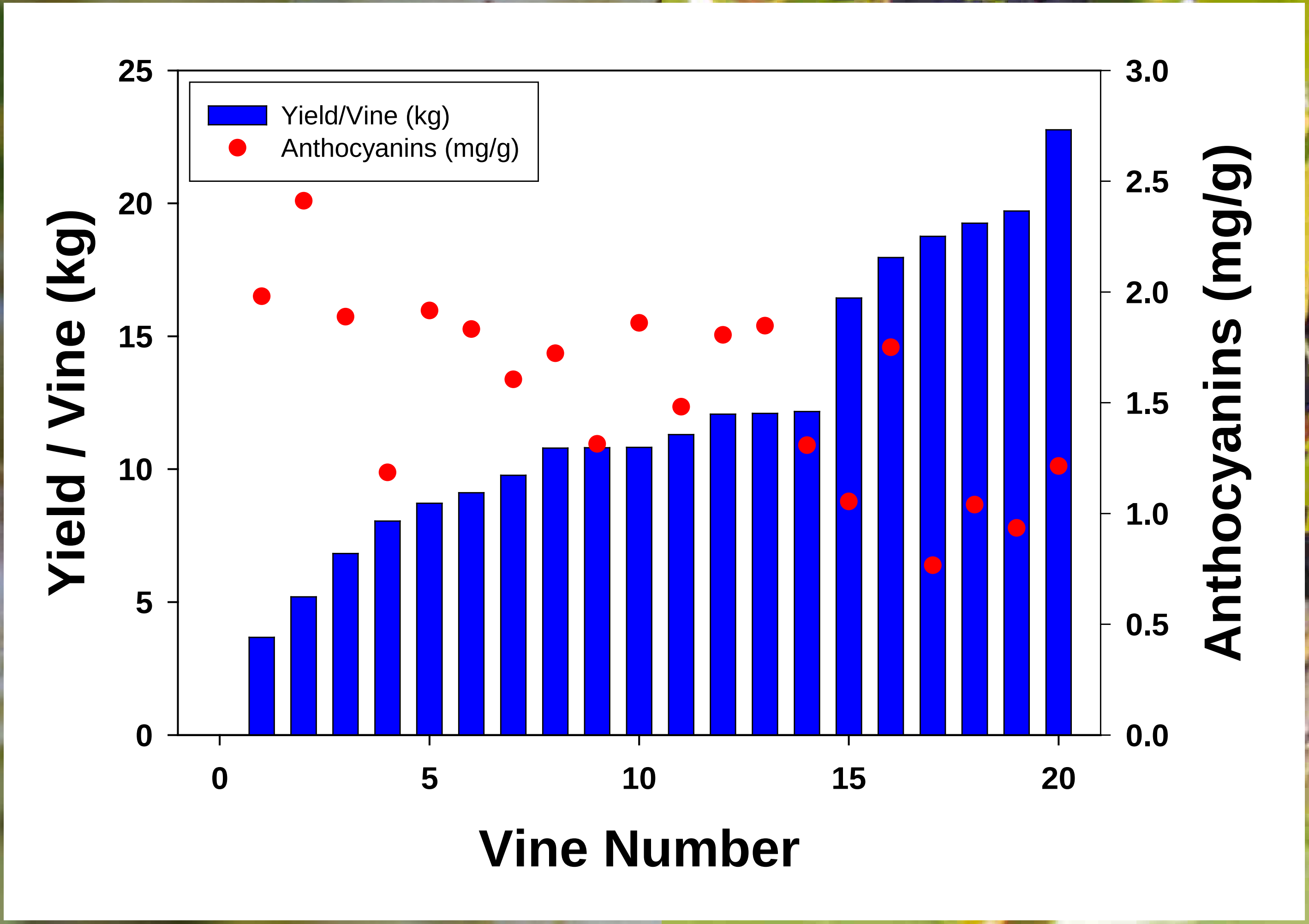
As long as enough berries are collected
(~double the number of bunches)
it probably doesn't matter !

Variation in ºBrix compared to Yield



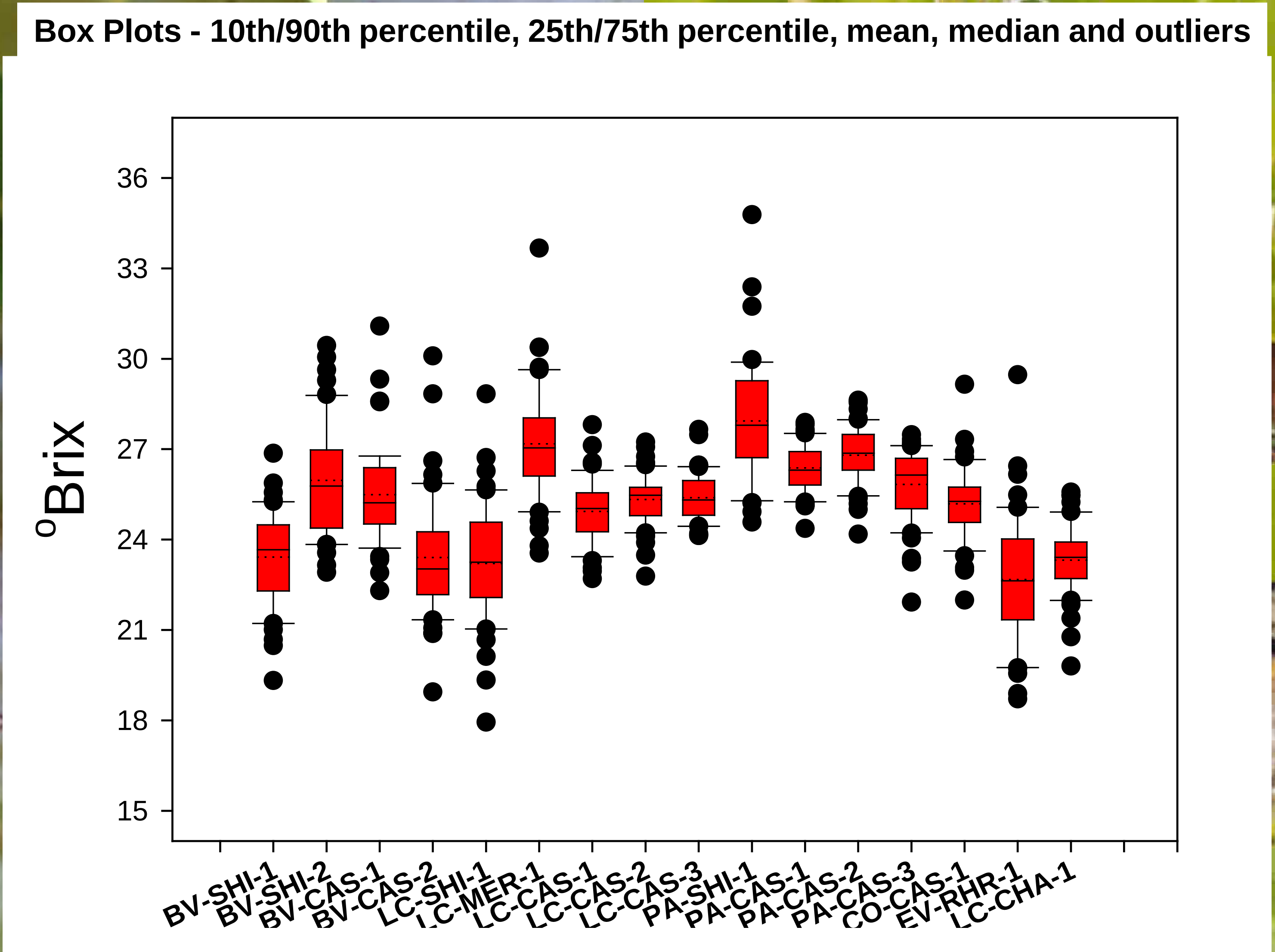
Cabernet Sauvignon

Variation in anthocyanins compared to Yield



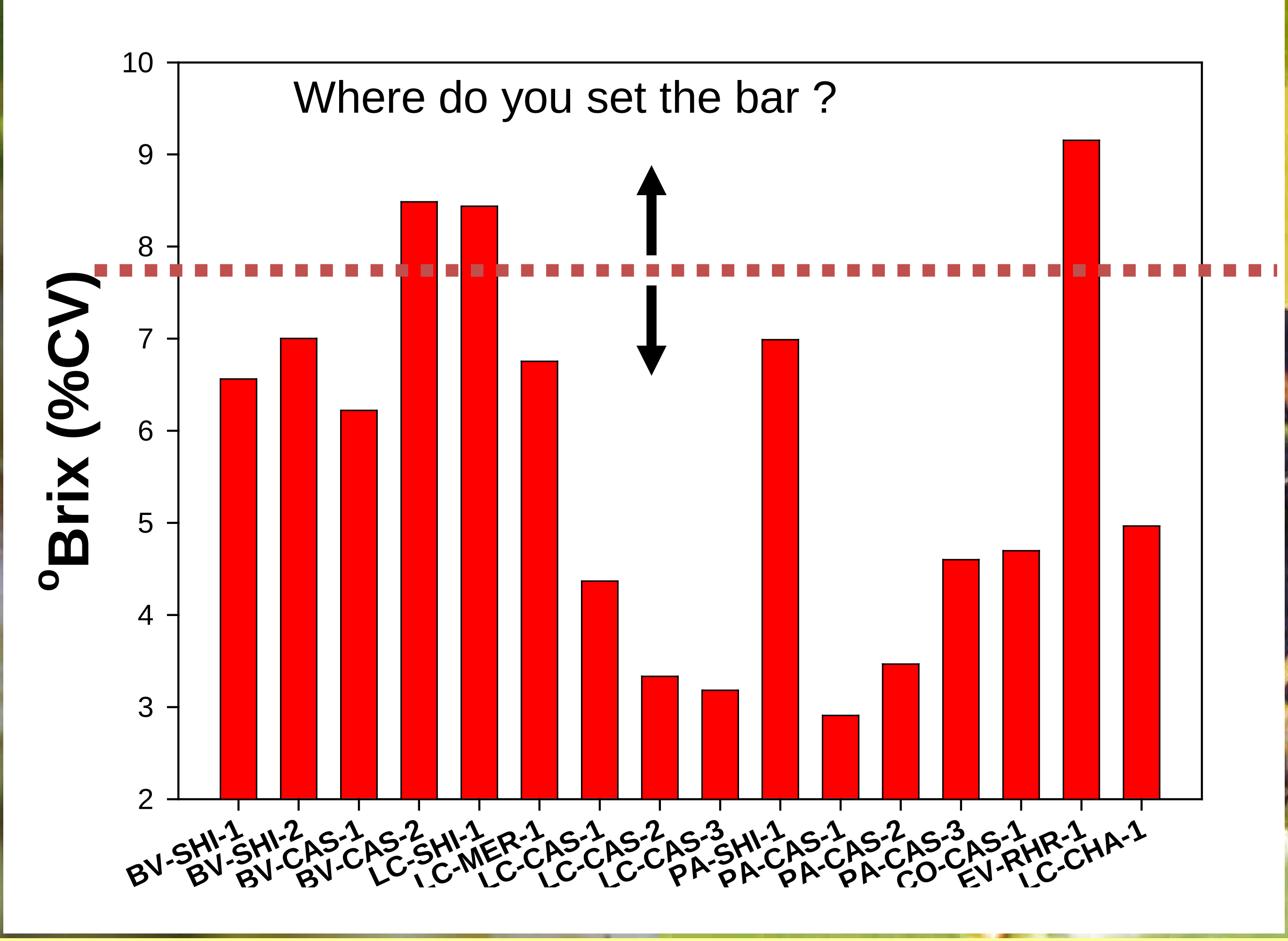
Cabernet Sauvignon

Variation in °Brix across 16 vineyards



Shiraz, Cabernet Sauvignon, Merlot, Reisling and Chardonnay

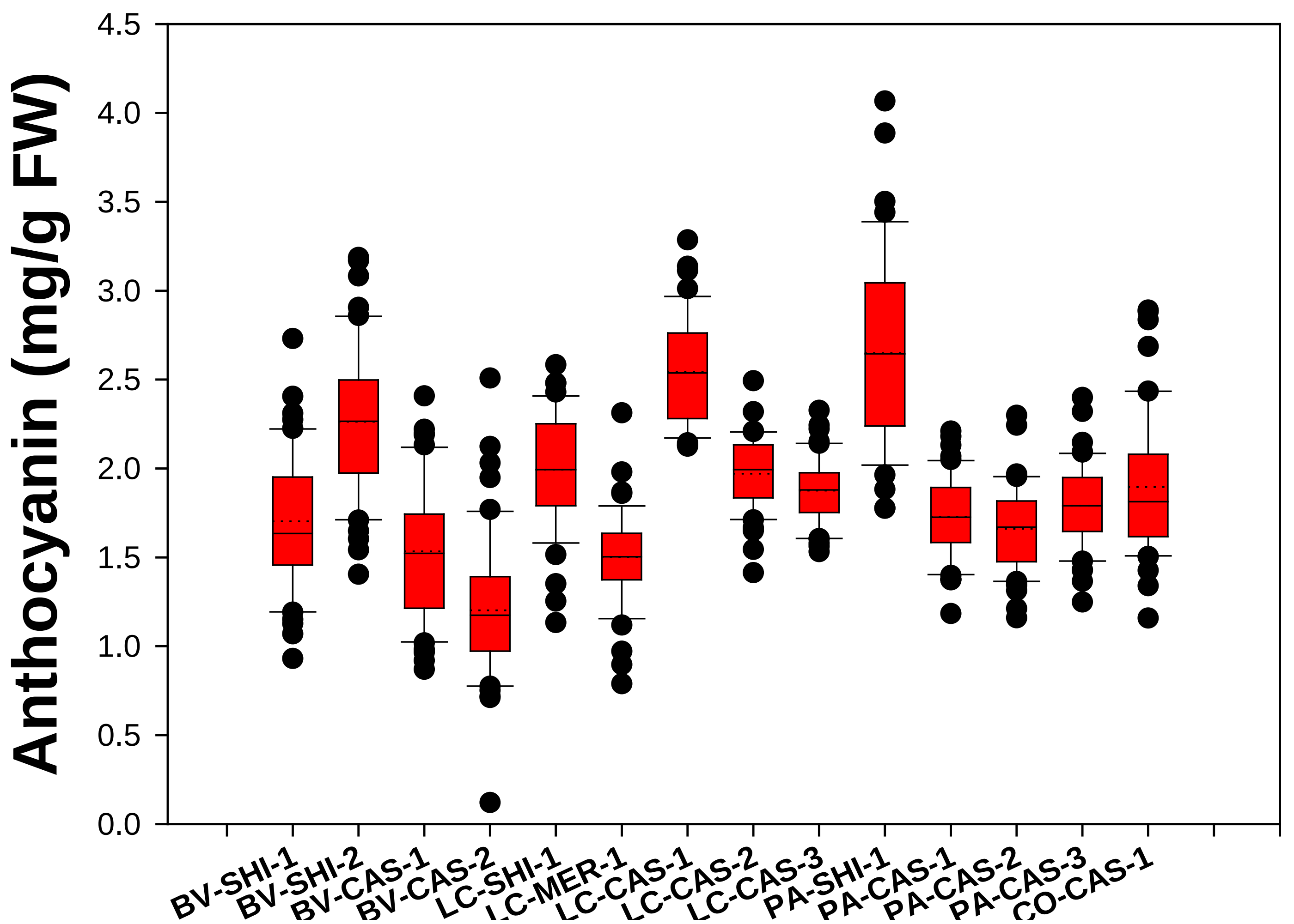
% Coefficient of Variation in ºBrix across 16 vineyards



Shiraz, Cabernet Sauvignon, Merlot, Reisling and Chardonnay

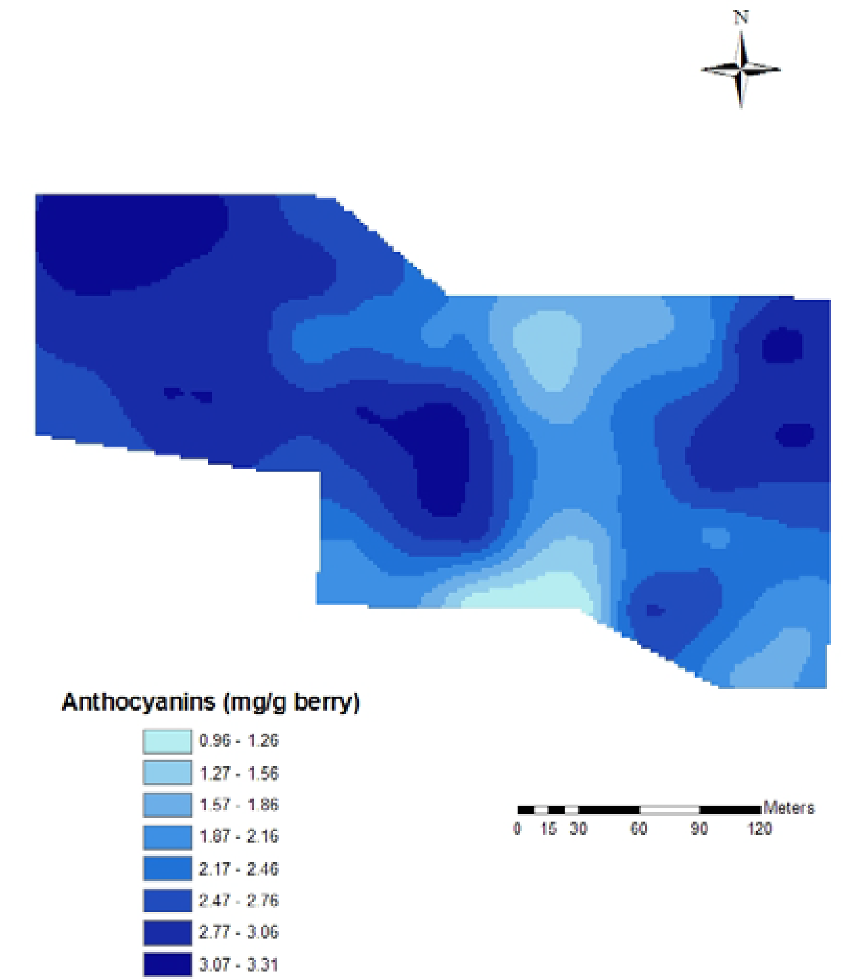
Variation in anthocyanins across 14 vineyards

Box Plots - 10th/90th percentile, 25th/75th percentile, mean, median and outliers

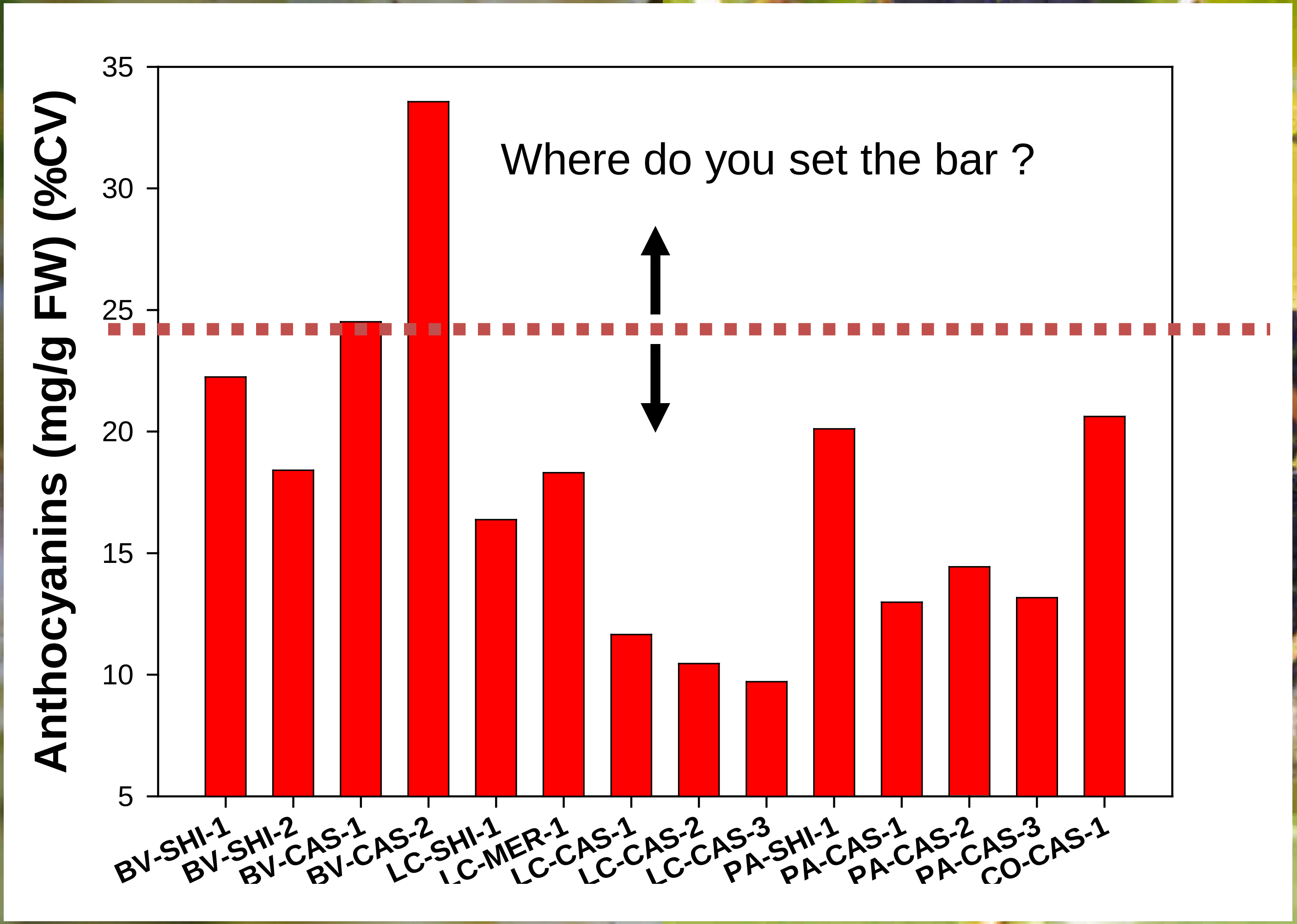


Shiraz, Cabernet Sauvignon and Merlot

Mildura Anthocyanins 2006



% Coefficient of Variation in anthocyanins across 14 vineyards

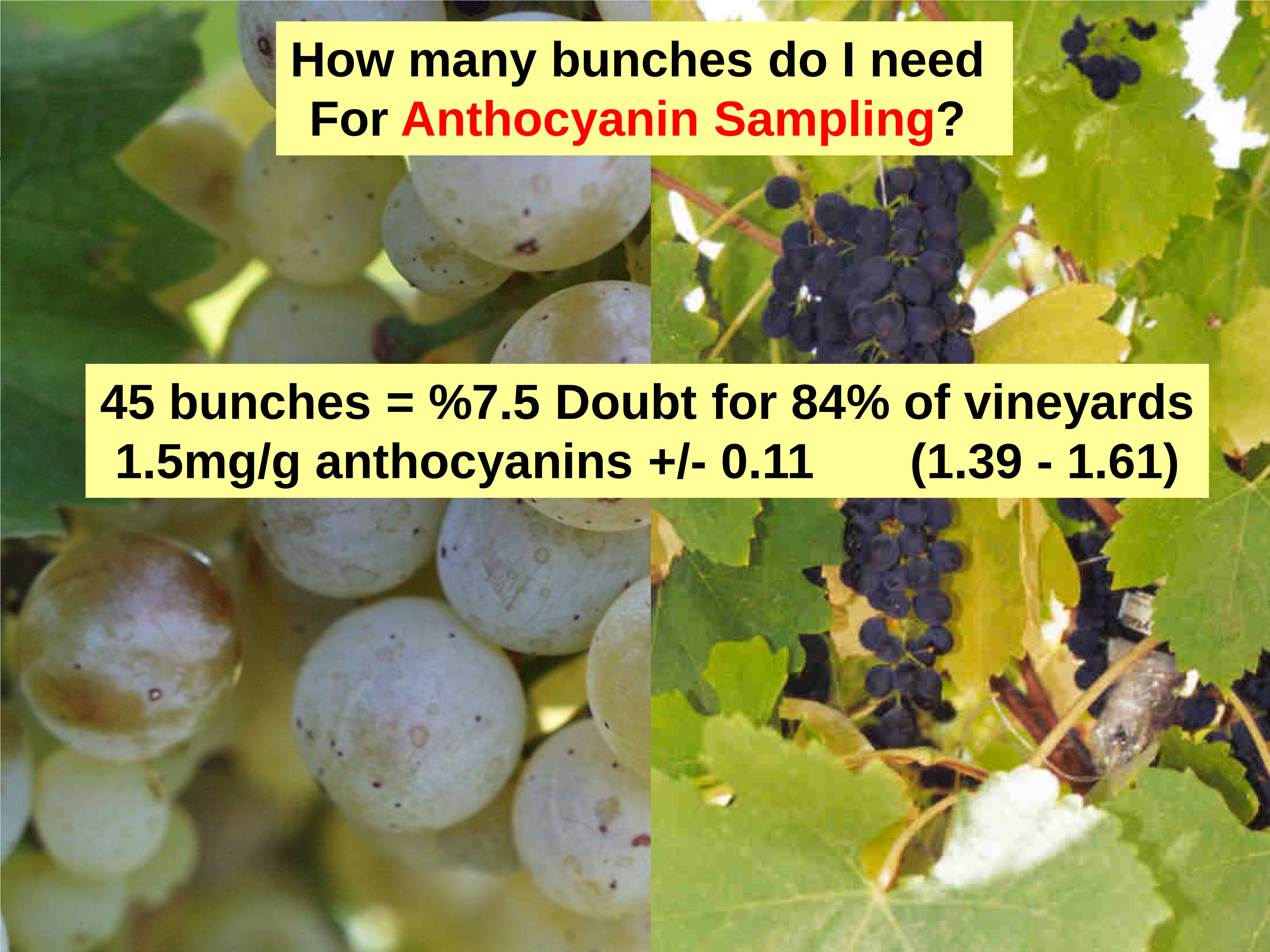


Shiraz, Cabernet Sauvignon and Merlot

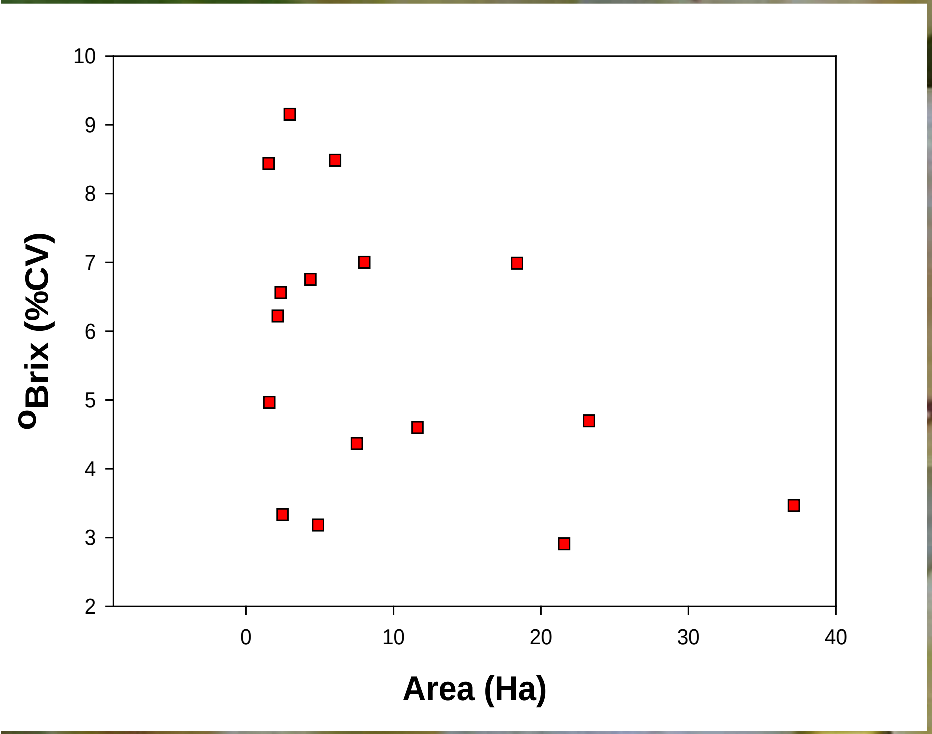
How many bunches do I need For **Maturity Sampling** ?

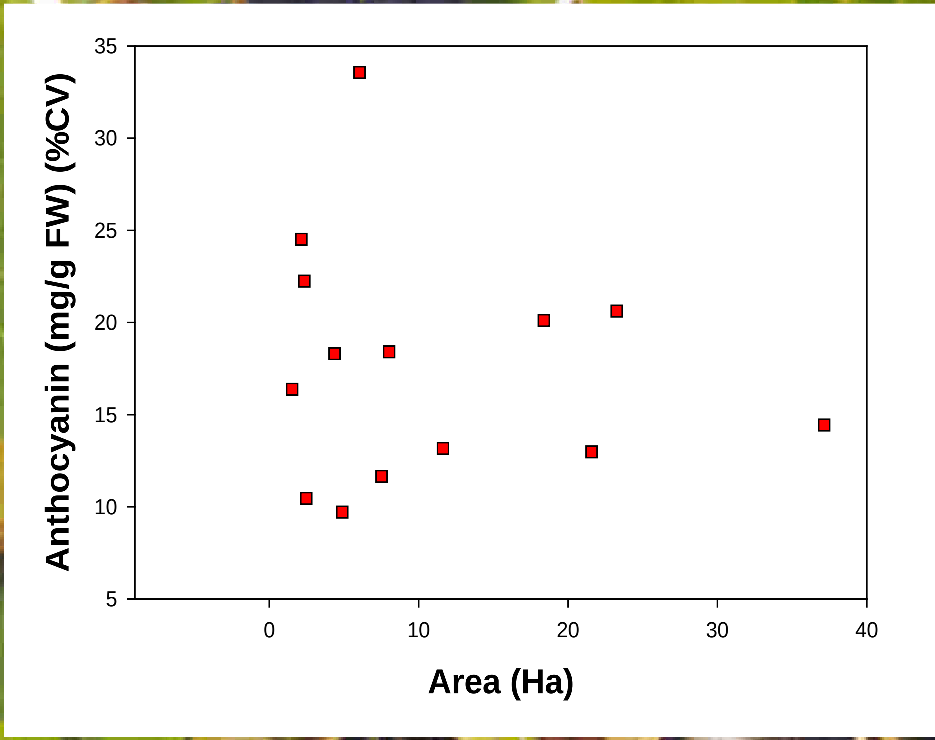
10 bunches = %5 Doubt for 84% of vineyards
24 ºBrix +/- 1.20 (22.8 - 25.2 ºBrix)
(12.7 - 14.0 Baume)

20 bunches = %3.5 Doubt for 84% of vineyards
24 ºBrix +/- 0.84 (23.16 - 24.84 ºBrix)
(12.9 - 13.8 Baume)


How many bunches do I need
For Anthocyanin Sampling?
45 bunches = %7.5 Doubt for 84% of vineyards
1.5mg/g anthocyanins +/- 0.11 (1.39 - 1.61)

Effect of vineyard size (Ha) on observed variability in °Brix and anthocyanins





Shiraz, Cabernet Sauvignon, Merlot, Reisling and Chardonnay

What does this mean in practice for <u>maturity and anthocyanin</u> sampling ?

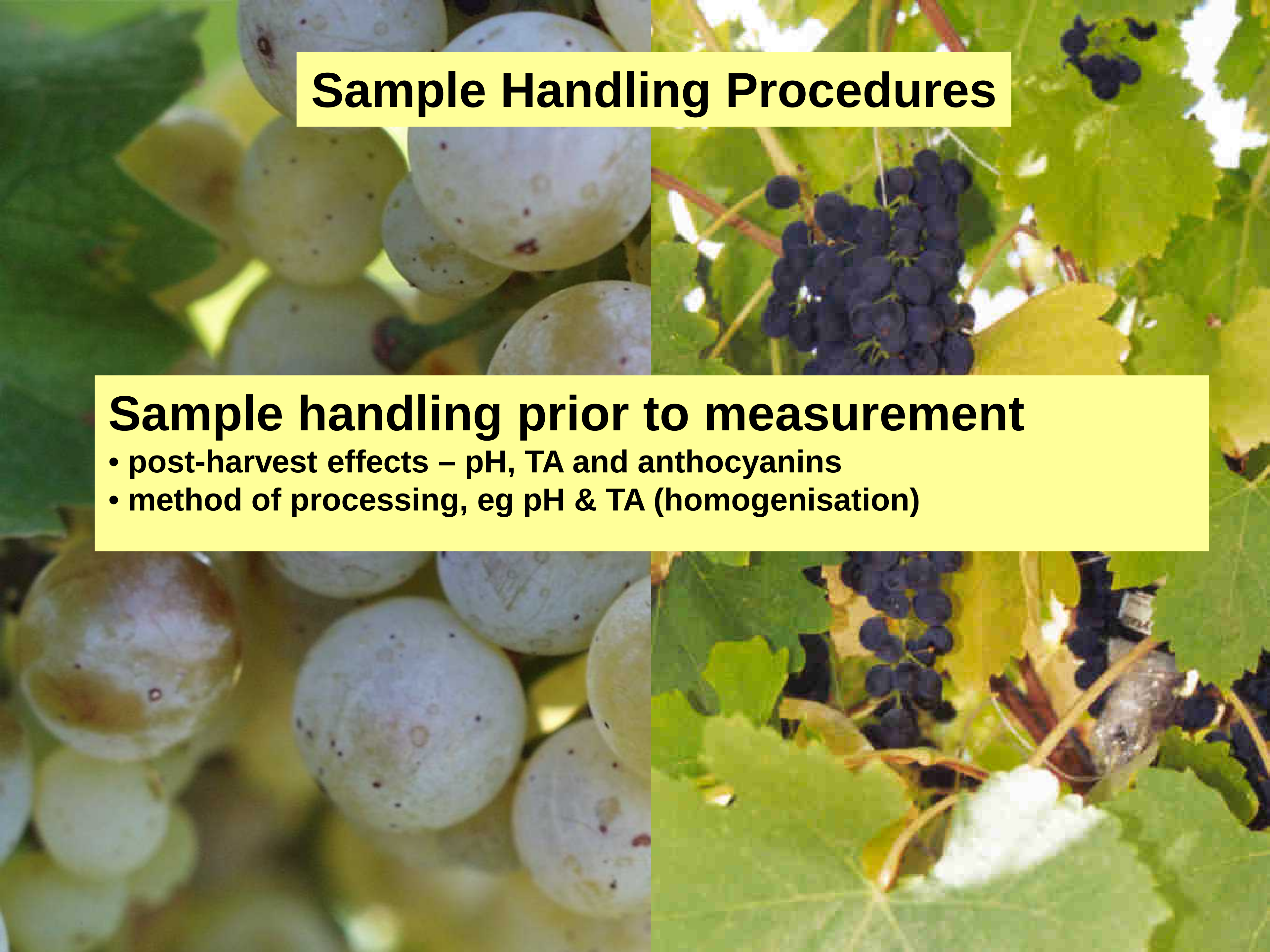
Intensity of sampling is dependant on accuracy required in the result

Maturity: 20 bunch sample (pooled)
Anthocyanin: 40 bunch sample (pooled)
Single result

- **no idea of variability around result**

How do you go about determining the method of bunch selection ?

Sample Handling Procedures



Sample handling prior to measurement

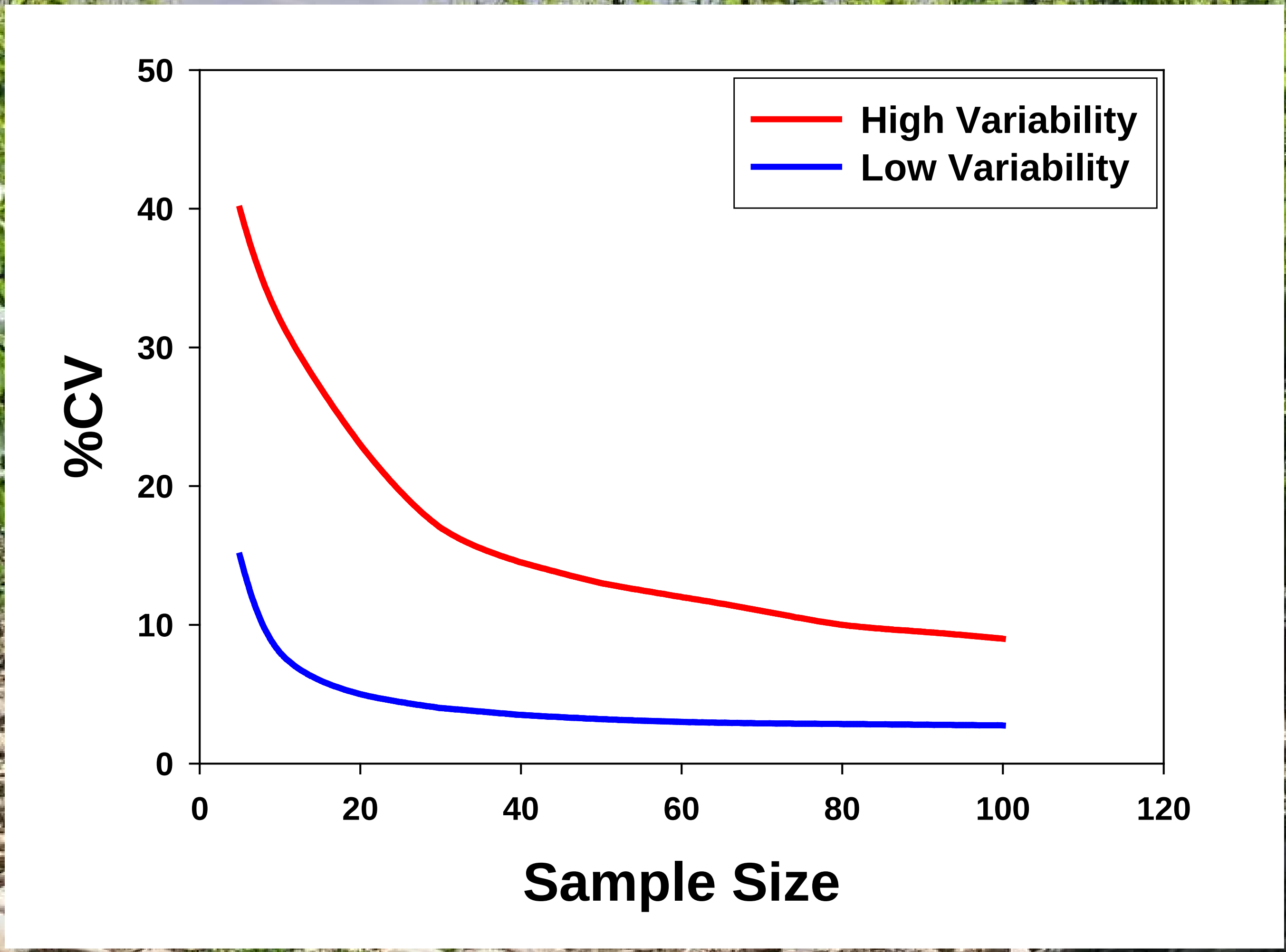
- **post-harvest effects – pH, TA and anthocyanins**
- **method of processing, eg pH & TA (homogenisation)**

In Summary

<u>Accurate sampling</u> depends on :

1. **Understanding spatial and temporal variation in each component.**
2. **Knowing the accuracy to which you would like to be able to estimate your maturity.**
3. **Understanding all factors which can influence your result.**
4. **Developing a consistent system**
5. **Still don’t have all the answers yet !**

In Summary



Sampling - the law of diminishing returns

Acknowledgements

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Research Institute

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with matching funds from the Australian government.

GRAPE AND WINE RESEARCH AND
DEVELOPMENT CORPORATION

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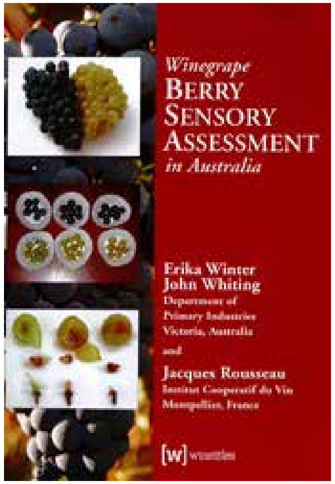
Berry sensory assessment in the vineyard for fruit grading – does it work?



Assessment schemes

- Many different types
- Differ greatly:
  - in degree of complexity
  - number of inspections
    - **Veraison to harvest common to all**
  - conducted by viticulturist or winemaker or both

Assessment schemes

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VINEYARD ASSESSMENT SHEET (an example)

VINES	Assessment Site 1	2	3
Main shoot length			
shoots trimmed Yes No			
% of shoots <50cm			
% of shoots 50-100cm			
% of shoots 100-150cm			
% of shoots 150-200cm			
% of shoots >200cm			
Average shoot length (cm)			
Number of leaves on average shoot			
Average internode length (nodes 6-7)			
% of shoots with growing tips			
Shoot lignification			
zero - little			
low			
moderate			
extensive			
fully lignified			
Extent of lateral growth			
low			
moderate			
extensive			
Leaf condition			
1. green, dull, healthy			
2. dark green, shiny, healthy			
3. green, healthy, lost turgor, backs visible			
4. pale green, wilting			
5. yellow leaves from shading			
6. basal leaves, yellowing from stress			
7. yellow leaves from autumnal senescence			
8. % leaves remaining			
9. other symptoms e.g. nutrient/salt/wind			
Assessment of overall leaf function (P, A, G or E)			
Canopy light condition			
heavily shaded			
partly shaded			
partly exposed (dappled light)			
fully exposed			
Average number of leaves in front of a bunch			
>3 leaves in front of a bunch			
3 leaves in front of a bunch			
2 leaves in front of a bunch			
1 leaf in front of a bunch			
no leaves in front of a bunch			
% Bunch exposure			

NOTES

Date of veraison:

Date of full colour:

Date of reaching set °Baumé: Yield

Date of harvest:

Overall vineyard rating = Classification grade or Score

Vineyard details:

Assessment date:

BERRIES	Assessment Site 1	2	3
Weight			
Size			
Berry shrivel (%)			
Deformability			
very soft			
soft			
firm			
hard			
Flesh texture			
watery			
juicy			
firm			
hard			
raisin			
Aroma descriptors (l = low; m = medium; h = high)			
eg herbal			
spicy			
peppery			
cherry			
raspberry			
plum			
blackberry			
earthy			
raisiny			
Skin thickness			
thin			
medium			
thick			
Skin astringency (1-5)			
puckering			
drying			
Seed colour			
green			
light brown			
brown			
dark brown			
Seed aroma			
pungent			
herbaceous			
biscuit			
nutty			
toasty			
Juice and berry analysis			
°Brix/°Baumé			
pH			
Titratable acidity			
Berry colour conc			
YAN			
Other			

	Assessment Site 1	2	3
Berry colour / Juice colour			
Comments			
Sugar-acid balance			
acidic			
balanced			
sweet			
very sweet			
fresh			
Comments: eg green, overripe, other			
Skin integrity & feel			
shreads easily			
firm & soft			
firm & leathery			
Skin ripeness (1-5)			
Seed hardness			
brittle			
hard			
cracking			
Seed astringency (1-5)			
Seed ripeness (1-5)			

Comments

Disease incidence and severity and fruit condition

Botrytis, Powdery mildew, Downy mildew, Splitting, Sunburn, Heat damage, Other

Record % incidence and % severity of each disease or damage

Comments

Iland et al. (2011) The Grapevine p.178

Assessment schemes

The Australian Wine Research Institute

Assessment schemes: extremes

At one extreme: Basic

- Pre-harvest assessment by viticulturist
  - Winemaker may or may not participate
- Up to 10 attributes
  - e.g. “vine balance”, berry size ….
  - Not all may be used
- Each attribute classified as “good”, “average” or “less than average”
  - Strongly benchmarked within that region
- → Allocation to one of 4 to 5 grades

Assessment schemes: extremes

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Research Institute

At the other extreme: elaborate

- Inspections in winter, budburst to veraison and veraison to harvest
- Pre-harvest assessment by viticulturist and winemaker
  - 15+ vine and 7+ berry attributes
    - Some with up to 5 categories
    - e.g. berry deformability: very soft, soft, firm or hard
- IPad
  - Integrated to → overall score for grading

Vine characteristics used for fruit grading

- Vine balance
- Canopy microclimate
- Berry
- Disease etc
- Yield

Vine balance: general

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- ØVisual integration
- ØBenchmarked
- ØNo standard method
- ØCorrelated with wine score

Characteristic: vine balance

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- Measure:
  - Leaf area relative to fruit
  - Extent of growing shoot tips
  - Main shoot length
  - Extent of lateral shoot development
  - Shoot lignification

Vine balance:
leaf area relative to fruit weight

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- Relationship with wine quality is well documented
  (Dry et al. 2005, Iland et al. 2011)
- Almost never measured in practice
  - Time-consuming, expensive
- Only visual assessment

Vine balance:
leaf area relative to fruit weight

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- LA/FW is strongly correlated with FW/PW
  - FW/PW ratio is best known quantitative assessment of vine balance
  - 5 to 10 is optimal (Smart and Robinson 1991)
  - not possible to calculate this during pre-harvest inspection – but would be useful to do so after the event to confirm visual assessment
- Recent research (Dokoozlian et al. 2011)
  - Bunch thinning (set + 3 weeks) to achieve ‘undercropped’, ‘balanced’ and ‘overcropped’, Cab Sauv

FW/PW and fruit quality
(Dokoozlian et al. 2011)

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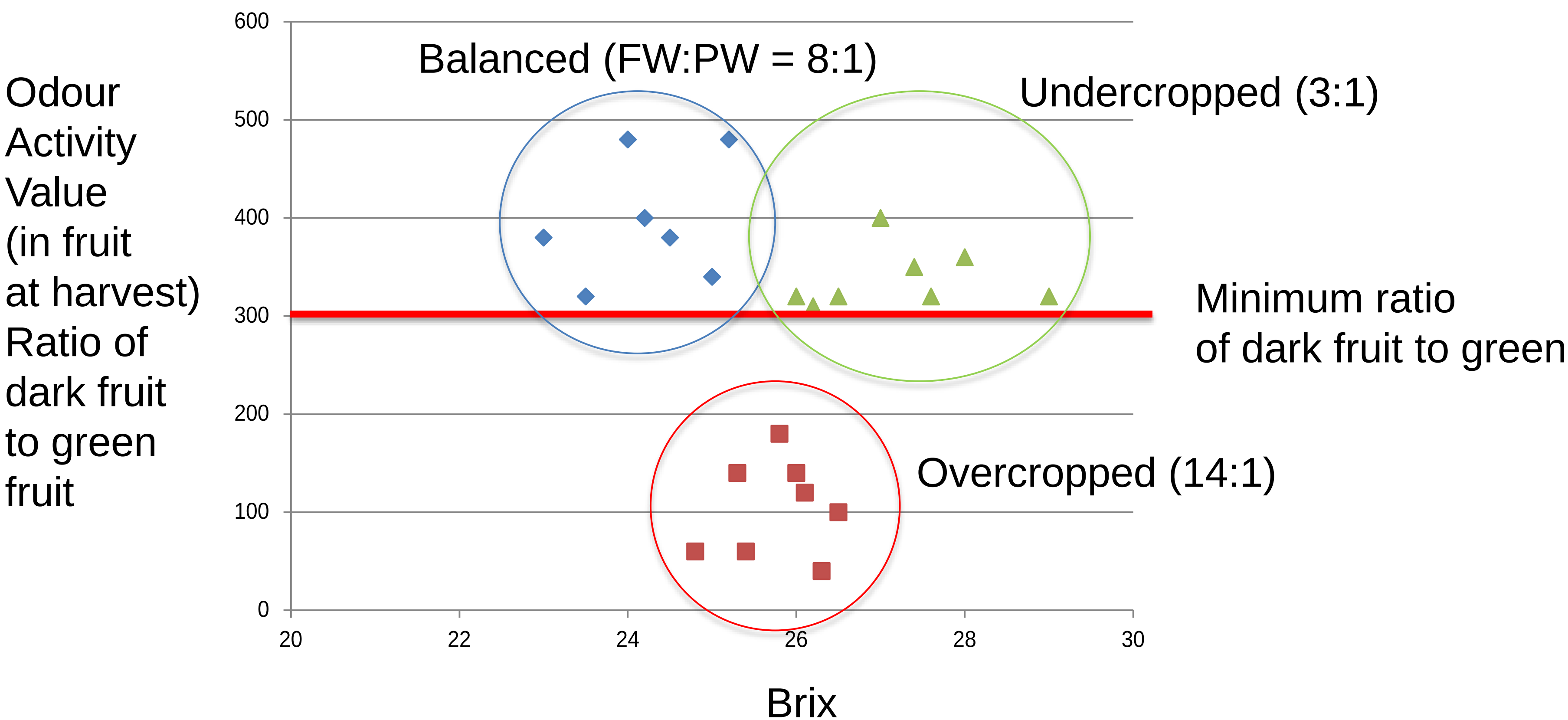

Vine balance: % growing shoot tips

ACTIVE ALMOST STOPPED

- % active shoot tips at veraison, shoot length and extent of lateral shoot growth are all indicators of **shoot vigour**
- % active shoot tips used in many schemes
  - e.g. McWilliams Shiraz: 6 categories from 0 to >50%

Vine balance: % growing shoot tips

- Some research on direct relationship between shoot vigour and fruit quality (Lakso and Sacks 2010)

- Good evidence that cessation of shoot growth by veraison is positively associated with wine quality
  - terroir studies e.g. van Leeuwen et al. (2004), Scarlett and Bindon (2012)
  - benchmarking studies e.g. Mornington Pen Pinot Noir (Winter et al. 2007); NE Vic Shiraz (Winter et al. 2005)

- Easy to quantify (Martinez-de-Toda et al. 2010, Smart 2010)

Vine balance:
extent of lateral shoot development

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- Indicator of shoot vigour
- Negatively correlated with quality rating
  (Riley 2000)
- Also related to canopy density
- High degree of “leafiness” correlated with low wine score
  (NE Vic Shiraz Winter et al. 2005)

Vine balance: shoot lignification (SL)

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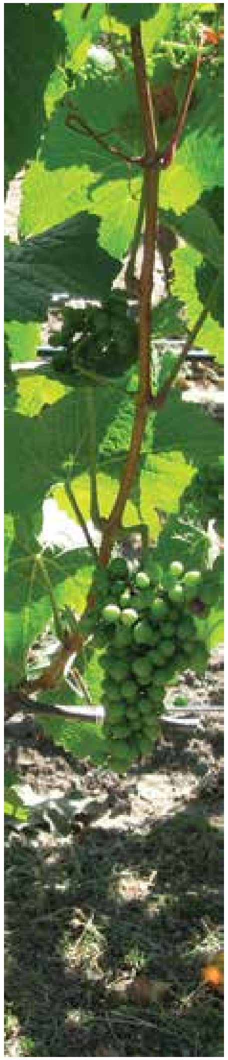
- Often used
- Few published studies
  - winegrape value positively correlated
    with SL at harvest, Shiraz, hot to cool regions
    (Gray et al. 1997)
- Regional benchmarking
  - SL at veraison positively correlated with wine score
    - e.g. McLaren Vale Shiraz (DVCS 2006)
      Mornington Pen Pinot Noir (Winter et al. 2007)
      NE Vic Shiraz (Winter et al. 2005)



Vine balance: shoot lignification (SL)

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- SL correlated with:
  - % growing tips, seed maturity
    Mornington Pen Pinot Noir (Winter et al. 2007)
  - Shoot length
    (Cloete et al. 2006)
  - Canopy density
    (Reynolds et al. 1986)

Characteristic: canopy microclimate

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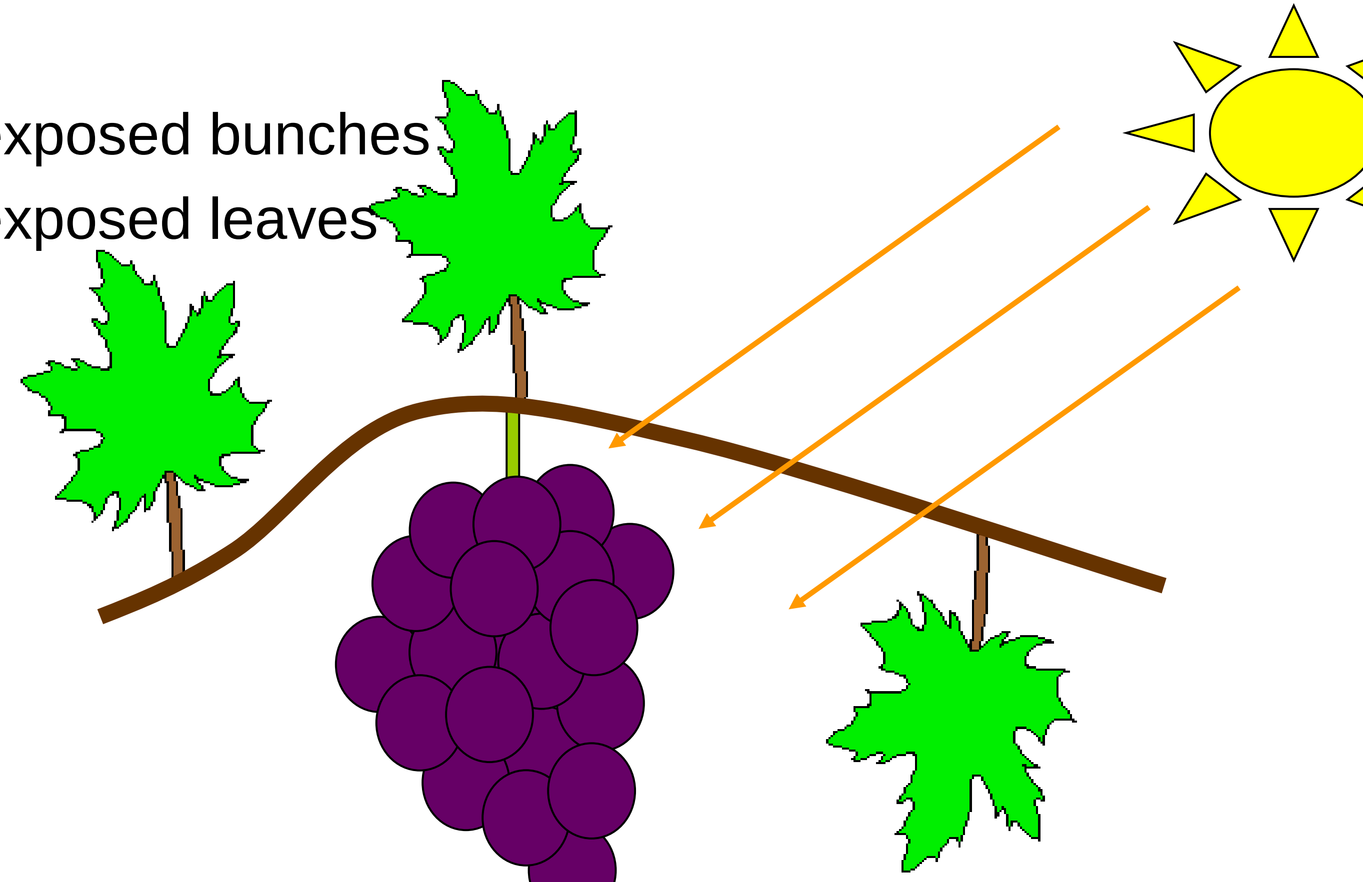
- Measure:
  - Leaf layer number in bunch zone
  - Shoot density
  - Bunch density
  - Proportion of exposed bunches
  - Proportion of exposed leaves



Canopy microclimate: LLN

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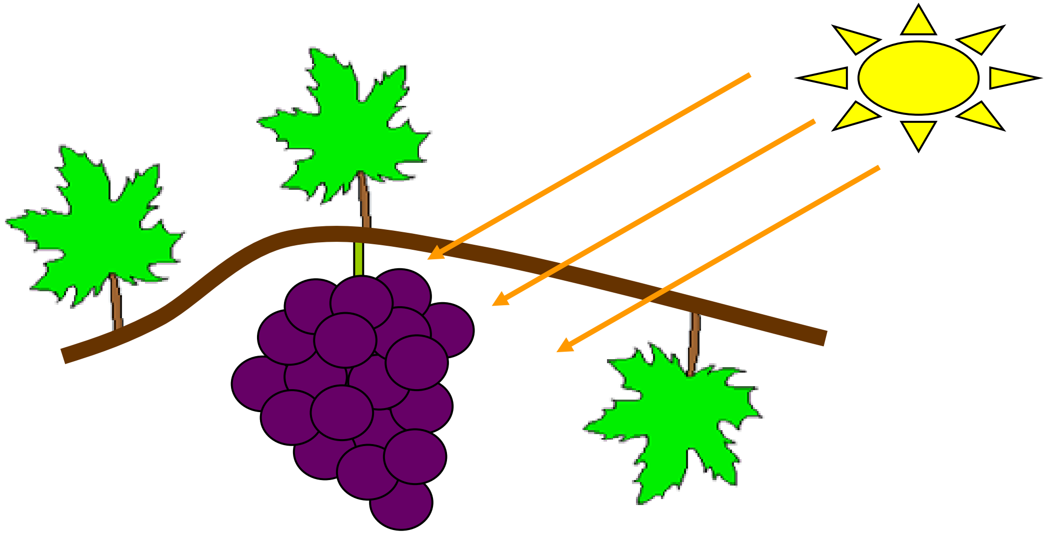
- Leaf layer number in bunch zone:
  - Negative correlation: leafy/dense canopies with winegrape value e.g. Gray et al. (1997)
  - Benchmarking studies: open canopy/low LLN = positive attribute (McLaren Vale Shiraz)



Canopy microclimate: shoot and bunch density

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- Used in some assessment schemes e.g. Riley (2000)
  - Shoot spacing related to canopy density
- Bunch clumping?
  - Disease issues or index of shoot density?

Canopy microclimate: bunch exposure

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- Positive influence of bunch exposure well understood (Dry 2009)
- However, trade-off between optimal degree of bunch exposure for disease control and quality on one hand - and avoidance of "chemical damage" and sunburn on the other
  - will depend on climate, variety and end use

Reflected in many assessment schemes and benchmarking studies

Berry characteristics

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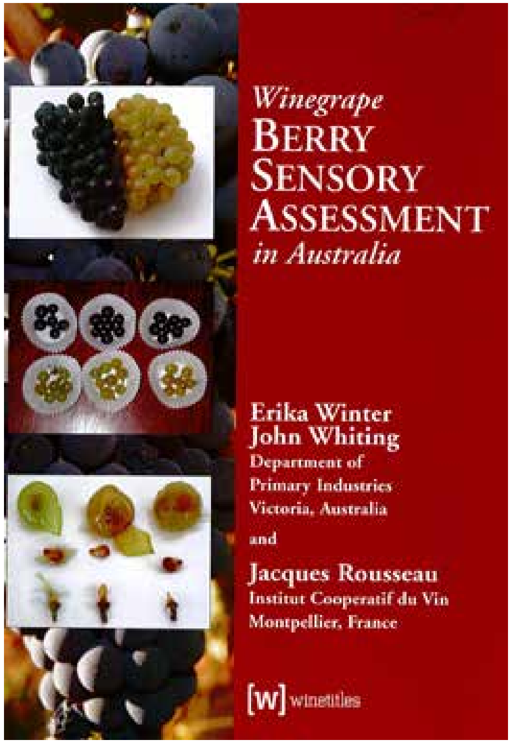
- Berry tasting in field is not new

- However, formalised
  berry sensory assessment BSA
  (Winter et al. 2004) is relatively new



Winter et al. 2004

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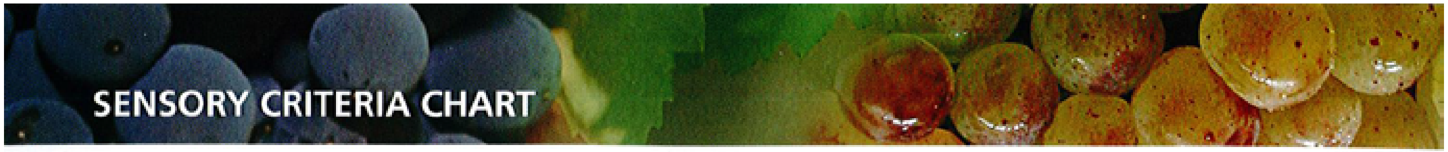

Visual and tactile examination of the grapes

	1	2	3	4
SOFTNESS *Squeeze the berry between the fingers*	> **Hard berry** > Bursts under strong pressure	> **Elastic berry** > Changes shape slightly under pressure but goes back to shape quickly	> **Plastic berry** > Changes shape easily, takes a while to go back to its shape	> **Soft berry** > Changes shape easily under light pressure, does not readily go back into shape
STALK REMOVAL *Remove berry from stalk (pedical)*	> Berry strongly attached and/or > Stalk tears the skin, takes much green pulp and some skin out	> Berry comes off with moderate difficulty > Stalk comes off with part of the green pulp	> Berry comes off fairly easily > Stalk and brush includes only a little of the uncoloured pulp	> Berry comes off very easily > Stalk and brush with no pulp stuck to them > Brush red in red varieties
COLOUR RED VARIETY *Look at stalk end*	> Pink, pale red	> Red, light penetrates berries	> Dark red, but not evenly coloured around the stalk	> Blackish red, evenly coloured
COLOUR WHITE VARIETY *Bulk Sample*	> Green	> Green yellow	> Straw yellow	> Amber yellow

Pulp characteristics

	1	2	3	4
DETACHMENT OF THE PULP FROM THE SKIN *crush berries against roof of the mouth to express juice, later slightly chew skins*	> Pulp adheres strongly to the skin and seeds	> A film of pulp adheres to the skin and/or seeds	> Film of pulp only slightly visible on skins but juice is released from skins when squashed	> No film of pulp on skin and seeds and no release of juice when squashed
JUICINESS OF PULP *melting properties of juice in the mouth*	> More than 80% is firm gelatine	> 50% is gelatinous and 50% juicy	> Almost all juice	> 100% juice
SWEETNESS *move juice over tongue*	> Not very sweet	> Moderately sweet	> Sweet	> Very sweet
ACIDITY *feeling on the side of the tongue*	> Very acidic	> Acidic	> Moderately acidic	> Low acid
HERBACEOUS AROMAS *analysis in the mouth*	> Intense	> Moderate	> Weak	> Absent
FRUITY AROMAS *in the mouth*	> Absent	> Weak	> Moderate	> Intense

Winter et al. 2004

Skin characteristics

	1	2	3	4
DISINTEGRATION *chew the skins 10 to 15 times*	> Very difficult > Big pieces	> Difficult > Small pieces	> Fairly easy > Mixture almost homogeneous	> Easy > Homogeneous mixture
ACIDITY *of chewed skins*	> Very acidic	> Acidic	> Moderately acidic	> Low acid
HERBACEOUSNESS AROMAS *of chewed skins*	> Intense	> Moderate	> Weak	> Absent
FRUITY AROMAS *of chewed skins*	> Absent	> Weak	> Moderate	> Intense
TANNIC INTENSITY *run the tongue over the palate*	> Tongue slides effortlessly over the roof of the mouth	> Tongue sticks slightly to the roof of the mouth	> Tongue slides over the roof of the mouth with difficulty	> Tongue slides over the roof of the mouth with great difficulty
GRAIN SIZE AND ASTRINGENCY OF TANNINS *spit the skin out, assess astringency and time needed to re-salivate*	> Grippy, rough, aggressive > Difficult to re-salivate after more than 5 seconds	> Coarse grains > Difficult to re-salivate for a few seconds	> Medium size grains > A little difficult to re-salivate	> Soft, fine and silky grains > Not difficult to re-salivate

Winter et al. 2004

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Seed characteristics

	1	2	3	4
COLOUR *at front of seed*	> Green, yellow-green	> Brown-green	> Grey-brown, no green traces	> Dark brown
CRUSHABILITY *crush the seeds between the front teeth*	> All seeds are soft	> Outside layer is soft > Seed crushes under pressure like a fresh almond	> Almost no soft outside layer > Most seeds are hard and crack easily	> No soft outside layer > All seeds are hard, crack quickly and are crunchy
FLAVOURS *of crushed chewed seeds*	> Not tasted	> Herbaceous	> Only slightly herbaceous, slightly toasted	> Toasted
ASTRINGENCY *first lick, then, if possible, chew the seeds*	> Very astringent when licked	> Astringent when chewed	> Moderately astringent when chewed	> No astringency
TANNIC INTENSITY *run the tongue over the roof of the mouth*	> Tongue slides with great difficulty	> Tongue slides with difficulty	> Tongue sticks slightly	> Tongue slides effortlessly

Winter et al. 2004

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Vineyard:	BSA FIELD SCORESHEET					
	Taster:					Date : ___/___/___
Sample 1:	Maturity level 1	2	3	4	Decision	Notes (abnormal)
Pulp maturity						
Pulp aromatic level						
Skin maturity						
Seed maturity						
Sample 2:	Maturity level 1	2	3	4	Decision	Notes (abnormal)
Pulp maturity						
Pulp aromatic level						
Skin maturity						
Seed maturity						
Sample 3:	Maturity level 1	2	3	4	Decision	Notes (abnormal)
Pulp maturity						
Pulp aromatic level						
Skin maturity						
Seed maturity						
Sample 4:	Maturity level 1	2	3	4	Decision	Notes (abnormal)
Pulp maturity						
Pulp aromatic level						
Skin maturity						
Seed maturity						
Sample 5:	Maturity level 1	2	3	4	Decision	Notes (abnormal)
Pulp maturity						
Pulp aromatic level						
Skin maturity						
Seed maturity						
Sample 6:	Maturity level 1	2	3	4	Decision	Notes (abnormal)
Pulp maturity						
Pulp aromatic level						
Skin maturity						
Seed maturity						

BSA

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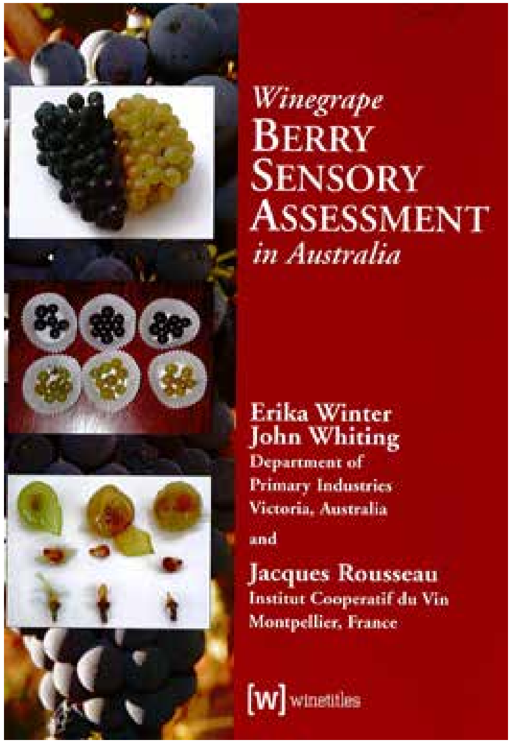
- Has been around for 10 years
- But it is still relatively unknown



What is the take up?

Survey by Olarte Mantilla et al. 2012

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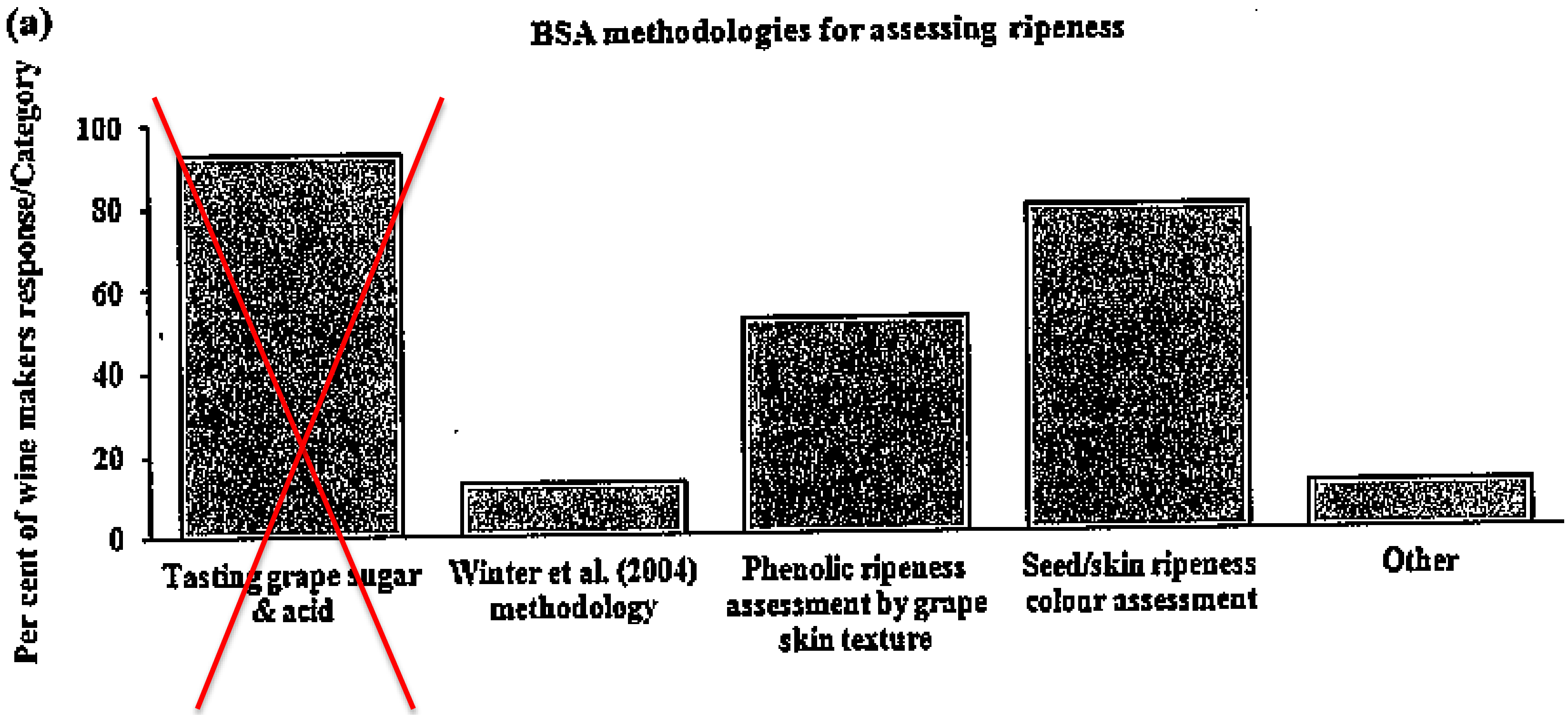

How trained?

Survey by Olarte Mantilla et al. 2012

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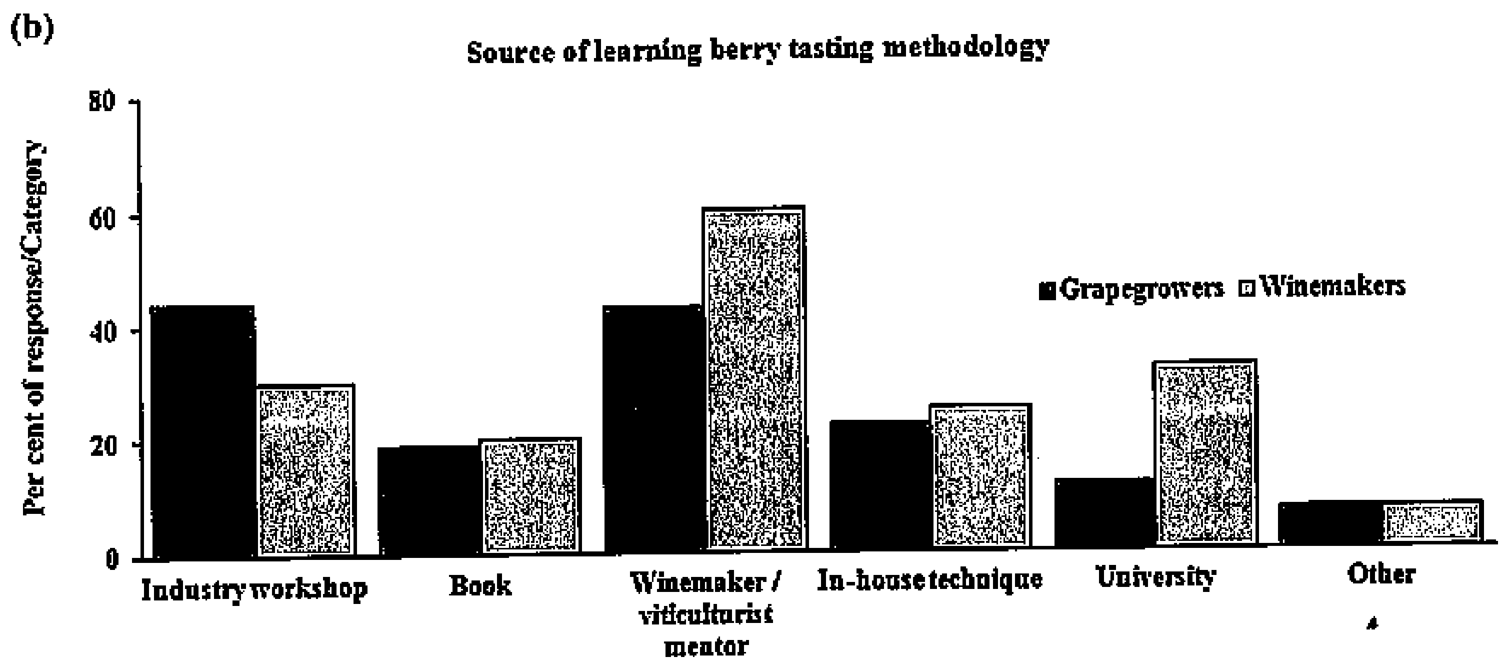


Berry characteristics: **BSA**

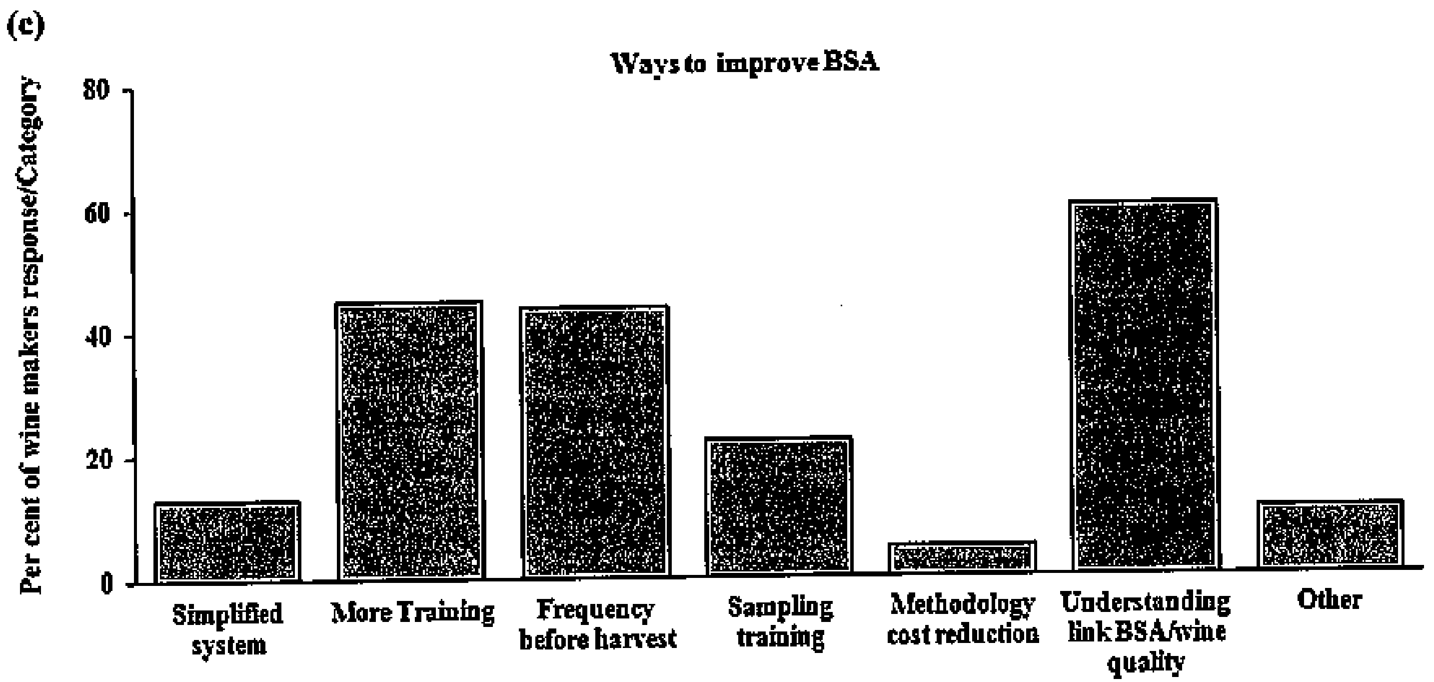
- Relatively little research
  - mostly recent
  - BSA positively correlated with juice composition/wine score
    - Le Moigne et al. (2008), Tardaguila et al. (2008), Witbooi and Carey (2009), Lohitnavy et al. (2010)
  - In some cases only a few out of 20+ attributes were correlated
    - eg. flesh maturity, astringency of pulp and skin, seed and skin colour

Semillon bunchzone leaf removal before flowering study (Lohitnavy et al 2010)

- 23 attributes, 11 trained assessors
- 16 attributes found to signif. differentiate berries from various treatments
- Leaf removal before flowering
  ® fruit with higher skin acidity, citrus flavour, more toasty seed flavour, lower skin astringency
  ® better wine

Ways to improve

Survey by Olarte Mantilla et al. 2012



Berry size

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- Visual assessment in many schemes
- Does it correlate negatively with wine score?
  - Yes – in some studies e.g. Gray et al. (1997)
  - No – in many studies e.g. Roby and Matthews (2004), Roby et al. (2004), Walker et al. (2005) Bindon et al. (2008a), Poni et al. (2009)
- Environmental and cultural factors may affect skin development independently of pulp and thus can alter fruit and wine composition <u>without any change in berry size</u> (Poni et al. 2009)

Berry size

- Some benchmarking studies: no correlation between berry weight/size and wine score
  - e.g. Swan Hill Shiraz (Swinburn 2006)
    NE Vic Shiraz (Winter et al. 2007)

Yield (t/ha)

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- Yield limits are included in most contracts – and this is reasonable for vintage planning and so on.
- The majority of vineyards producing premium wine tend to have low yield (t/ha)
  - so it is assumed, by some, that low yield is indicative of good quality.

Yield (t/ha)

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- many wine companies use yield as a criterion for fruit grading
  - even though the weight of experimental evidence indicates that yield is not a reliable predictor of quality (Dry et al. 2005).
- supported by some benchmarking studies
  - yield and wine composition/score not correlated (DeGaris 2000, Winter et al. 2005).
- measures of vine balance are much more valid for fruit grading than yield alone

Conclusions

- Vineyard assessment for fruit grading needs improving
- Recent survey indicated both grape sellers and buyers want more consistency and clarity in application and communication (Longbottom et al. 2013)
- Perhaps greater use of BSA may be desirable
  - But not mentioned in above survey
- But what are the challenges associated with such a move?

BSA – what are the challenges?

The Australian Wine Research Institute

- Needs qualified trainers not just colleagues
- Needs well-trained assessors
- Needs assessors who are able to identify tastes and mouthfeel attributes
  - 25% of population are bitter blind
- Selection of type and number of attributes
  - Depends on variety, purpose of exercise, fresh or frozen berries
- How many berries to taste?
  - only 3 done easily simultaneously
- Needs experienced operators to analyse and present data
- **Do your research before including BSA in your pre-harvest assessment**

Further reading

The Australian Wine Research Institute

- Dry P.R. et al. (2013) Common vineyard measures – theory and practice. Proc ASVO Seminar 2012 'Objective measures of grape and wine quality (in press)
- Iland, P.G., Dry, P.R., Proffitt, T. and Tyerman, S. (2011) The Grapevine: from the science to the practice of growing grapes for wine (Patrick Iland Wine Promotions, Adelaide).
- Lohitnavy, N., Bastian, S. and Collins, C. (2010) Berry sensory attributes correlate with compositional changes under different viticultural management of Semillon (*Vitis vinifera* L.). Food Quality and Preference 21, 711-9.
- Longbottom M. et al. 2013 Grape quality assessments: a survey of current practice. Wine and Vitic J 28(3) , 33-37
- Olarte Mantilla, S. et al. (2012) Review: Berry Sensory Assessment: concepts and practices for assessing winegrapes' sensory attributes. Aust J. Grape Wine Res. 18, 245-255.
- Roby, G. and Matthews, M. (2004) Relative proportions of seed, skin and flesh, in ripe berries from Cabernet Sauvignon grapevines grown in a vineyard either well irrigated or under water deficit. Aust. J. Grape Wine Res. 10, 74-82.
- Winter, E., Whiting, J. and Rousseau, J. (2004) Winegrape Berry Assessment in Australia (Winetitles).

Acknowledgements

The Australian Wine Research Institute

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Australian Government

Grape and Wine Research and Development Corporation

Rainfall redirection for managing soil salinity in the vineyard

Tim Pitt, Rob Stevens, Chris Dyson, Jim Cox and Mike McCarthy

Outline

Background

Proof of concept – Groundwater, Padthaway SA

Pre-trial investigations

Hypothesis

Results

Pilot study – Recycled Wastewater, McLaren Vale SA

Progress

Summary

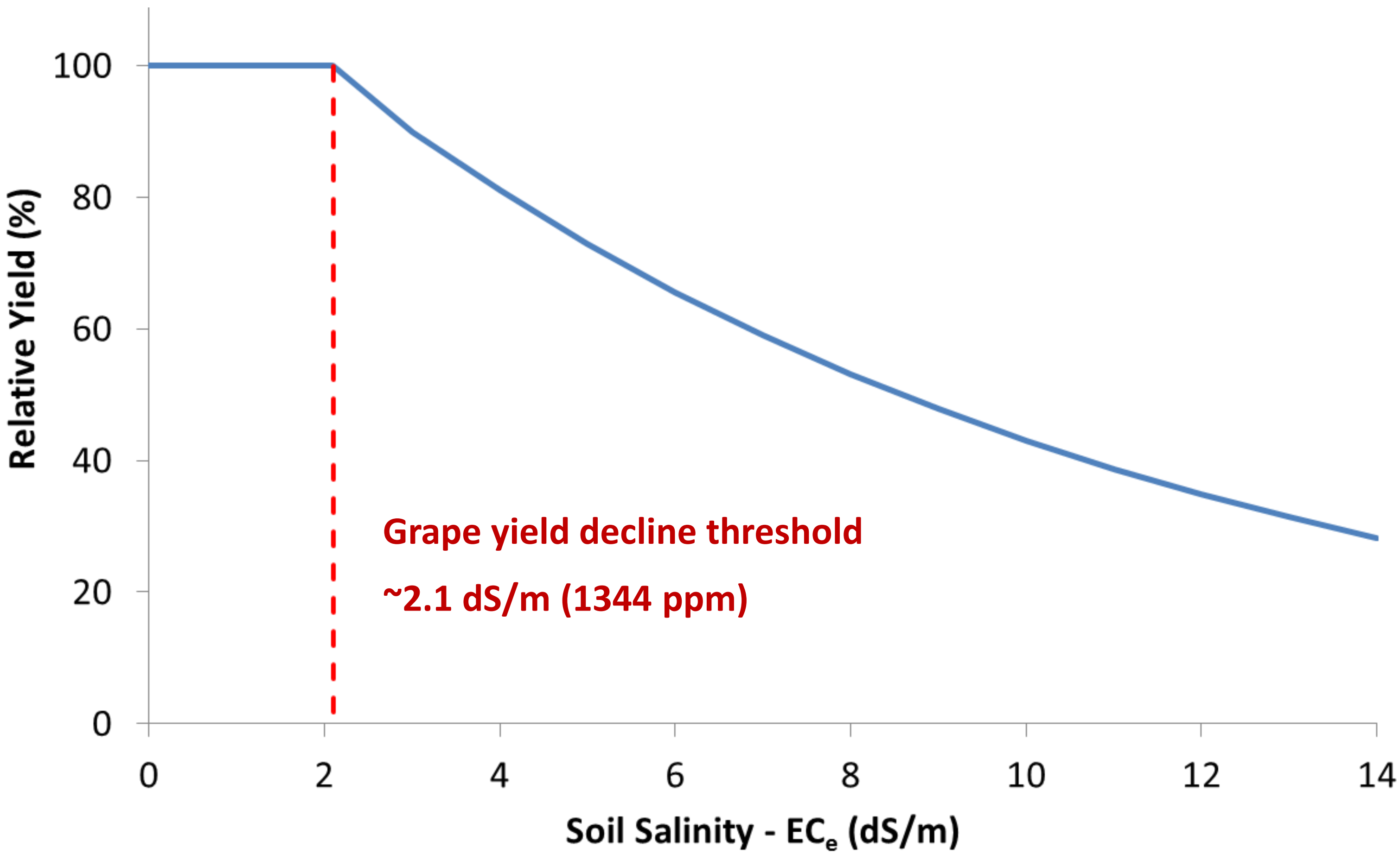
Background

Salinity can be reported in various units

1000EC = 1000µS/cm = 1mS/cm

= **1dS/m** = 640mg/L = 640ppm

Background



Relative Yield (%)
100
80
60
40
20
0
0
2
4
6
8
10
12
14
Soil Salinity - EC_e (dS/m)
Grape yield decline threshold
~2.1 dS/m (1344 ppm)

Background

2007 – 2009   salinity project developed for South East SA

Emerging salinity damage

Downward trend in rainfall

Increasing groundwater salinity

Introduction of regulated allocations

2010 – 2012   'Proof of concept' trial

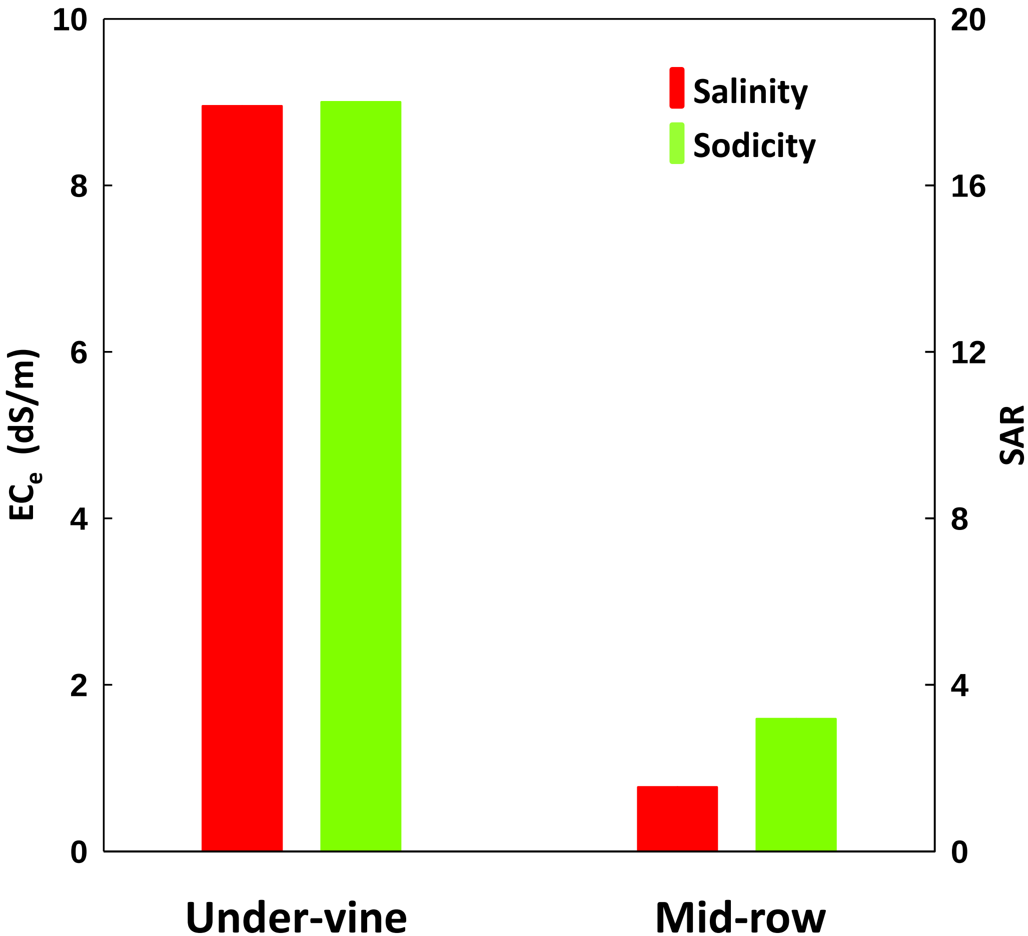
AIM – to identify techniques to manage rootzone salinity in vineyards receiving *supplementary* saline 'groundwater' irrigation

Proof of concept

Pre-trial measures 2009

Salt symptoms in vines, petiole Cl^- = 1-1.5 % (toxic)

Salt and sodicity distribution across vineyard floor

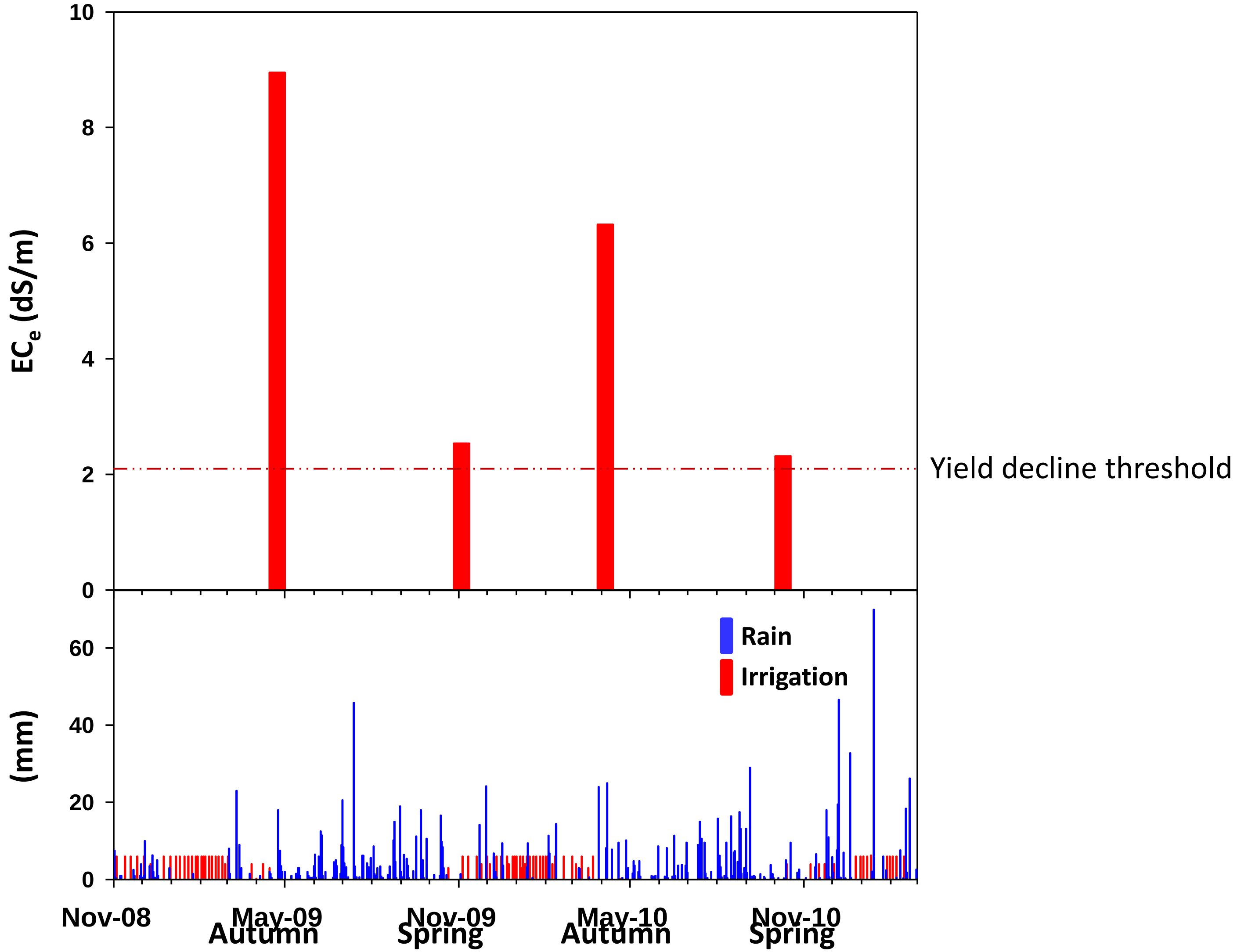


Salinity higher UV than in MR

Sodicity higher UV than in MR

Infiltration >30 mm/hr at both points

Average rootzone salinity under-vine



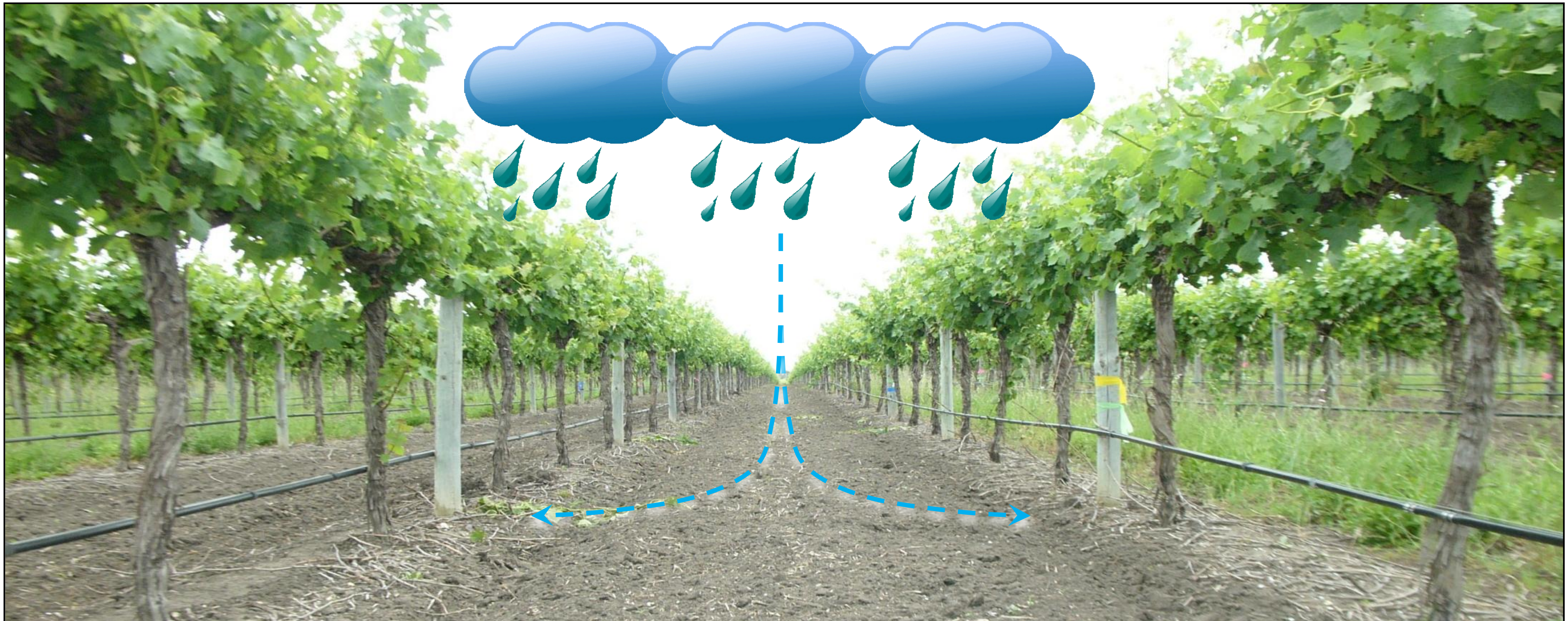
Winter rain flushing salt from rootzone

High SAR under-vine not impeding infiltration

Proof of concept

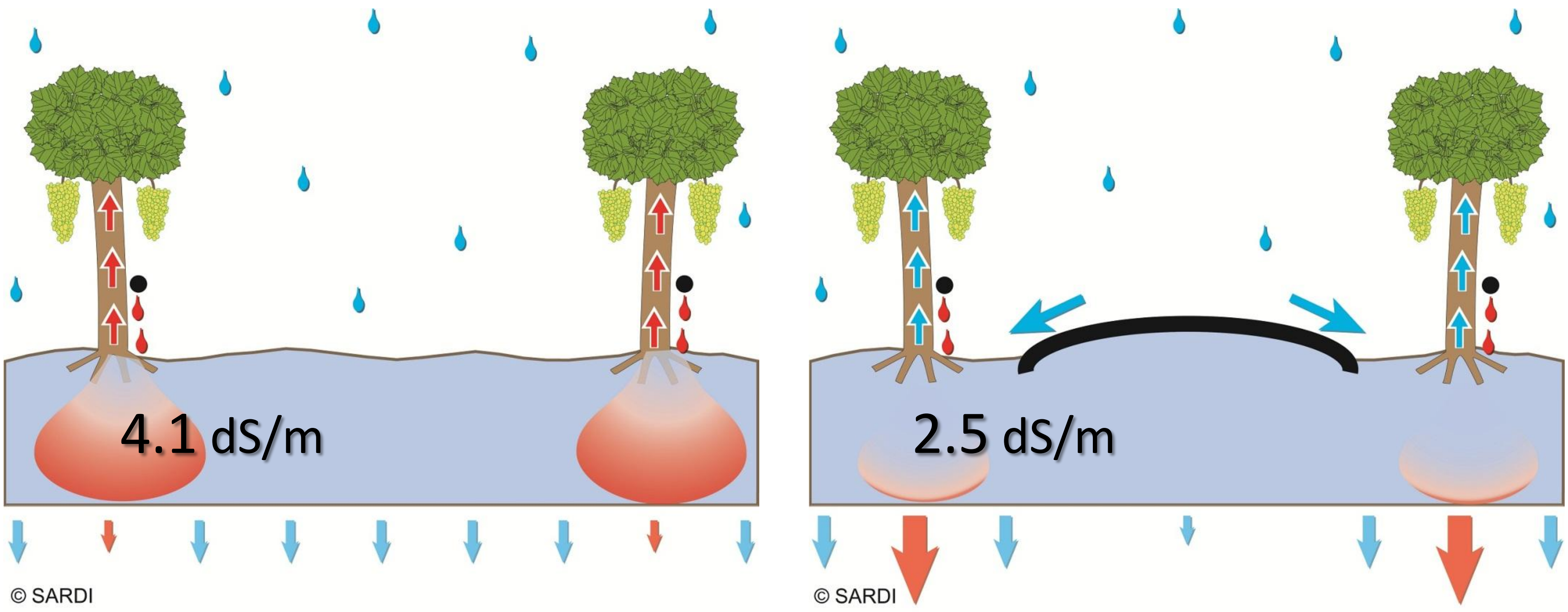
<u>Hypothesis</u>

Re-distributing rain falling on the mid-row to under the vine will reduce rootzone salinity



Proof of concept

Results



Reduced under-vine soil salinity by 40%

Proof of concept

<u>Results</u>

Re-directing rain from mid-row to under-vine soils:

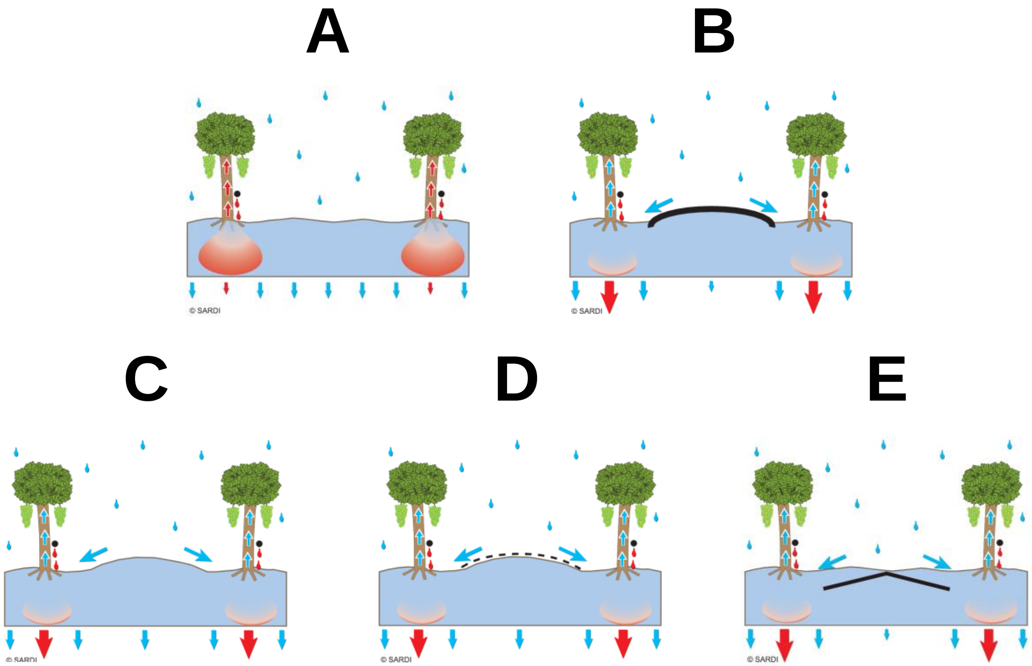
- reduced juice Na^+ by 25 % and Cl^- by 40 %

		Rain re-directed from mid-row to under-vine?	
Juice	**Vintage**	**No**	**Yes**
Na^+ (mg/L)			
	2011	33	28 *
	2012	28	18 **
Cl^- (mg/L)			
	2011	72	49 *
	2012	59	29 **

* < 0.05 ** < 0.001

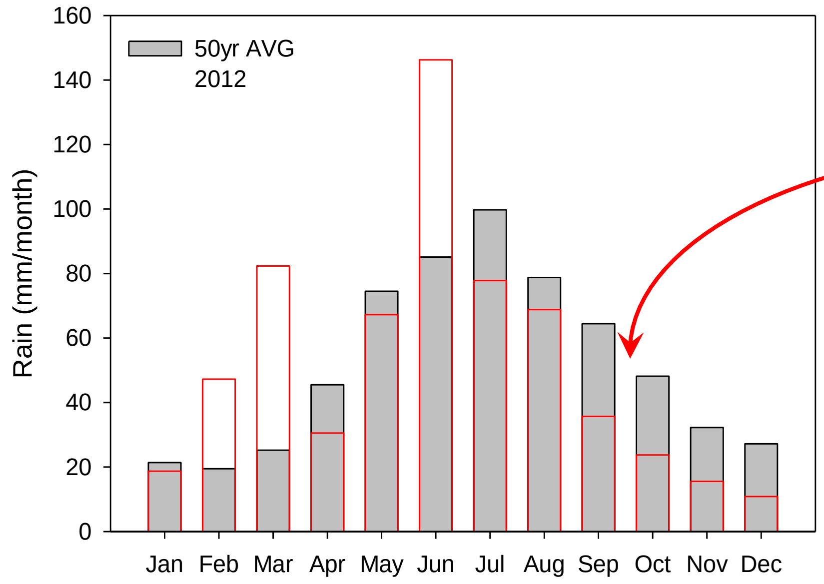
Proof of concept → Pilot study

Will more commercial treatments be as effective?

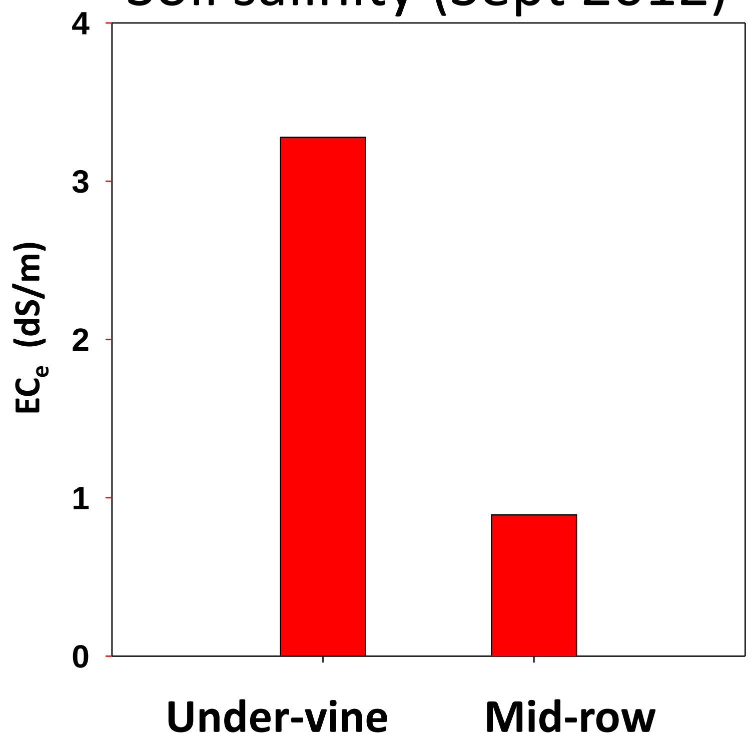


Pilot study

Pre-trial 2012



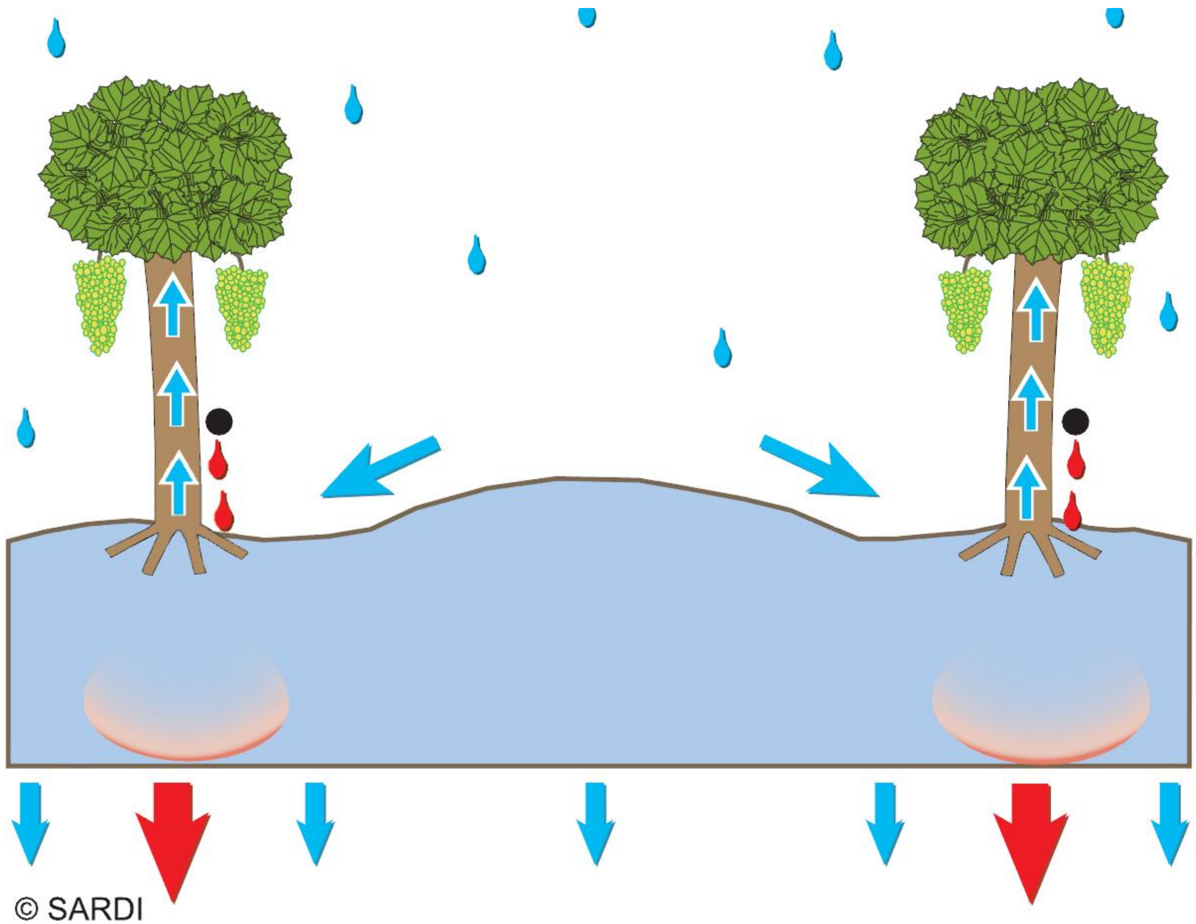
Soil salinity (Sept 2012)



Petiole (Nov 2012) Cl^- < 0.5 %

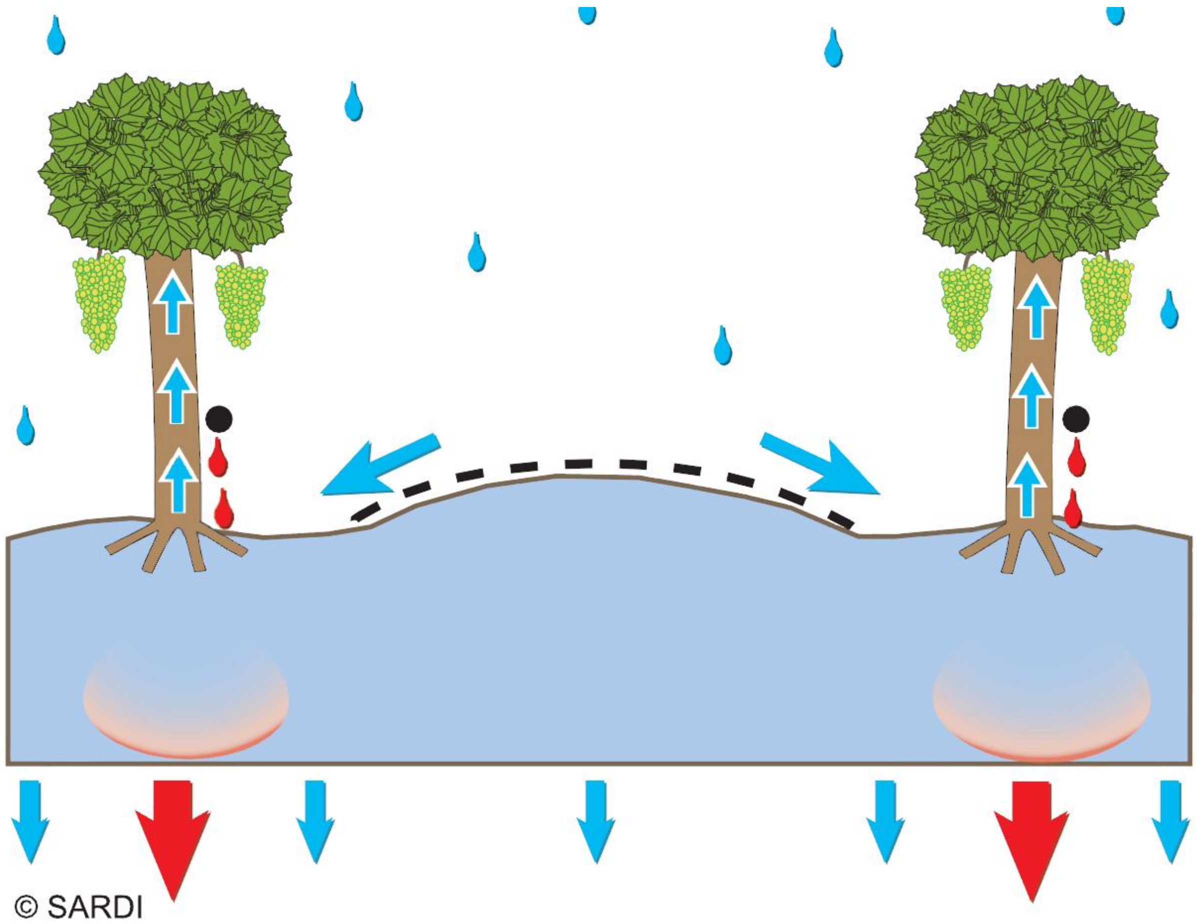
Na^+ < 0.15 %

Pilot study



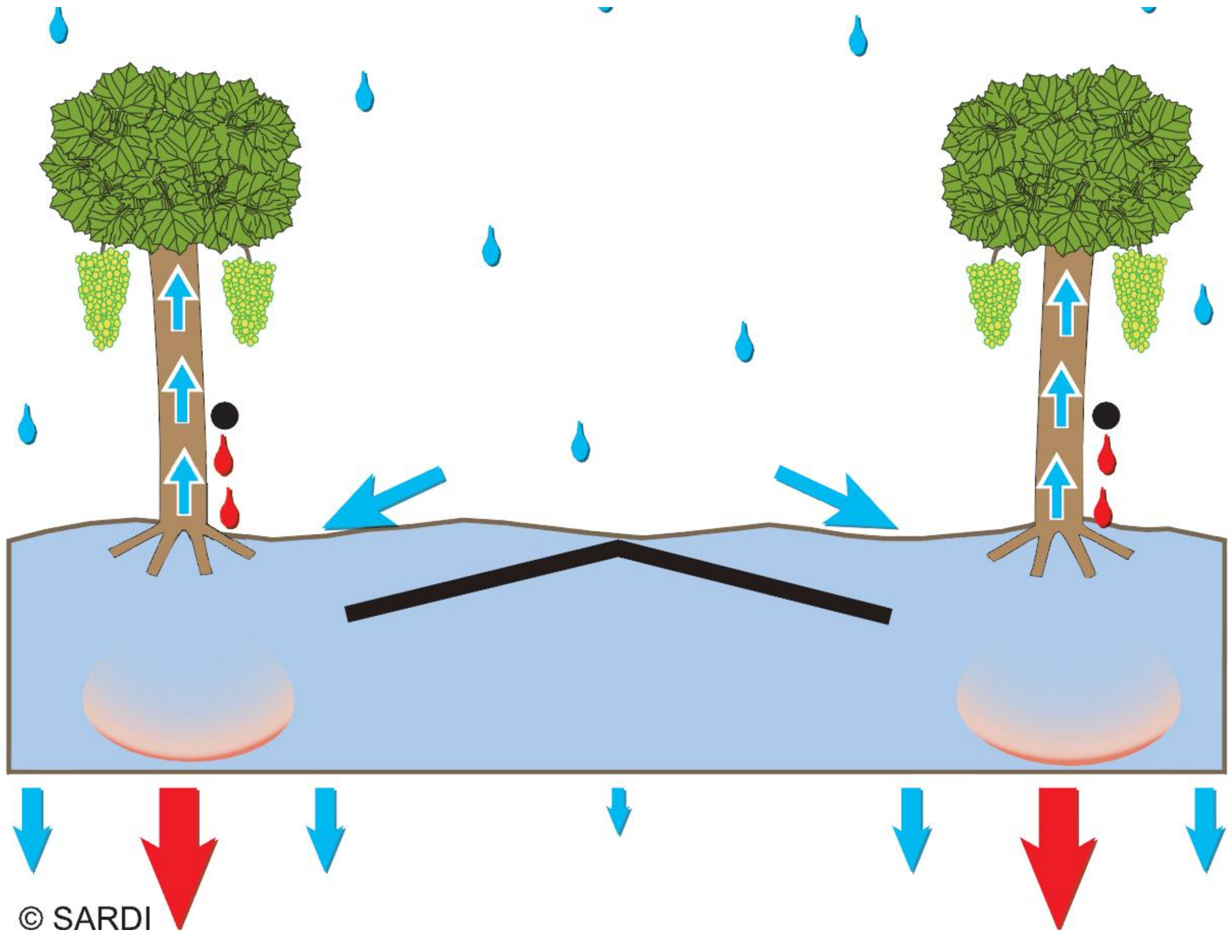
Mid-row mound

Pilot study



Mid-row mound sprayed with surface sealing polymer

Pilot study

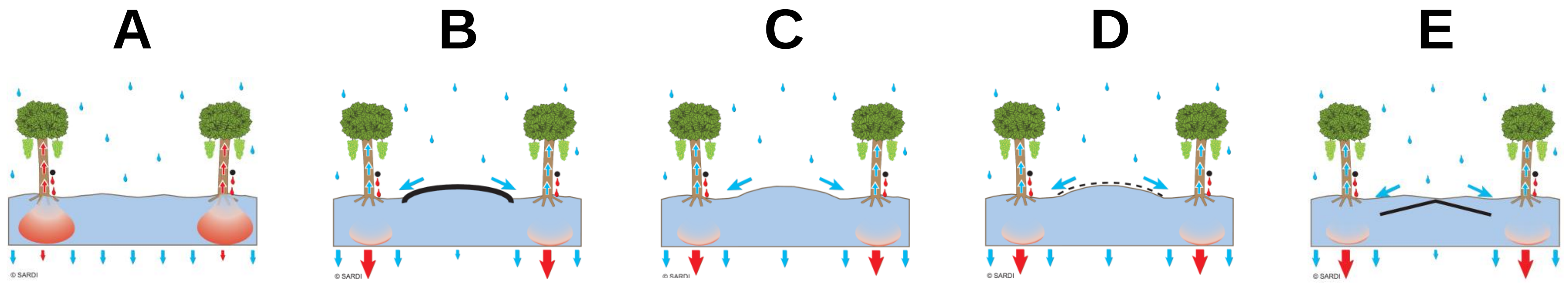


Buried plastic covered mid-row mound

Pilot study

Progress 2013

Treatments installed in December 2012



< 20 mm rain between treatment construction and vintage 2013

No significant difference in:

- harvest data
- post-harvest soils
- pruning weights

Yield	=	2.2 kg/vine
Sugar	=	25.3°Brix
pH	=	3.5
TA	=	6.0 g/L
Na	=	20 mg/L
Cl	=	30 mg/L

Summary

Proof of concept – Groundwater, Padthaway SA

Rainfall redirection: reduced under-vine soil salinity by 40%

reduced juice sodium by 25%

reduced juice chloride by 40%

'Proof of concept' treatments commercially impractical

Pilot study – Recycled Wastewater, McLaren Vale SA

Year 1 data consistent with 'proof of concept' trial

Investigations continuing through to mid 2015





SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Thankyou

Collaborators — Limestone Coast & McLaren Vale Grape Growers

University of Adelaide

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(2013-15) — Australian Water Recycling Centre of Excellence; GOYDER INSTITUTE FOR WATER RESEARCH

SARDI — Rob Stevens (formerly of SARDI)

Jim Cox, Mike McCarthy & Chris Dyson

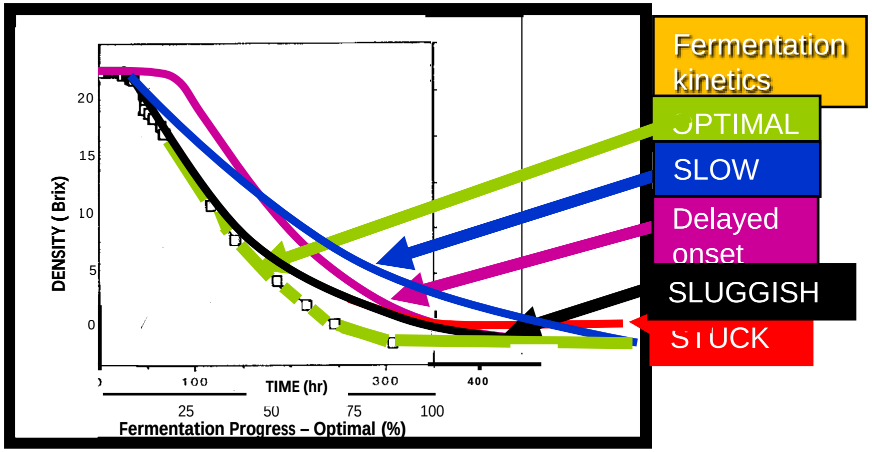
AWRI

Managing Stuck Fermentations and Rescue Procedures

Paul Henschke, and

AWRI Industry Development & Support team

- Con Simos
- Adrian Coulter
- Geoff Cowey
- Matt Holdstock



The problem of sub-optimal fermentation

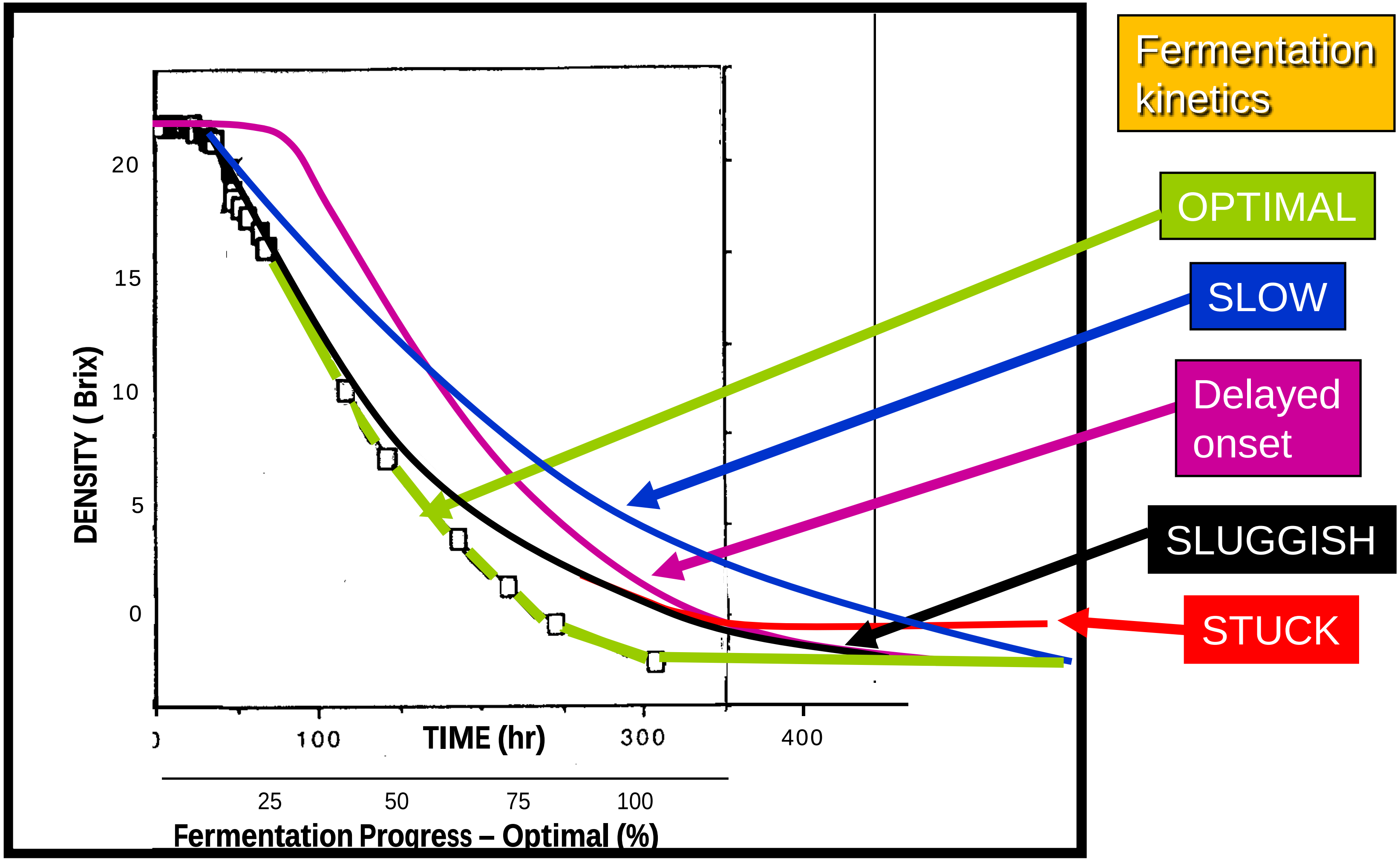
The Australian Wine Research Institute

- A common seasonal problem, but exacerbated by hot weather
- Affects most wineries at some stage, both in Australia and overseas
- White, red & sparkling wines, in tanks & barrels
- Multifactorial problem, including yeast, nutrients, toxic substances and fermentation conditions/management
- Most (all ?) yeast types are affected, including benchmark EC1118/PDM/Prise de Mousse
- Expensive in resources (time, energy, yeast, tank space) and potential loss of quality

>>> This talk contains practical information on how to reduce the risk and how to rescue a fermentation

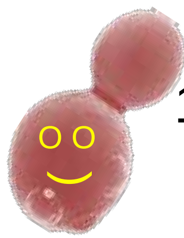
Sub-optimal fermentation profile

The Australian Wine Research Institute

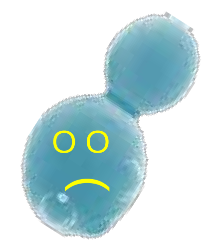


Environmental changes during fermentation - major stresses to which yeast must adapt

The Australian Wine Research Institute



Factor	Grape juice	Wine
Sugar (g/L)	180 – 260	0 – 4
Alcohol (% v/v)	0	10 – 16
Nutrients:		
YAN (mg N/L)	50 – 300	<50
Oxygen (ppm)	0 – 9	0
Conditions	***Nutrient rich***	***Nutrient poor High conc. toxic products***

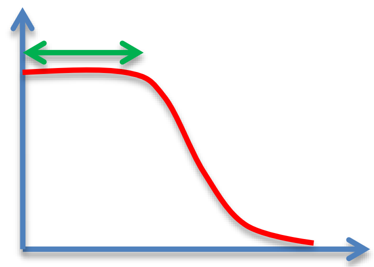


Failure to adapt results in sub-optimal fermentation

Causes of sub-optimal fermentation

The Australian Wine Research Institute

v Delayed onset of fermentation



Causes:

§ Poor quality starter culture
  - Low viability or low cell count/inoculation rate
  - Poor physiological condition (low metabolic rate)

§ High SO_2, resulting in growth inhibition until level of free SO_2 has decreased below a critical point

Diagnosis:

§ Perform a microscopic cell count before & after treating the sample with vital stain, eg methylene blue (see Iland et al. 2007)

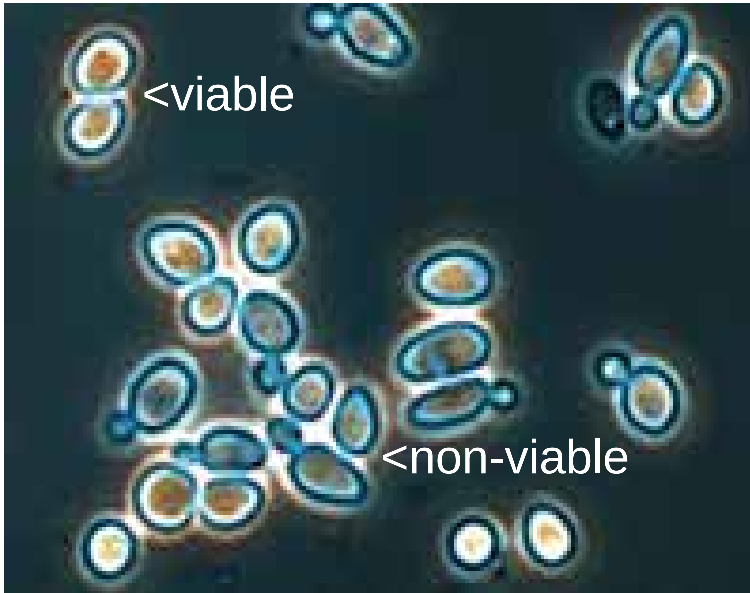
§ Viability <75% indicates poor yeast culture or must toxicity, eg SO_2

§ Measure must/juice SO_2; should be <10-15 mg/L free SO_2

Vital staining of yeast culture to assess culture health (viability)

The Australian Wine Research Institute

- Methylene blue is a dye that is used to differentiate live and dead yeast cells in a culture.
- Methylene blue is a redox sensitive dye, such that metabolically active cells reduce it to the colourless form; viable cells are highly reductive.
- Dead cells (non-metabolically active) stain blue, ie the oxidised form.
- Population viability is a strong indicator of culture health:
  - Healthy culture typically contains >95-98% viable cells
  - <75% viability indicates toxicity, which can lead to stalled fermentation

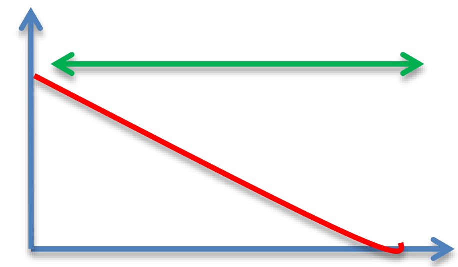


Consult Iland et al (2007): Microbiological analysis of grapes and wine: techniques and concepts

Causes of sub-optimal fermentation

The Australian Wine Research Institute

v Slow (continuously) fermentation



Causes:

§ Low yeast biomass or cell number

§ Low budding index

§ Low level of key nutrient, typically YAN, O_2 or lipids

Diagnosis:

§ Confirm by microscopic cell count:

- 0% FP (Fermentation Progress) count should be >1-5x10^6 cells/mL;
- 35% FP should exceed 50x10^6 cells/mL

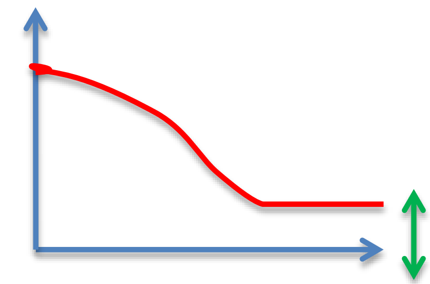
§ Measure juice/must YAN, should exceed 100-150 mg N/L

§ Failure of aeration or grape solids addition to stimulate fermentation suggests deficiency of a key nutrient, eg YAN

Causes of sub-optimal fermentation

The Australian Wine Research Institute

v Sluggish & Stuck fermentation



Causes:

§ Multifactorial problem

Interaction between:

1. <u>yeast strain</u>
2. <u>juice/must</u> (nutrients, toxic substances) and
3. <u>fermentation conditions/management</u> (under control of winemaker)

§ Most yeast types are affected, including the industry benchmark strains EC1118 / PDM / Prise de Mousse

Diagnosis: complex & the subject of this talk

Sub-optimal fermentation kinetics

Risk Factors – common high risk factors

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Yeast-related factors	• incorrect choice (alcohol stress tolerance) • poor quality starter culture - rehydration / reactivation - viability / vitality • indigenous microflora (esp yeast & LAB) • unsuccessful inoculation • temperature stress • vigour and sedimentation
Nutrient deficiency	• yeast assimilable nitrogen (YAN) • phytolipids (grape solids – clarification) • oxygen • vitamins (thiamin) • minerals (ie low K+ & pH)
Inhibitors	• high concentration of sugar (high Brix/Be) • high ethanol • fatty acids (acetic acid & mid chain length FAs) • SO_2 • toxic (killer) proteins/other organisms • residues (pesticides, cleaning agents)

Adapted from Henschke (1997)
ASVO Seminar Procs pp. 30-38,41

Active Dried Yeast
Rehydration/reactivation risk factors

The Australian Wine Research Institute

- Follow manufacturers instructions precisely
- Rehydration medium
  - Tap/Mineral water/Grape juice or diluted concentrate
  - Consider proprietary 'inactivated yeast' reactivation nutrients rich in sterols for high risk juices [ie high sugar (>13 Be), bright (low solids), low YAN (<150 mg/L), to be fermented cold (<15C)]
- Temperature of medium: 38-40 C unless specified
- Ensure yeast is correctly rehydrated
- Use within 30 min of rehydration
- Do not use expired stock

Hydration temperature is very important

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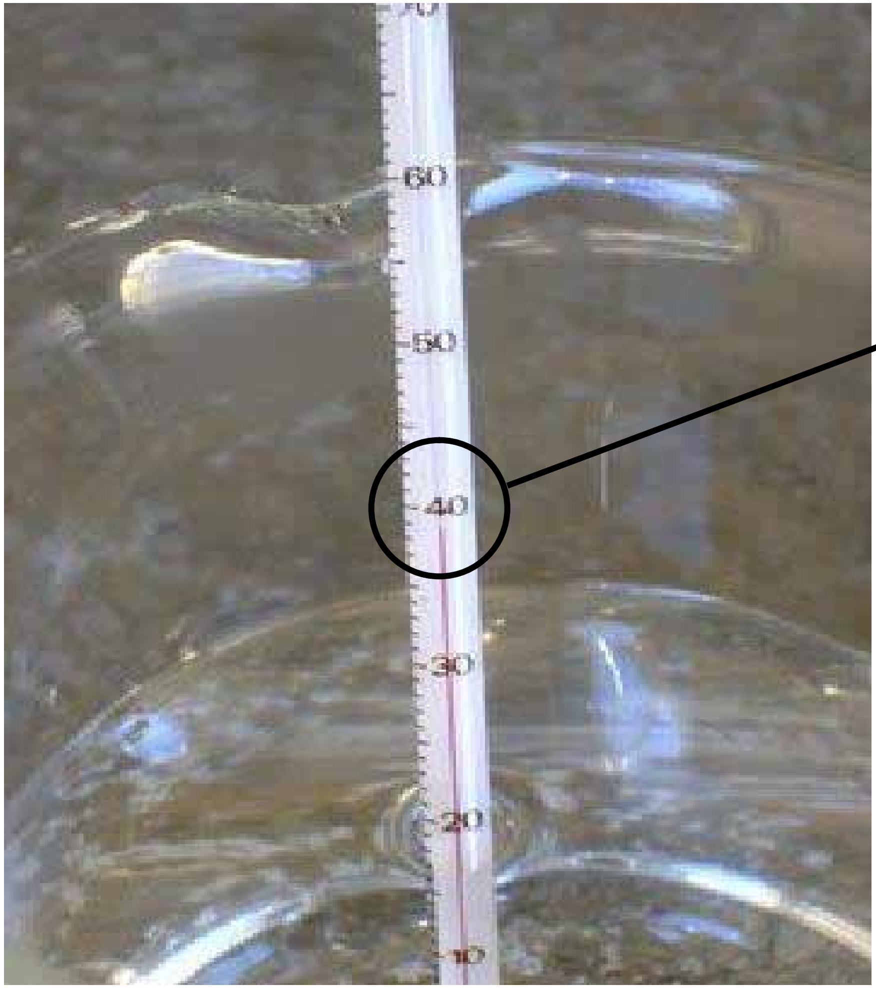
Research Institute



Critical
38 – 40 °C

Hydration step – prevent ‘dry lumps’ of yeast

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Correct

Incorrect

Active Dried Yeast
Rehydration/reactivation risk factors

- Add rehydrated yeast to pre-warmed juice (ie after cold settling or cold soak, preferably >15°C
- Step-wise cool reactivated yeast in 5-10°C steps at 5 min intervals by adding appropriate volumes of the juice to be inoculated for high risk juices (ie cold (<15°C), highly clarified, anaerobic, high sugar juice ferments)
- Ensure sufficient time has elapsed after SO_2 addition to must to avoid damaging yeast (<10 ppm SO_2 @ pH3.5) – consider adding a 'sacrificial culture' of about 15–20% of aerated active yeast (containing aldehyde) to the juice in order to bind SO_2 and other potentially inhibiting substances, about 30 min before inoculation

Fermentation Management

The Australian Wine Research Institute

- Add yeast hulls for high risk ferments (detoxification role)
- Allow ~10% of sugar to ferment before cooling
  - It is critical to build-up cell number (growing yeast - v. stress sensitive)
  - Do not cool in greater than 2-4 ° C increments
- Monitor fermentation progress & temperature daily
  - Spreadsheets provide an efficient record of fermentation data, comparison with similar ferments and early identification of problems
- Look for a steady fermentation rate; compare with previous data of similar ferments and/or previous years data to identify problems
- Cell numbers should reach 70 x 10^6 cells per ml for cellar bright juice ferments (determine with microscope and haemocytometer)
  - Monitor budding % as an indication of yeast growth or problems
  - Expect high % budding during first third stage of fermentation
  - Vital staining (eg methylene blue) is also a useful diagnostic for dead yeast cell estimation – check when fermentation rate becomes slow
  - **Also look for presence of (lactic acid) bacteria, which can adversely affect yeast activity and lead to fermentation arrest**

Optimising yeast inoculation

The Australian Wine Research Institute

Factors affecting yeast implantation

- Pure culture inoculation strategy
  - Maximising the benefits of selected yeast strains

- Minimise indigenous yeast population of must (<10^5 cfu/ml)

  - Minimise must exposure to moderate-hot temperature, during harvest, transport, juice preparation (enzyme treatment, clarification, etc) which otherwise promotes indigenous yeast & bacteria growth

  - Add sufficient SO_2 (50-100 ppm, depending on fruit condition) during machine harvest to limit indigenous microbial growth

  - Clarification procedures can lower indigenous microbial growth

  - High indigenous yeast count can indicate nutrient depletion – add nutrs.

- Recommended Inoculation rates

  Under inoculation will compromise ability of culture yeast to dominate

  - whites: 5 x 10^6 cells/ml(typically 250 g ADWY per kL juice);

  - reds: 4 x 10^6 cells/ml ; lower rates can compromise yeast implantation

Nutritional deficiency risk factors

The Australian Wine Research Institute

- **Yeast Assimilable Nitrogen** (YAN)
  - A variable proportion of Australian juices/musts have inadequate YAN
  - Measure YAN on a grape maturity sample or juice sample
  - Low YAN (whites <150 mg N/L; reds <100 mg N/L) high risk slow/stuck ferm
  - Adjust with DAP (200 mg N/1g DAP) or proprietary N supplement
- **Lipid deficiency** (phytosterols and unsaturated fatty acids (UFA))
  - Over clarification removes lipids essential for yeast growth
  - i.e. when <0.1-0.5 v/v juice solids (ie ‘cellar bright’) or <5 NTU
  - Addition of “fine” settled grape solids highly stimulatory to yeast growth
  - Avoid “hard” settled grape solids, which can impart phenolic coarseness, hotness, bitterness to wine
  - Rehydrate yeast with proprietary inactivated yeast product rich in sterols
- **Dissolved Oxygen** (dO_2)
  - dO_2 is highly variable in juice/must – ranging 0 – 8 ppm (air-saturated)
  - Aerating fermentations at least once, at the stage when they are most active (during fermentation of 35-50% sugar) is highly beneficial
  - Aerate to give max ~5 ppm oxygen (sparge, pump over, rack-return, etc)
  - Oxygen alleviates yeast REDOX imbalance & stimulates sterol formation

Nutritional deficiency risk factors

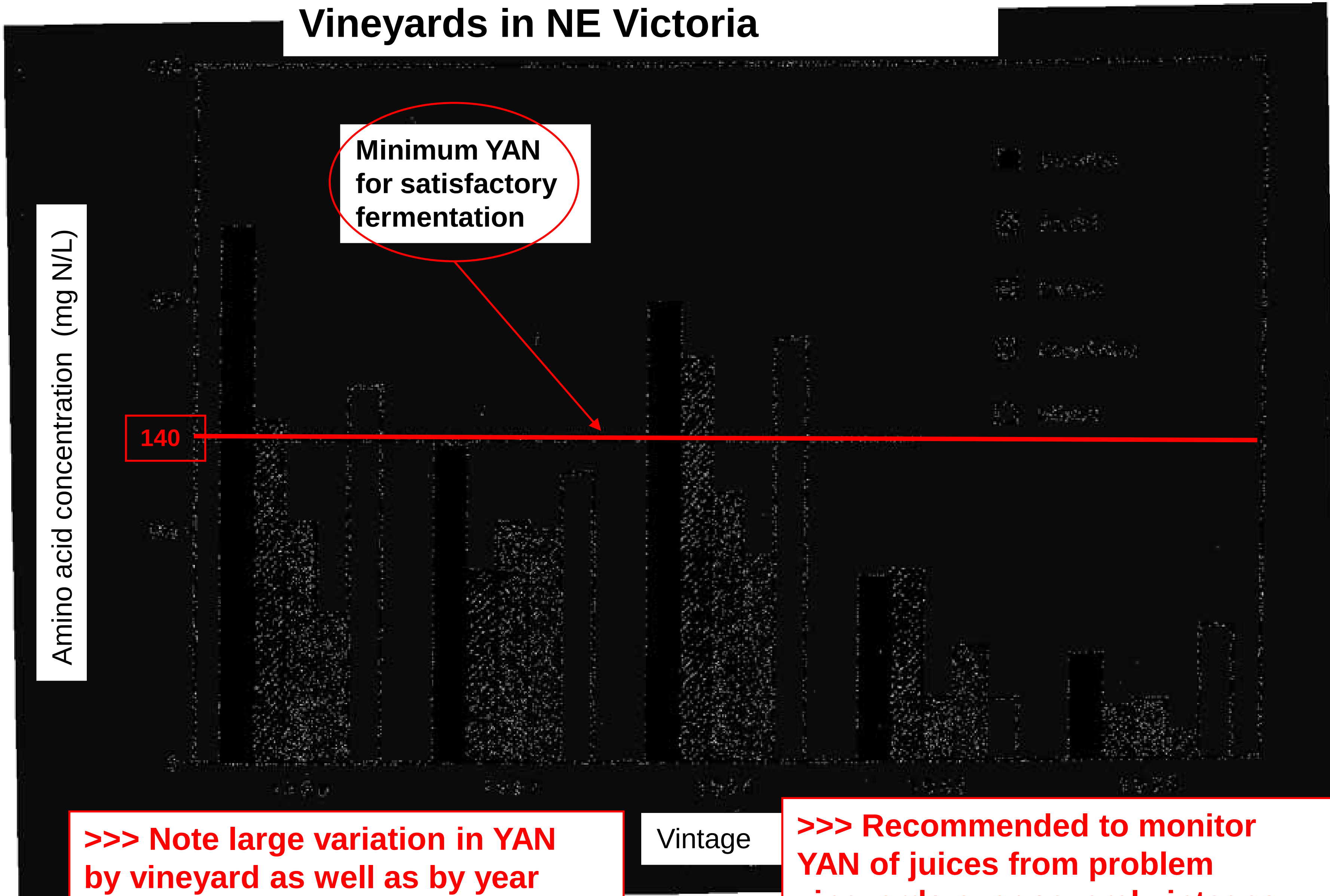
The Australian Wine
Research Institute

- ## Vitamins
  - Vitamin status of Australian musts/juices is unknown
  - **Thiamine** - essential for ethanol production by yeast
    - **major losses caused by high SO_2 use and wild yeast growth** (ie during transport or must processing)
  - Vitamins (thiamine, niacin, biotin, pantothenate, pyridoxine, inositol) can be added to starter cultures under ANZFA Wine Regulations
  - Some proprietary yeast foods provide a useful source of vitamins

- ## Minerals
  - Mineral status of Australian musts/juices poorly known (see Schmidt et al 2010)
  - **Phosphate – normally considered adequate; can be added with DAP**
  - **Low K^+/Low pH** - stuck ferms with some yeast strains (sparkling/tirage or early harvest must)
  - **Magnesium, zinc, manganese, which are enzyme co-factors are thought to be sub-optimal** (these cannot be added under ANZFA Wine Regulations)
  - Some proprietary yeast foods provide a limited source of minerals and can be beneficial

- ## Low YAN juices/musts
  - Low YAN musts can also be suboptimal in other nutrients
  - **Useful to add proprietary inactivated yeast nutrients to yeast starter cultures when deficiencies are suspected, especially to difficult to ferment juices/musts**

Vineyard & Year effect on juice YAN

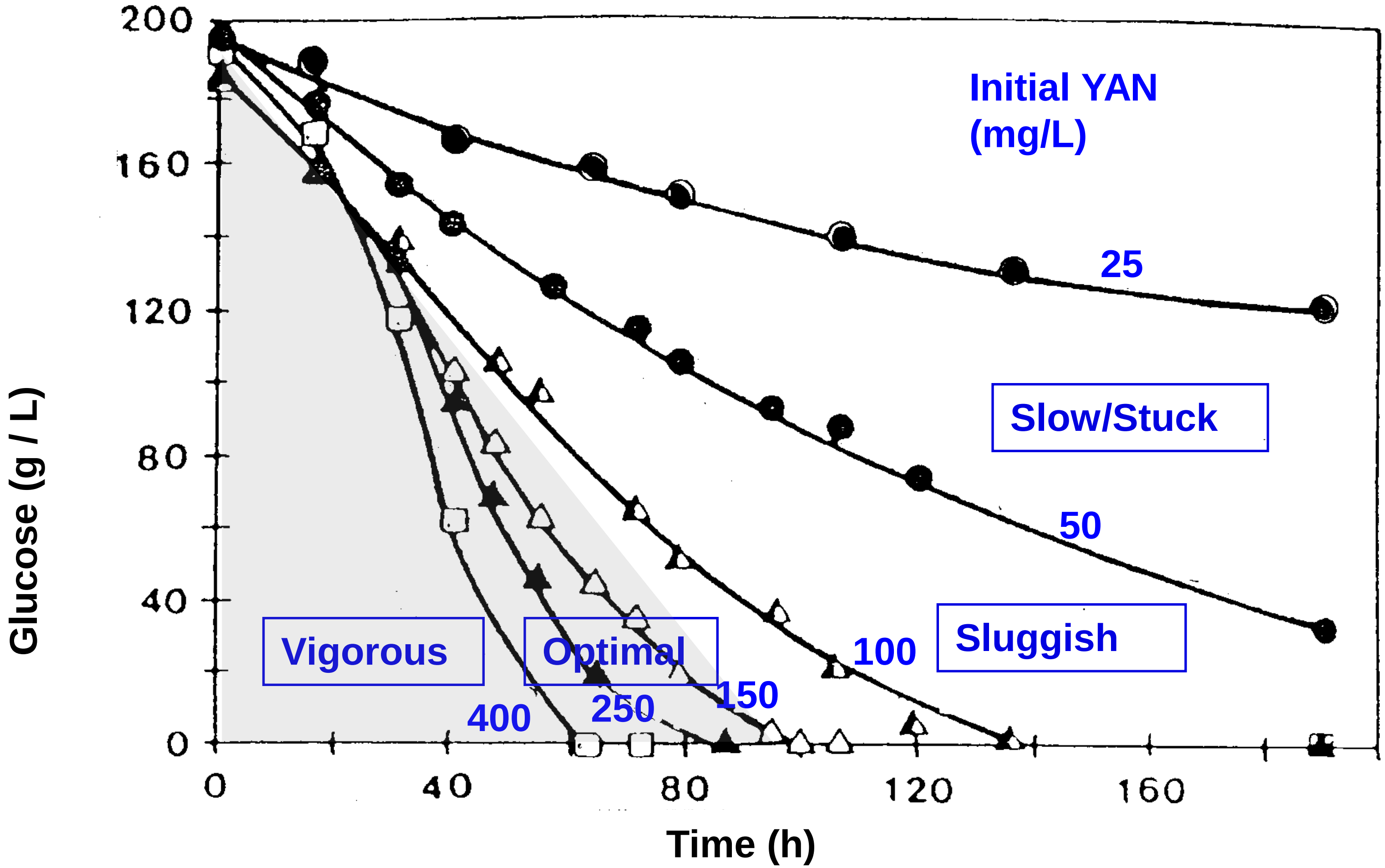


>>> Note large variation in YAN by vineyard as well as by year

>>> Recommended to monitor YAN of juices from problem vineyards over several vintages

Fermentation response to YAN

Synthetic juice ≡ 'cellar bright' juice
All other nutrients are adequate, representing Nitrogen-limited growth



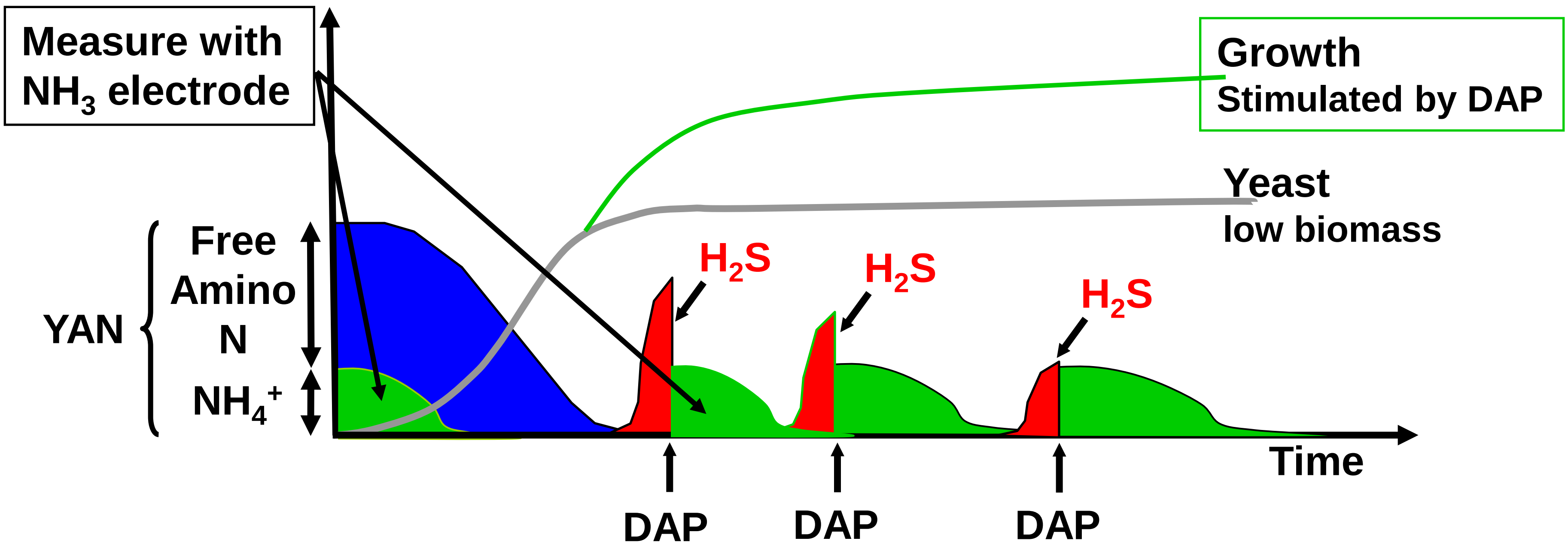
>>> Low YAN - slow/stuck fermentation
Excessive YAN – too vigorous

Sourced from Salmon (1989)
***Appl. Envir. Microbiol*. 55:953-958**

Nitrogen utilisation – Low YAN fermentation
Risk of H_2S as well as slow fermentation

The Australian Wine Research Institute

Low Nitrogen (<200 mg N/L)
Low biomass increases risk of slow/stuck fermentation and H_2S production



- Inverse relationship between Initial YAN and H_2S production
- Initial YAN should exceed 250 mg N/L YAN to prevent H_2S but H_2S profile depends on yeast strain X juice/must interactn
- Not all Yeast H_2S responds to DAP; could be a vitamin deficiency?

YAN Requirements of Yeast

The Australian Wine Research Institute

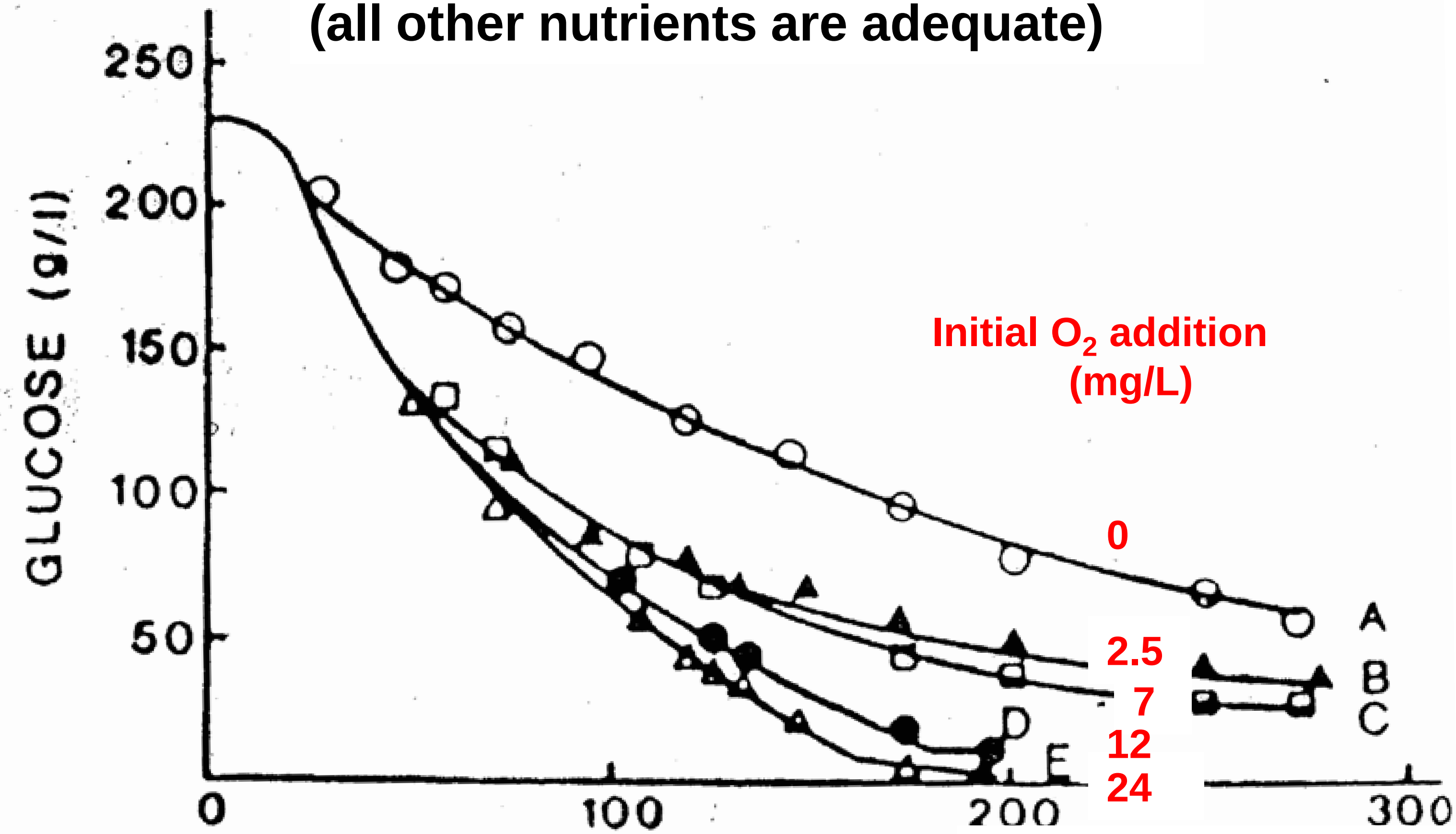
(depends on yeast, solids content, fermentation conditions & wine style)

1. **Maximum N demand:**
   Mean = 400 mg N/L
   Range = 330 – 470 mg N/L
2. **Minimum YAN requirement**
   Whites (clarified) – approx. 150 mg/L
   Reds (high solids) – approx. 100 mg/L
3. **Minimum YAN to prevent H_2S**
   approx. 250 – 350 mg/L (yeast x must dependent)
4. **Optimum flavour formation (YAN & DAP affects ester prod^n)**
   Whites (strong style effects – complex thr' to fruity)
   – Chardonnay – fruity: 250–350 mg/L; <200: complex
   – Sauvignon Blanc – ? mg/L
   – Reds – fruity: 250–350 mg/L ; <200: complex

Fermentation response to O_2

The Australian Wine Research Institute

Synthetic juice ≡ 'cellar bright' juice
(all other nutrients are adequate)



Time (h)

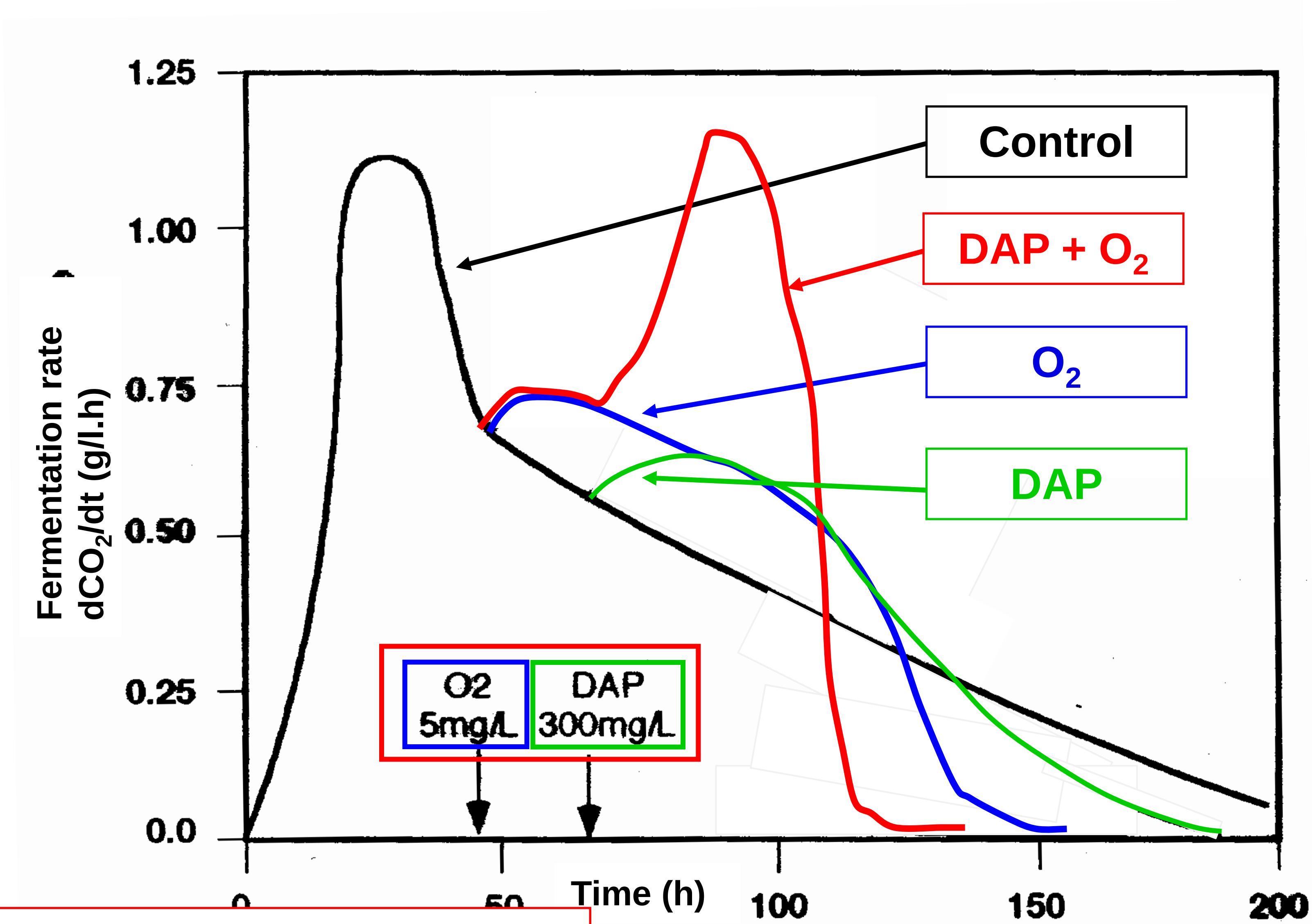
Sablayrolles & Barre (1986)
Sciences des Aliments 6:177-185

>>> Oxygen stimulates fermentation rate and is shown to prevent most suboptimal ferments

Combined effect of DAP + O_2 on fermentation

Nutrient strategy for stimulating fermentation

The Australian Wine Institute

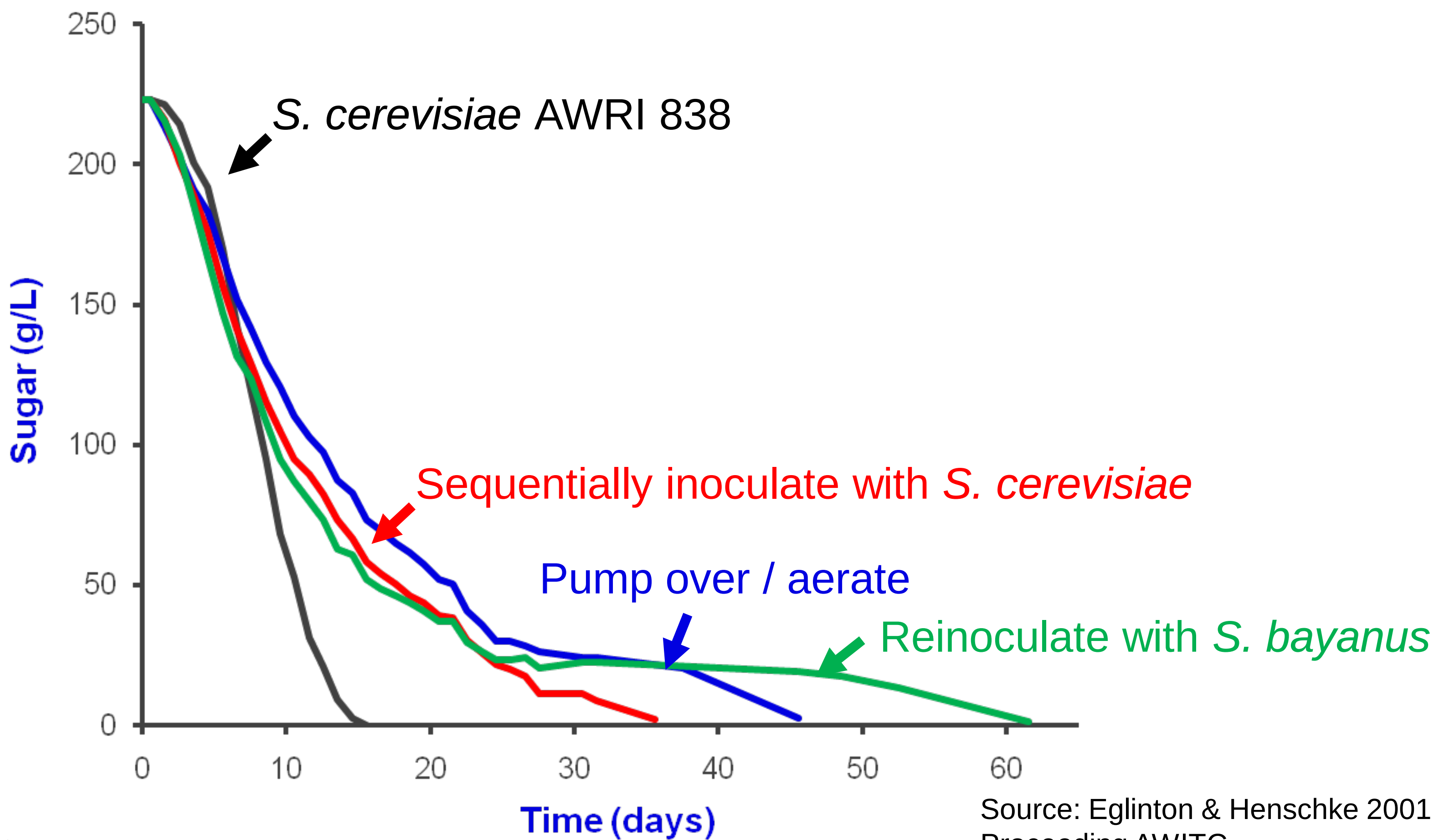


>>> Combined O2 and DAP greatly stimulates fermentation rate

Sablayrolles, Dubois, Manginot & Barre (1986)
J. Ferment. Bioeng. 82:377-381

Practical strategies for ensuring a complete fermentation with low vigour yeasts

eg S. bayanus AWRI 1375



Source: Eglinton & Henschke 2001 Proceeding AWITC

All treatments tested promoted refermentation and had no signif. sensory affects

N.B. Rescue cultures were prepared by AWRI step-wise acclimatisation procedure

Juice Clarification affects Fermentation Rate and Wine Residual Sugar

The Australian Wine Research Institute

Ferment rate	Wine residual sugar	turbidity	Clarification treatment
Highest	Lowest		Cold settled
			Bentonite treated and settled
			Enzyme treated and settled
			Centrifugation, 10 min at 1500g
			Coarse filtration
			Centrifugation, 20 min at 10000g
Lowest	Highest		Fine filtration (eg Sietz EK)

High clarity enhances varietal character BUT increases fermentation risk
Therefore, turbidity is adjusted to balance yeast performance and flavour

Inhibitory substances – risk factors

The Australian Wine Research Institute

- **Ethanol – probably largest cause of stuck ferments**
  - inhibition is strain dependent: growth at 8-12%, fermentation at 12-16%
  - **determined by grape maturity at harvest**
- SO_2
  - strain dependent inhibition, typically >10 mg/L free SO_2 at pH 3.5
  - cell death at 45 mg SO_2/L at pH 3.5 (0.8 mg/L mol. SO_2)
- Fatty acids (FAs) (good hygiene / aerate ferments)
  - acetic acid: yeast growth inhibited at >1.5 g/L at 8% EtOH
    fermentation inhibited at 3-4 g/L
  - aliphatics (C6, C8, C10 FAs): ca. >3 mg/L at 10% EtOH
- Toxins (low risk except for lactic acid bacteria infection)
  - yeast toxins most active in low solids (bright) ferments
  - Do not coinoculate non-killer with killer wine yeast
  - **some Lactobacillus toxins can inhibit ferm. (high or low solids) check microscopically for lactic acid bacteria**
- Agrochemical residues (very uncommon)
  - copper oxychloride 10-15 mg/L
- Residues of winery sanitisers (uncommon)
- **Yeast hulls can be used as a broad spectrum detoxification additive**

From: Henschke (1997) ASVO Seminar Procs pp. 30-38,41

Fermentation management – Risk factors

The Australian Wine
Research Institute

- **Temperature stress**

  Do not commence cooling until 10% sugar fermented
  Excessive temperature (32-35 ºC depend on [EtOH]) can inactivate yeast
  Over-cooling for particular yeast (non-cryophilic) / may need to use methods to maintain yeast in suspension if T<13-15 ºC
  Excess heating or cooling (transition exceeding 5 ºC)
  Cooling preferably should be <3 ºC per day to avoid yeast stress during growth

- **Vigour and sedimentation** (flocculation)

  Yeast sediments in low vigour ferments (CO_2 bubbles keep yeast in suspension and assists ferment circulation)
  Physical stirring can help prevent sedimentation
  Avoid flocculating strains in cool, cellar bright, anaerobic, high sugar ferments

- **Grape solids – avoid over-clarification**

  Beneficial to wine style but deprives yeast of key nutrients
  Lipids increase yeast tolerance to ethanol stress – consider adding cold-settlings to increase turbidity

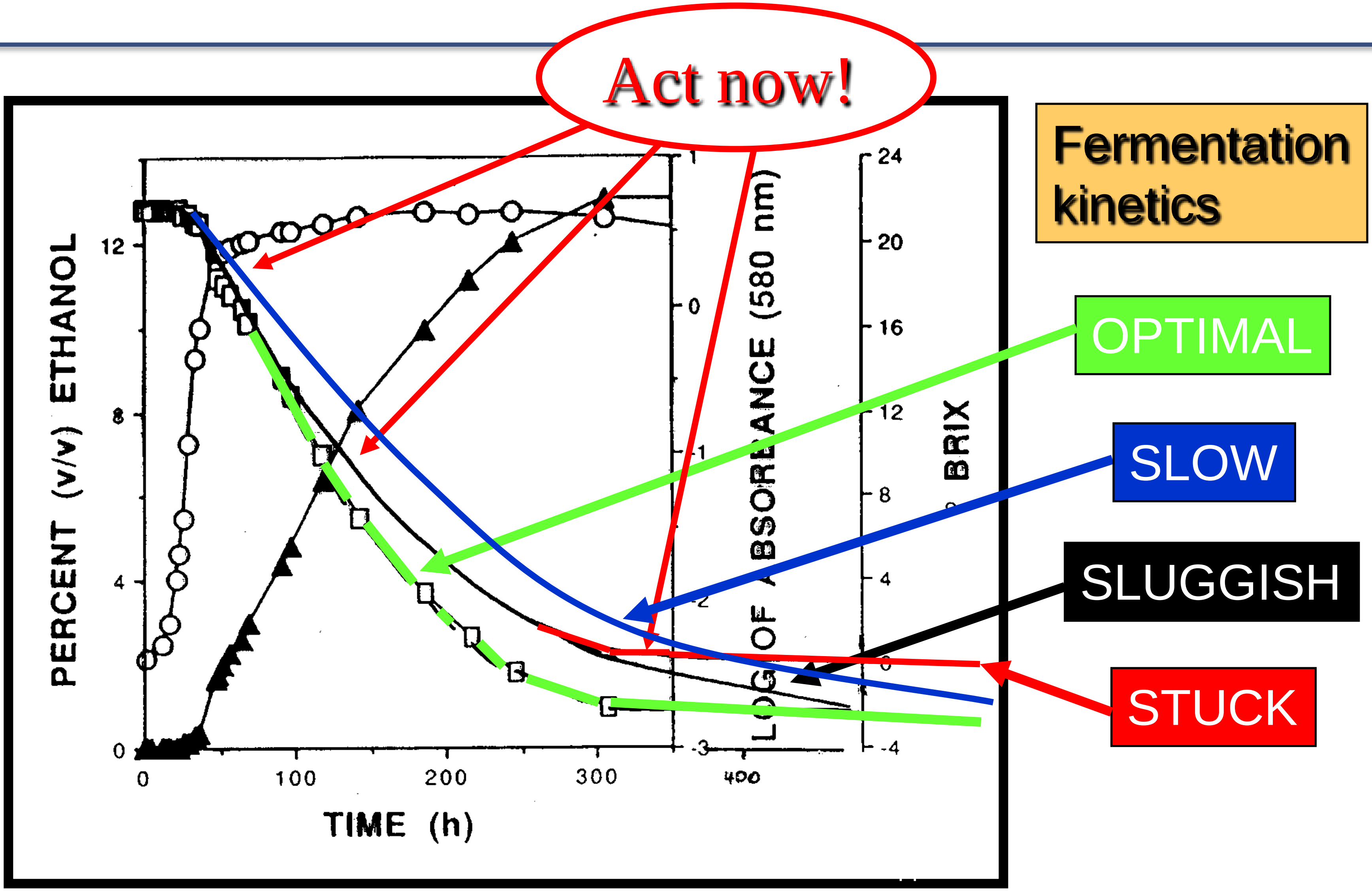
- **Nutrients**

  If known or suspected lack of nutrients (especially YAN and O2) recommend aeration (ca. 5 ppm O_2) and adding 300 mg/l DAP at 30-50% fermentation progress; yeast hulls and proprietary ferment nutrients can be beneficial

Henschke (1997) ASVO Seminar pp. 30-38,41

Problem fermentations

The Australian Wine
Research Institute



Take corrective action early

Choice of rescue procedure

The Australian Wine Research Institute

If ferment stops with <10 g/L residual sugar and the alcohol content is <12 % v/v:

- **Then recommend** preparing a starter culture in grape juice with a recommended yeast. This procedure is relatively quick and will produce moderate tolerance to alcohol / fresh yeast sediments from active ferments can also prove successful

- **Otherwise** use a rescue culture prepared by stepwise acclimatisation of a recommended rescue yeast. This procedure builds tolerance to the toxic substances present in the problem ferment

AWRI Rescue procedure – key factors

The Australian Wine
Research Institute

- Use high yeast rate 500 mg/L (EC1118, PDM, Uvaferm 43 are successful – consult yeast supplier)
- Rehydrate with sterol-rich reactivation nutrient
- Don't let culture run dry – go onto next stage

  when 50% of sugar has gone (monitor with hydrometry)
- Add DAP/Yeast hulls and aerate once culture is active
- Treatment of stuck wine before adding rescue culture:
  - Measure YAN and add DAP if necessary
  - Adding yeast hulls/ferment nutrients can be beneficial
  - If bacteria present treat stuck wine with SO_2
  - Rack or centrifuge stuck wine (remove dead yeast)
- Add wine to culture, rather than culture to wine
- Avoid temperature shock / Keep yeast in suspension
- Limited aeration beneficial only when yeast are active
- Keep good records

Yeast acclimatisation procedure for restarting difficult and stuck ferments
(See AWRI Website for details)

The Australian Wine Research Institute

Procedure for 1000 L of ferment

Stage	Function		Cumulative volume
1	Preparation of rescue culture		20 L
2	Acclimatisation		
	Step	Proportion of ferment	
	1	50%	40 L
	2	75%	80 L
	3	88%	160 L
	4	94%	320 L
3	Inoculate problem ferment		1020 L

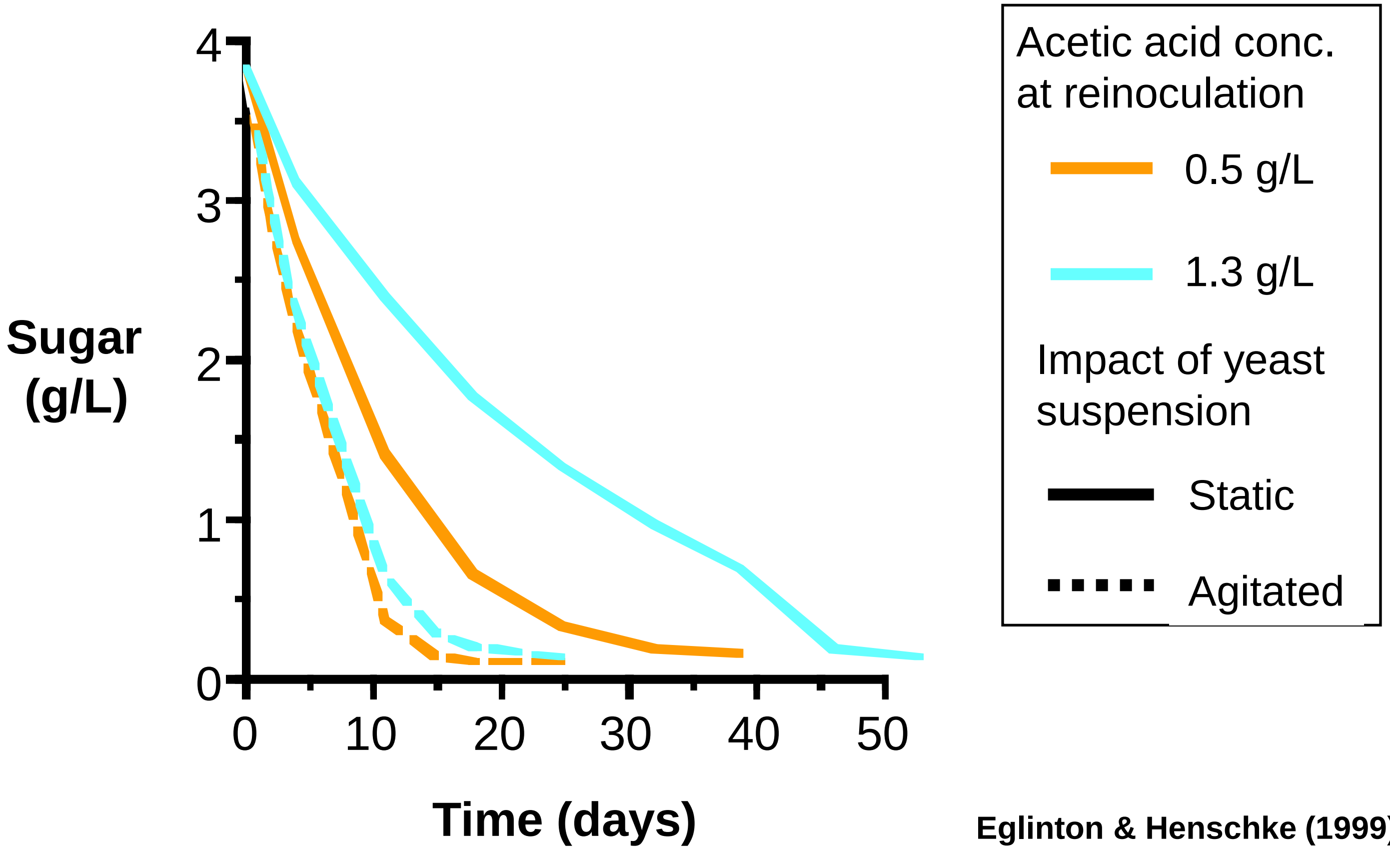
Adapted from Henschke (1997)
ASVO Seminar Procs pp. 30-38,41

Important principles of rescue procedure

- Stepwise acclimatisation of yeast to toxic substances of the problem ferment – if possible, incrementally add the ferment to the culture rather than the culture to the ferment
- No sugar depletion stress
- No nitrogen depletion stress
- Aeration yeast during acclimatisation procedure
- Keep yeast in suspension - agitation prevents nutrient starvation stress

Agitation aids refermentation

The Australian Wine Research Institute



Eglinton & Henschke (1999)
***Aust. J. Grape Wine Res.* 5:71-78**

>>> When restarting fermentation, important to keep yeast in suspension by physical means until CO_2 production commences, which then maintains yeast in suspension

For more information

The Australian Wine Research Institute

- **AWRI website – wealth of practical information**
- **ASVO seminar proceeding (1997) papers by: Henschke, Monk & Four industry practitioners**
- **Industry Services Group ; AWRI Technical Note 05 (updated 2013)**
- **Contact AWRI Industry Development & Support team: Con Simos, Adrian Coulter, Geoff Cowey, Matthew Holdstock for technical advice**

Acknowledgments

Peter Leske (former AWRI team leader)/Peter Godden (IA Team)

Wine Microbiology team:

Simon Schmidt, Paul Chambers , Paul Henschke

(former members: Jeff Eglinton, Holger Gockowiak, Nancy Davis and Lisa Buckingham)

Research at The AWRI is supported by Australia's grapegrowers and winemakers through their investment agency the Grape and Wine Research and Development Corporation, with matching funds from the Australian Government.

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AWRI

The Australian Wine Research Institute

Pepper and spice in Shiraz:

what influences rotundone levels in wine?

Tracey Siebert, Mark Solomon & Sheridan Barter

Australian Shiraz

The Australian Wine
Research Institute

- **Volume and value**

  2012 vintage crush 378,000 tonnes

  45% of red grapes; 23% of total

  26% of domestic & export sales

- **Heritage clones**

  Arrived 1832

  165 y old vines - Barossa Valley

  149 y old vines - VIC

  124-146 y old - Hunter Valley

- **Diversity of styles**

  > *blends:* Shiraz x Cab Sauv,

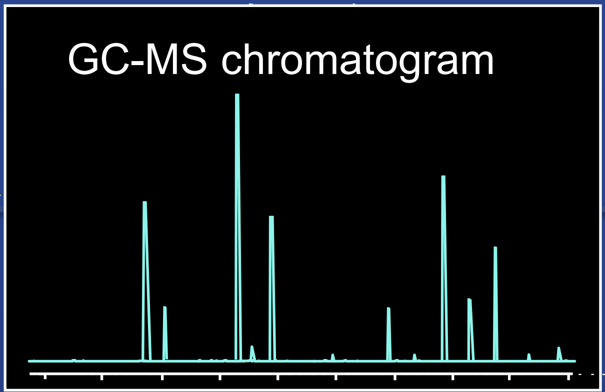
  Grenache x Shiraz x Mouvedre,…

  > *co-ferments:* Shiraz & Viognier

  > sparkling *Shiraz*

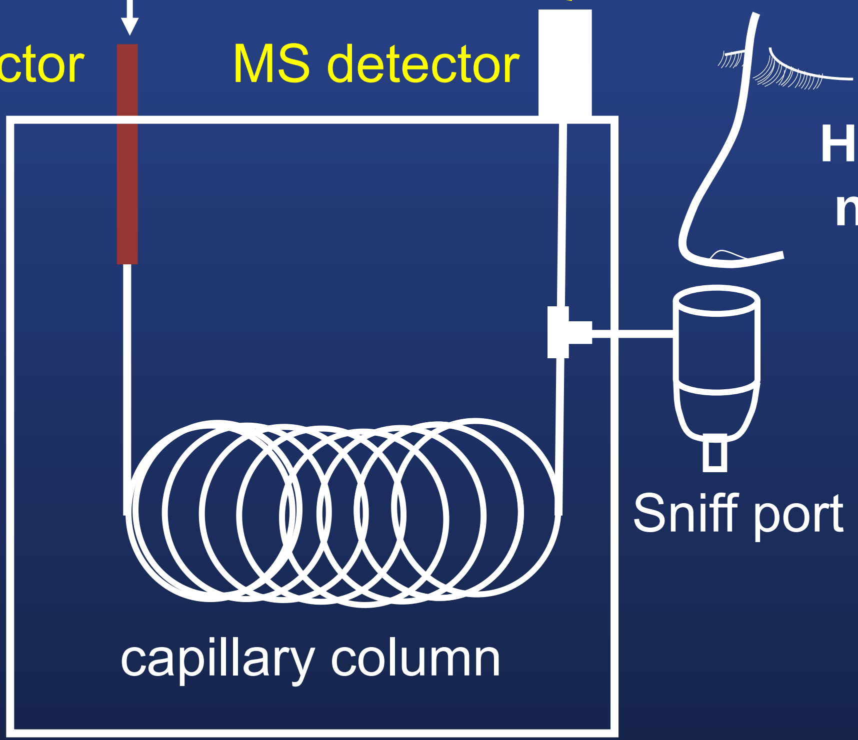
  => terroir, regionality

Identification of an aroma compound by GC-MS-O

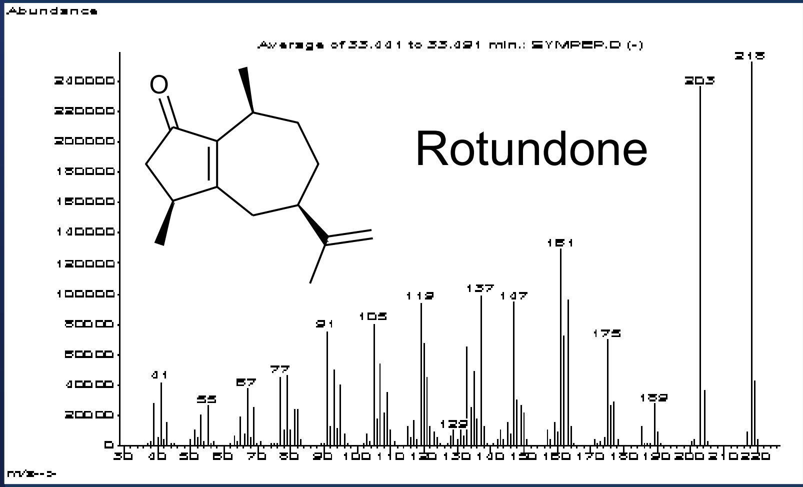


Retention time (min)

Grape or wine extract



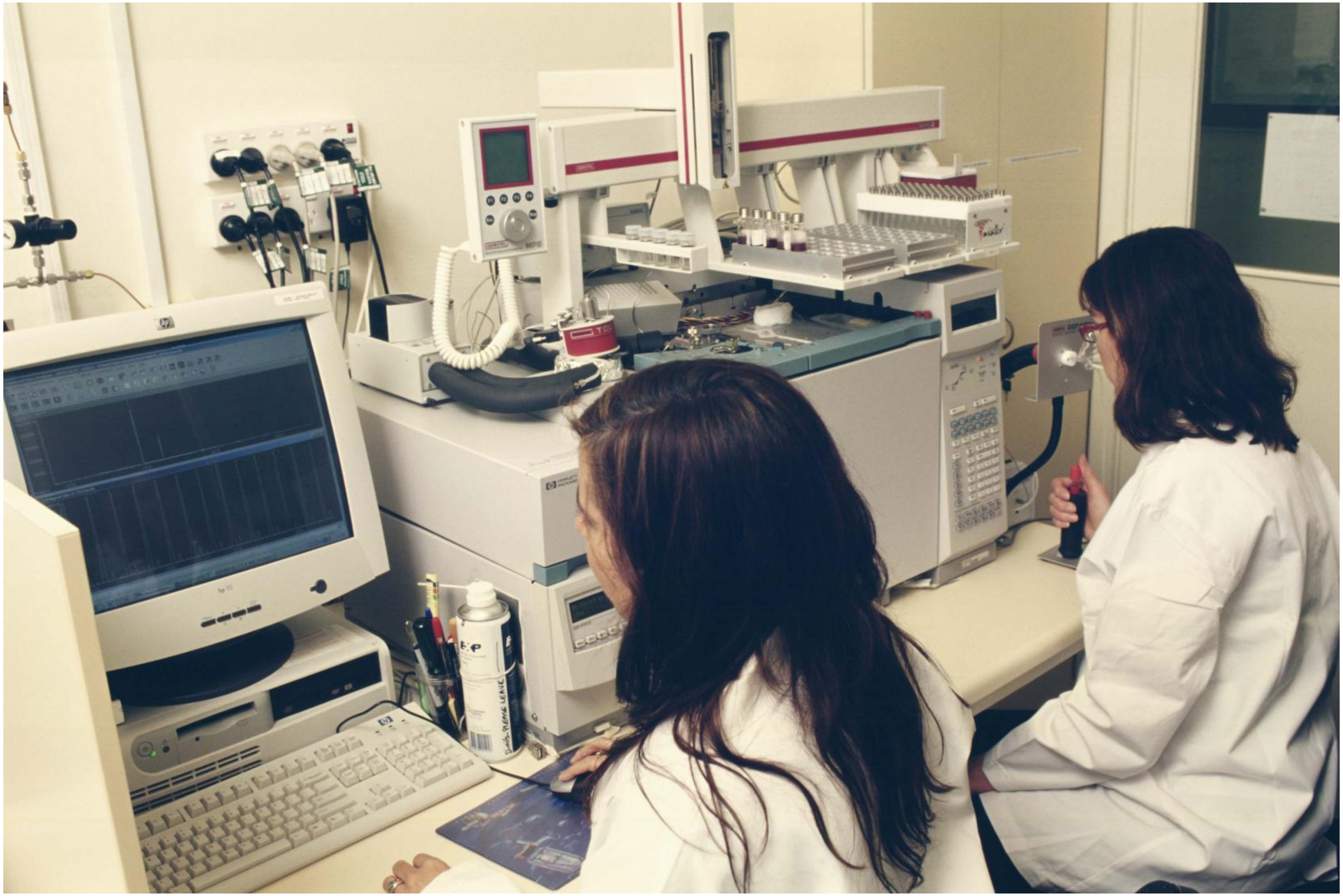
Optimized extraction, purification and enrichment



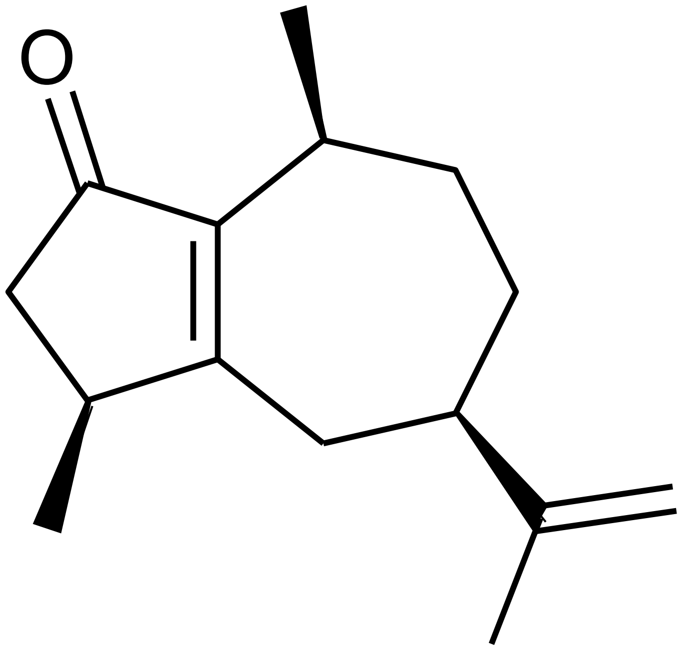
Mass spectrum

GC-Sniff in action

The Australian Wine Research Institute



(-)-Rotundone



Cyperus rotundus, nut grass weed

By GC-MS-O, rotundone was established as the principal aroma impact compound for pepper aroma in grapes and wine.

Wood, C.; Siebert, T. E.; Parker, M. et al. *J. Agric. Food Chem.* **2008**, 56, 3738-3744
Siebert, T. E. et al. *J. Agric. Food Chem.* **2008**, 56, 3745-3748

How potent is rotundone?

The Australian Wine Research Institute

8 ng/L in water

16 ng/L in red wine

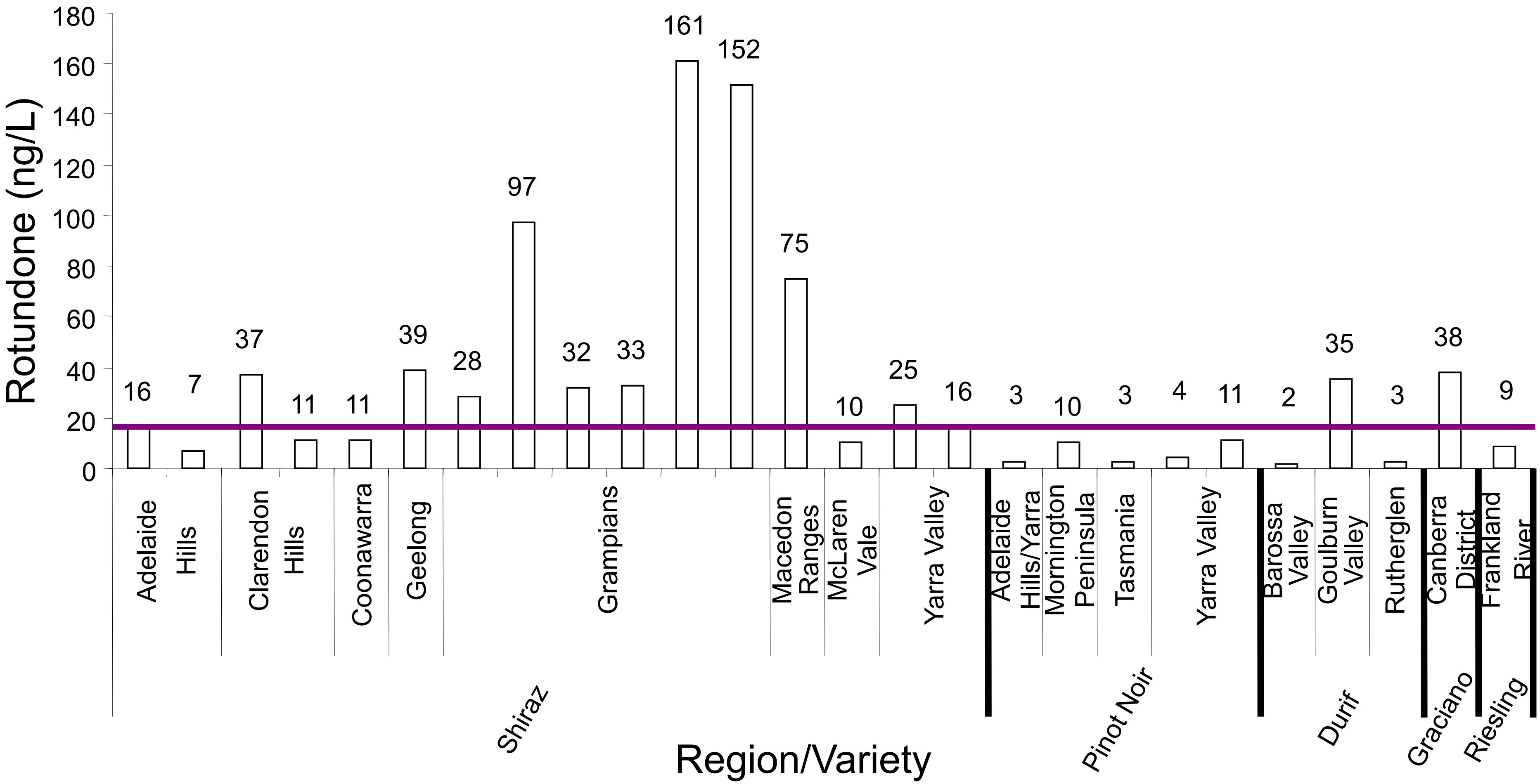
20 to 25% of the panellists were anosmic to rotundone

Wood, C.; Siebert, T. E.; Parker, M. et al. *J. Agric. Food Chem.* **2008**, 56, 3738-3744

Rotundone in Australian wines

The Australian Wine Research Institute

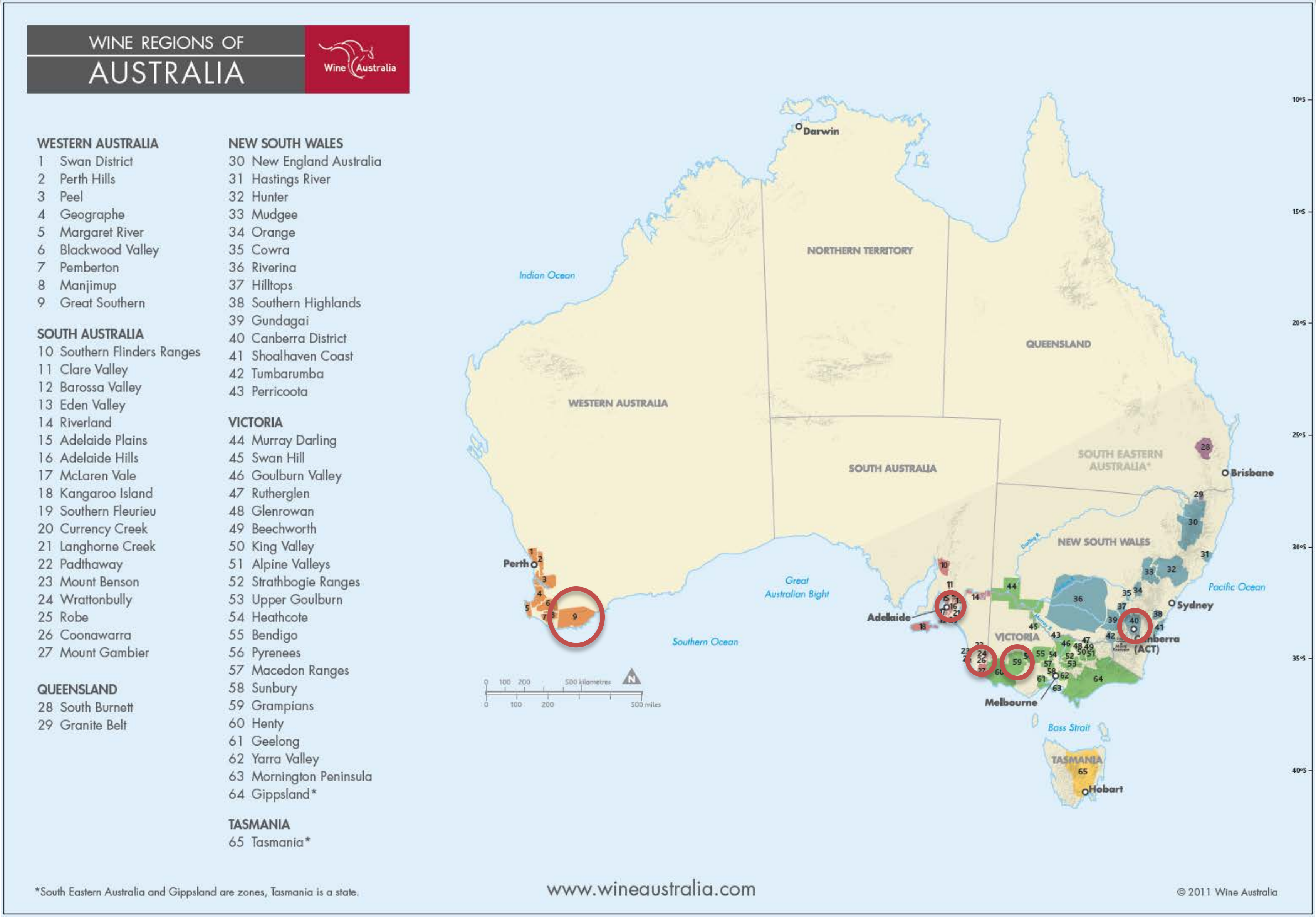
- We can now start to look at what influences rotundone levels
- A large survey of commercial wines was undertaken to guide us



AWRI TR #180 (June 2009)

Cool climate collaborators

The Australian Wine Research Institute



New Zealand

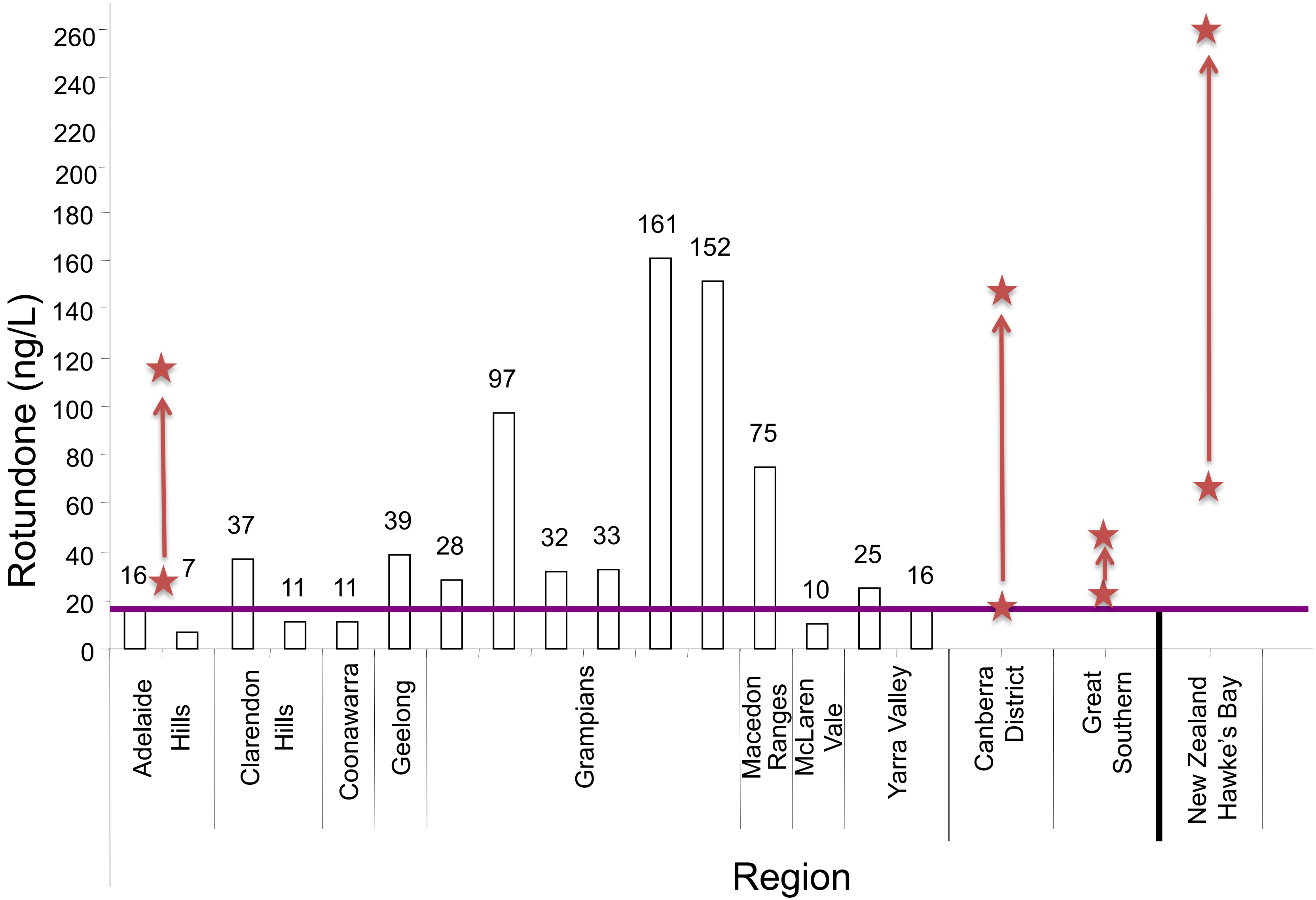
The Australian Wine Research Institute

Gimblett Gravels (400 Ha), Hawke's Bay, New Zealand

- 39°37' S, 176°44' E
- 1435 GDD (Base 10°C) (17 year average)
- 803mm rainfall (21 year average)
- 2188 hours of sunshine/year
- 14.5°C mean temperature all year
- Omahu Gravel Soil
- Maritime with a little continentality

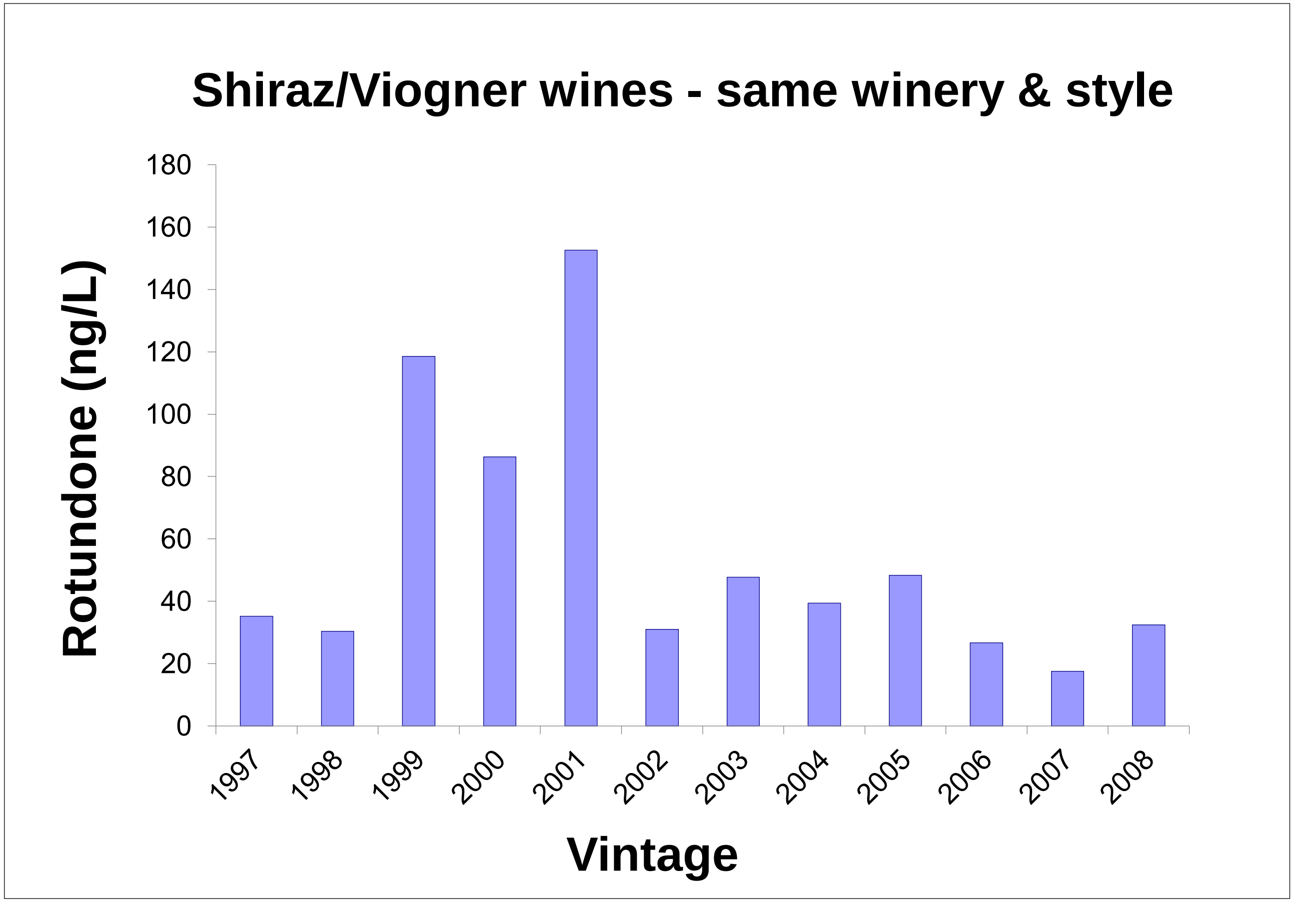
Rotundone in other commercially available Shiraz wines

The Australian Wine Research Institute



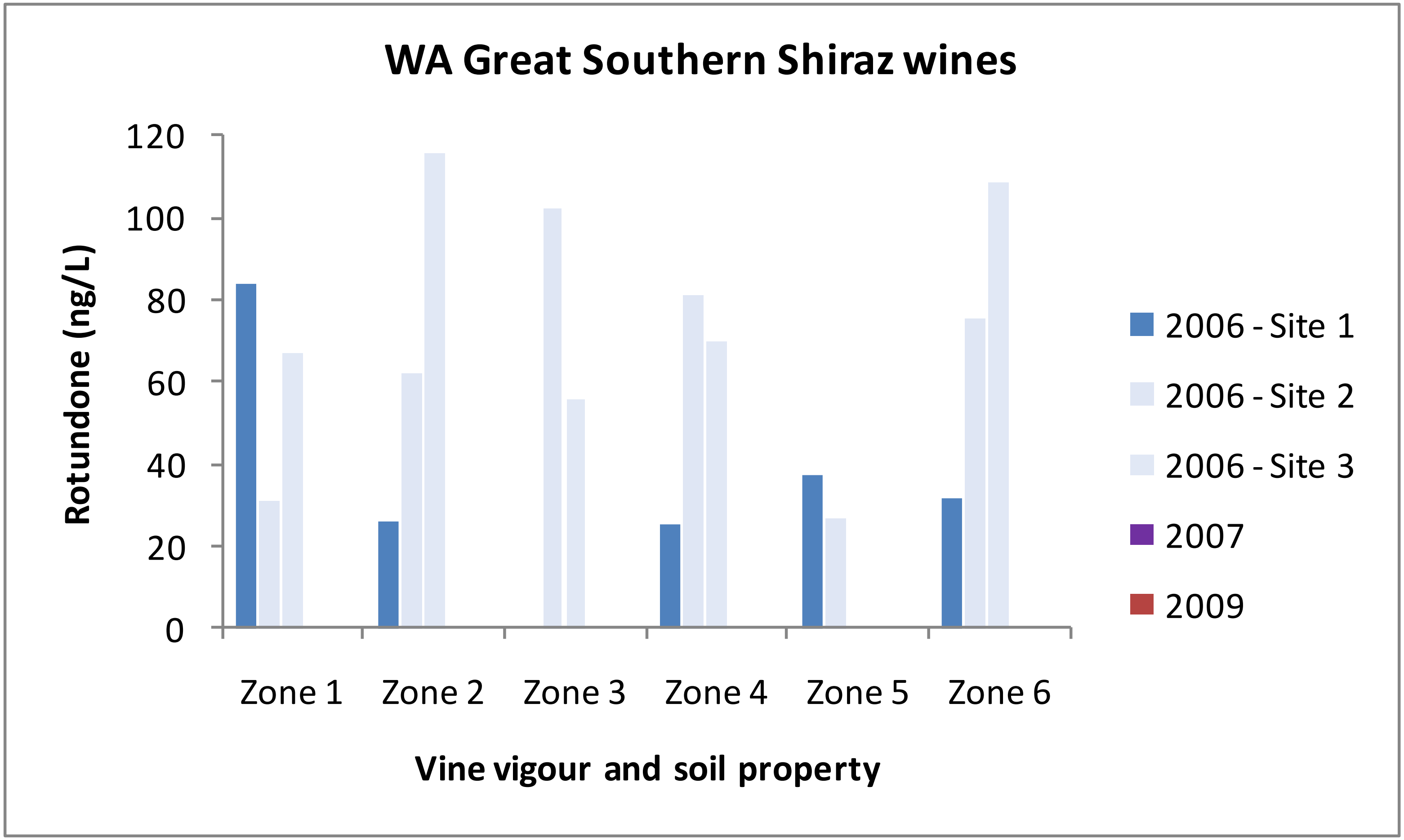
Variability across the vineyard & vintages: Canberra District

The Australian Wine Research Institute



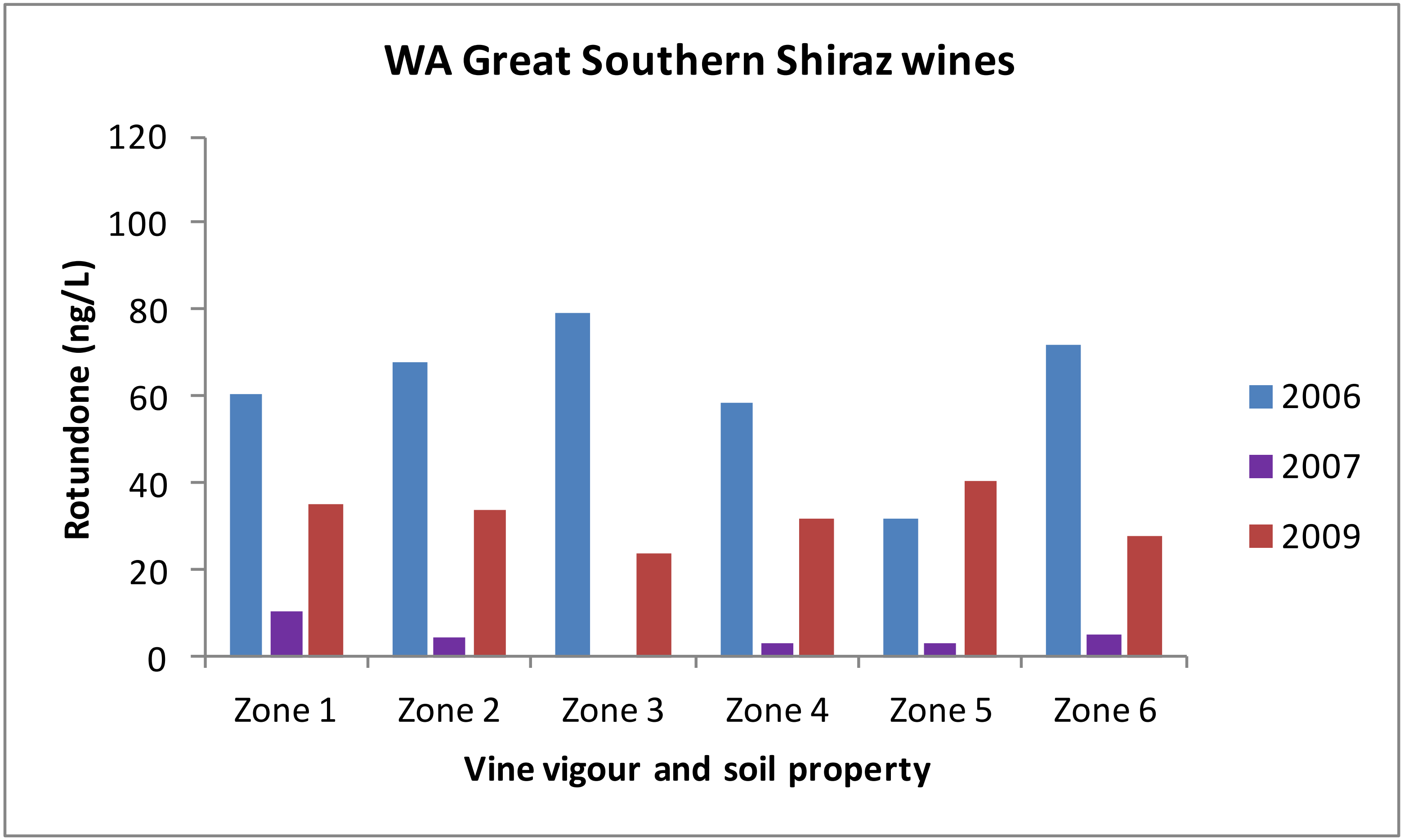
Variability across the vineyard & vintages: Great Southern

The Australian Wine Research Institute



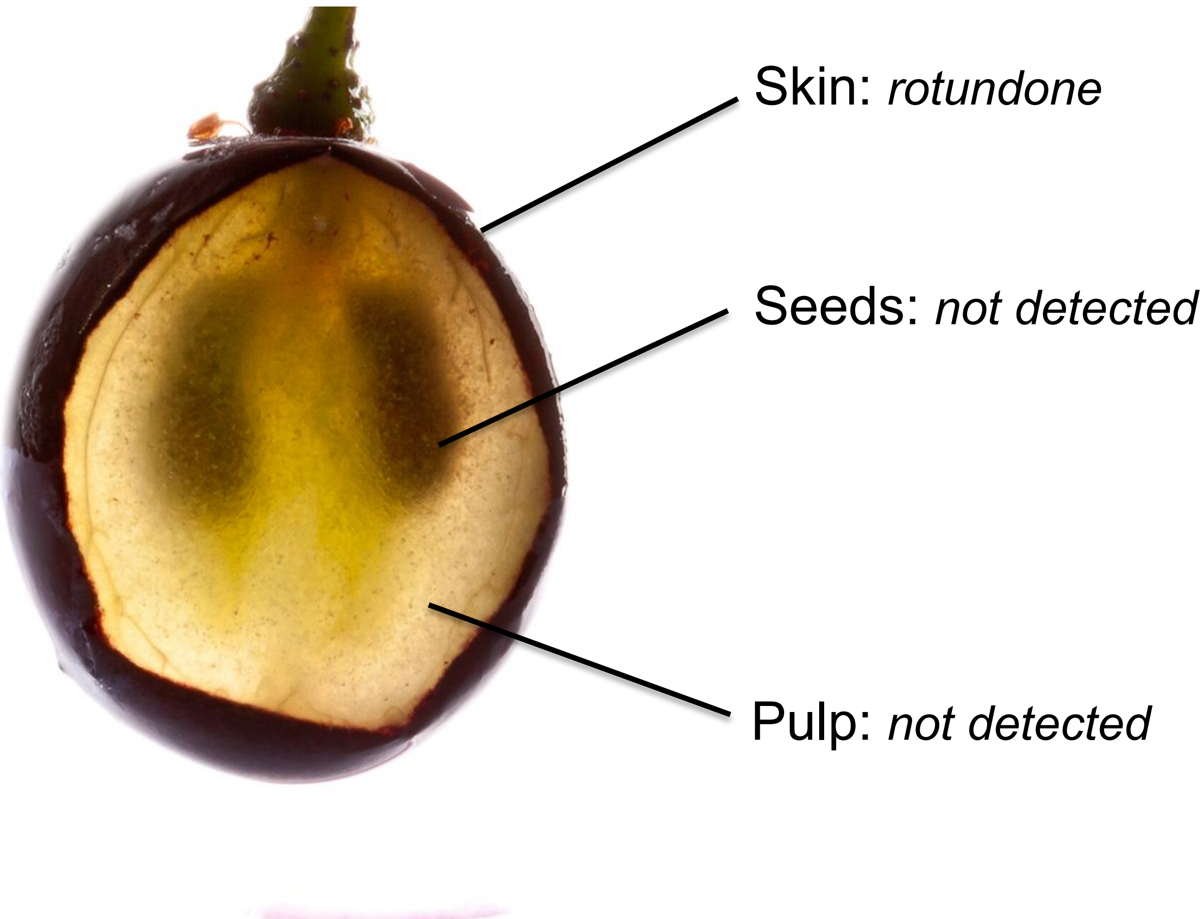
Variability across the vineyard & vintages: Great Southern

The Australian Wine Research Institute



Where and when does rotundone turn up in the berry?

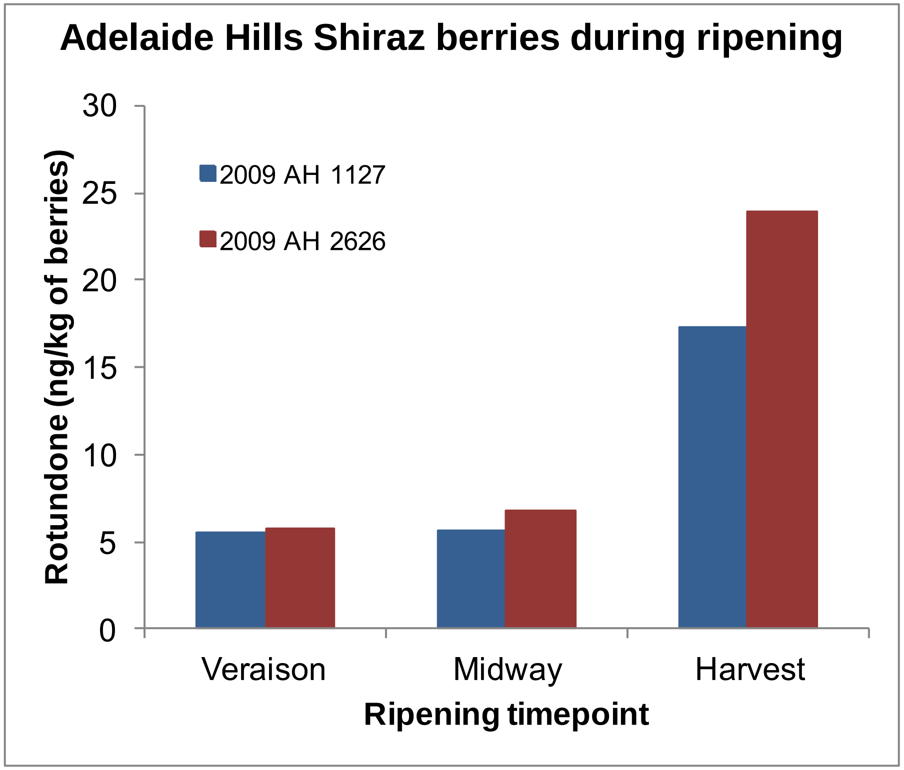
The Australian Wine Research Institute

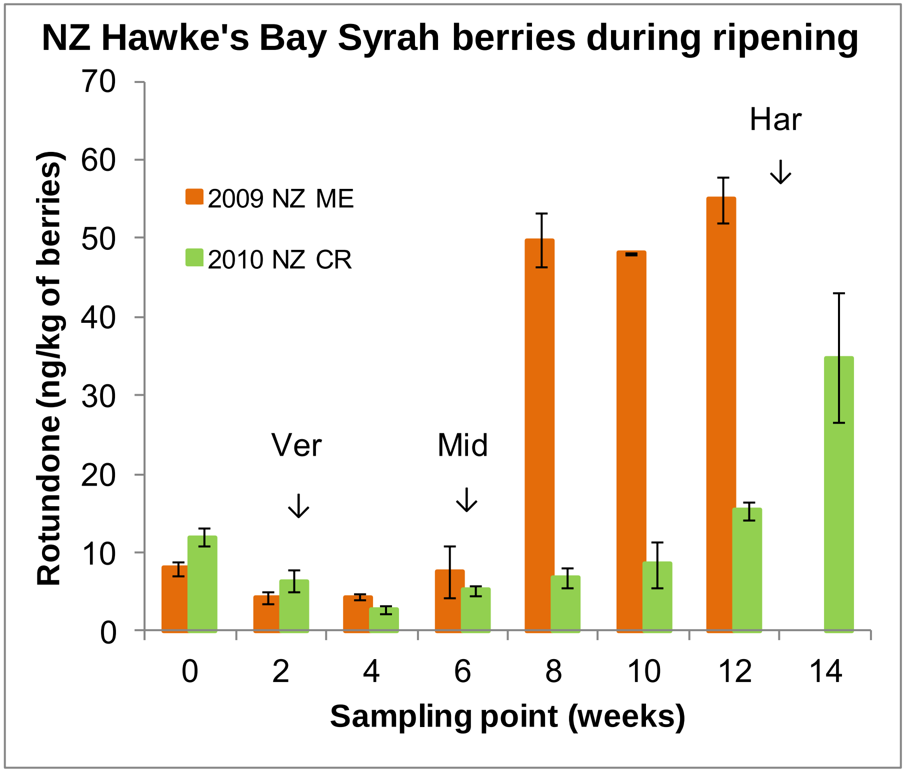


Photograph by Eric Wilkes

Where and when does rotundone turn up in the berry?

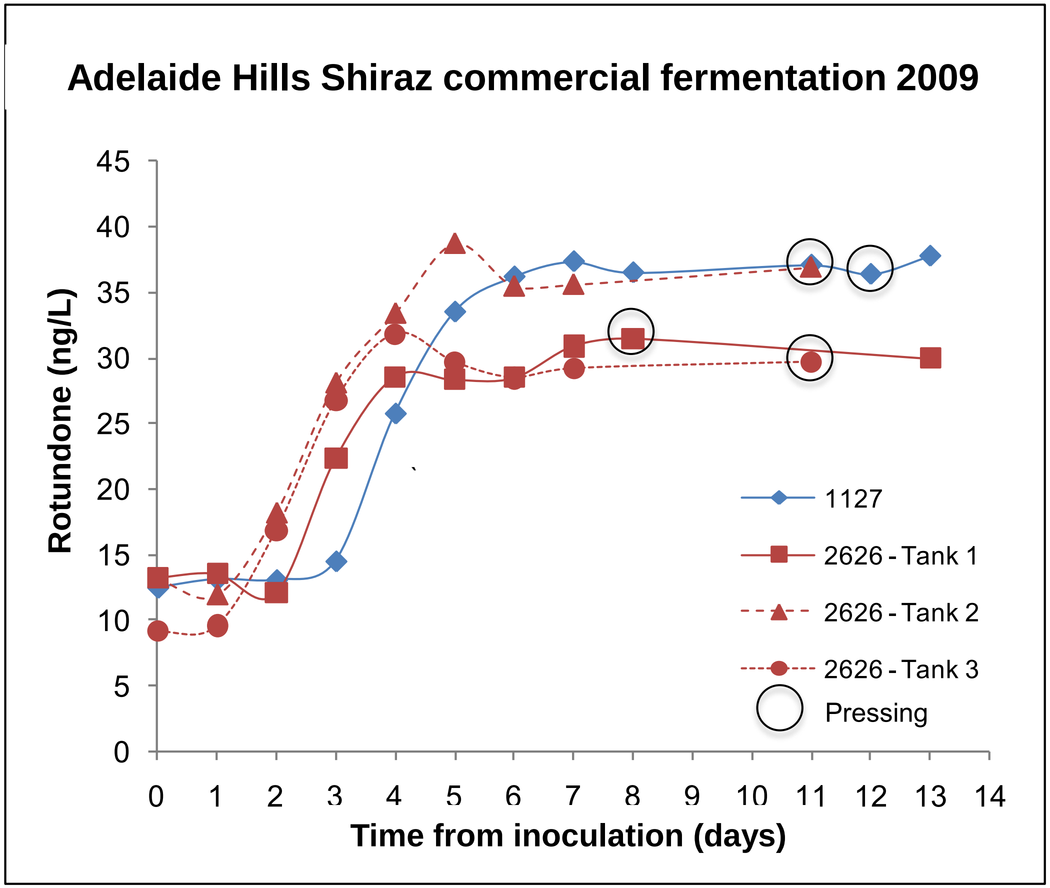
The Australian Wine Research Institute





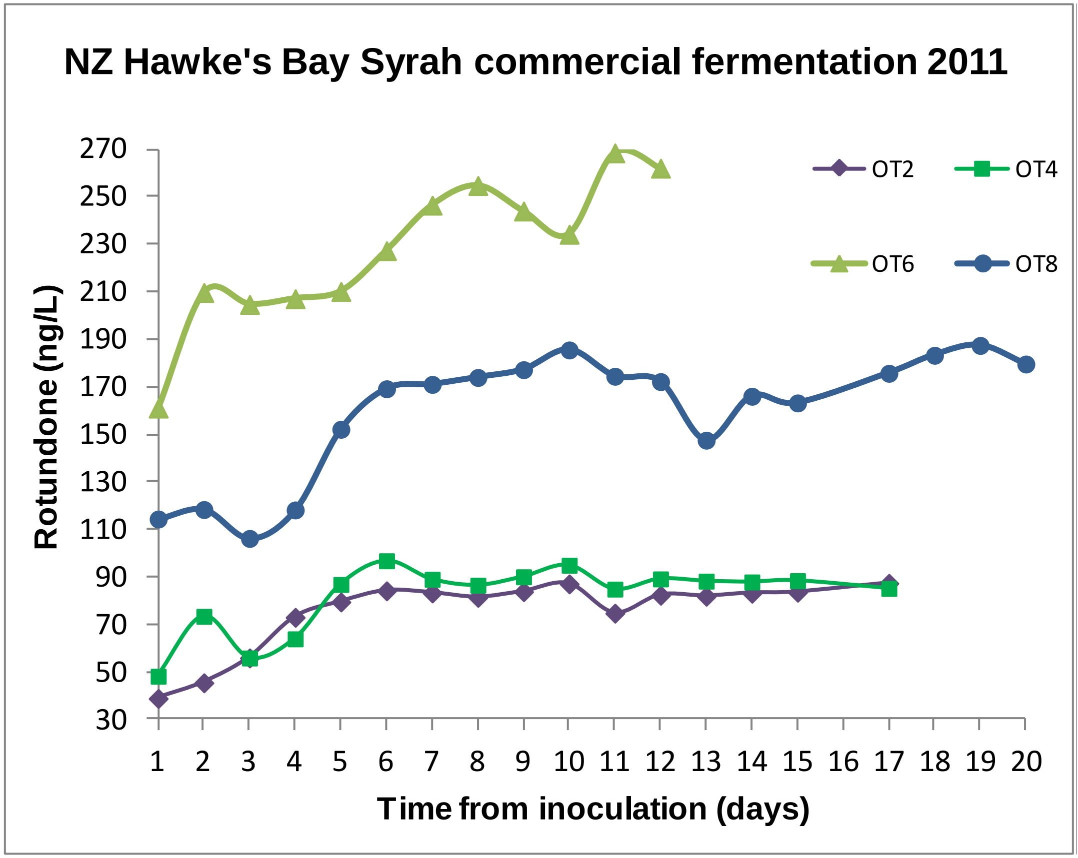
Rotundone extraction from berries during winemaking

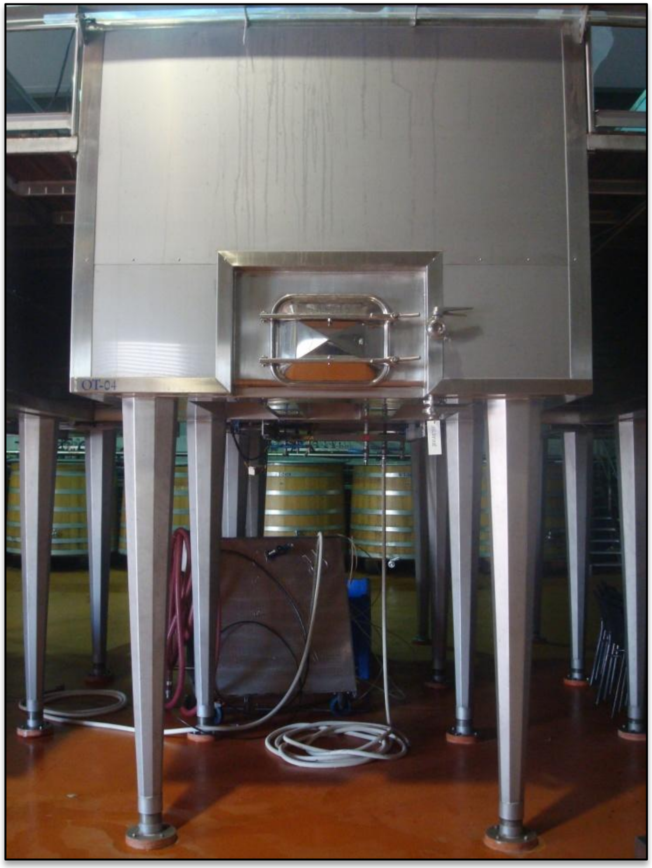
The Australian Wine Research Institute



Rotundone extraction from berries during winemaking

The Australian Wine Research Institute





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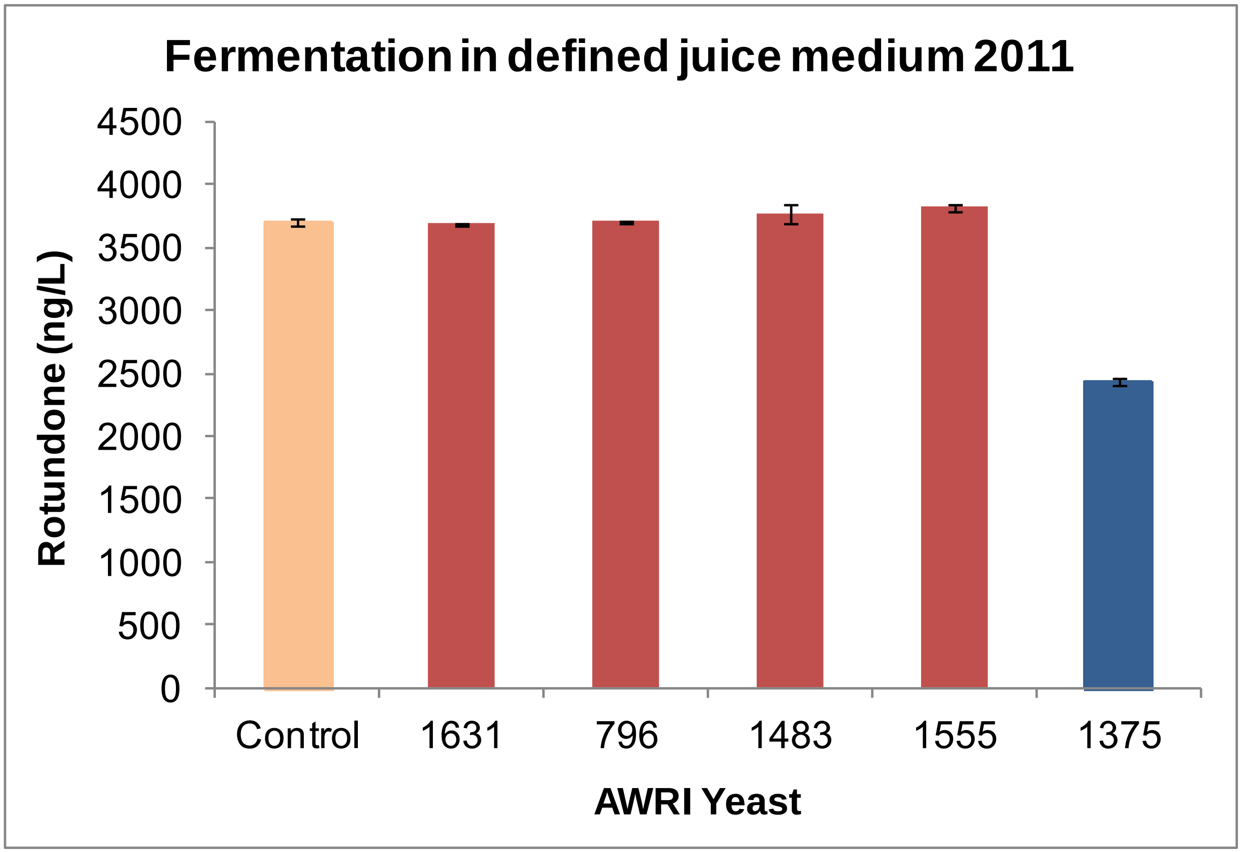
NEW ZEALAND

Can yeast affect rotundone levels during fermentation?

The Australian Wine Research Institute



Does vine management affect rotundone levels?

The Australian Wine Research Institute

- Impact of viticulture
  - Fruit exposure
  - Leaf removal time
  - Crop load
  - Vine vegetative vigour

- Clones

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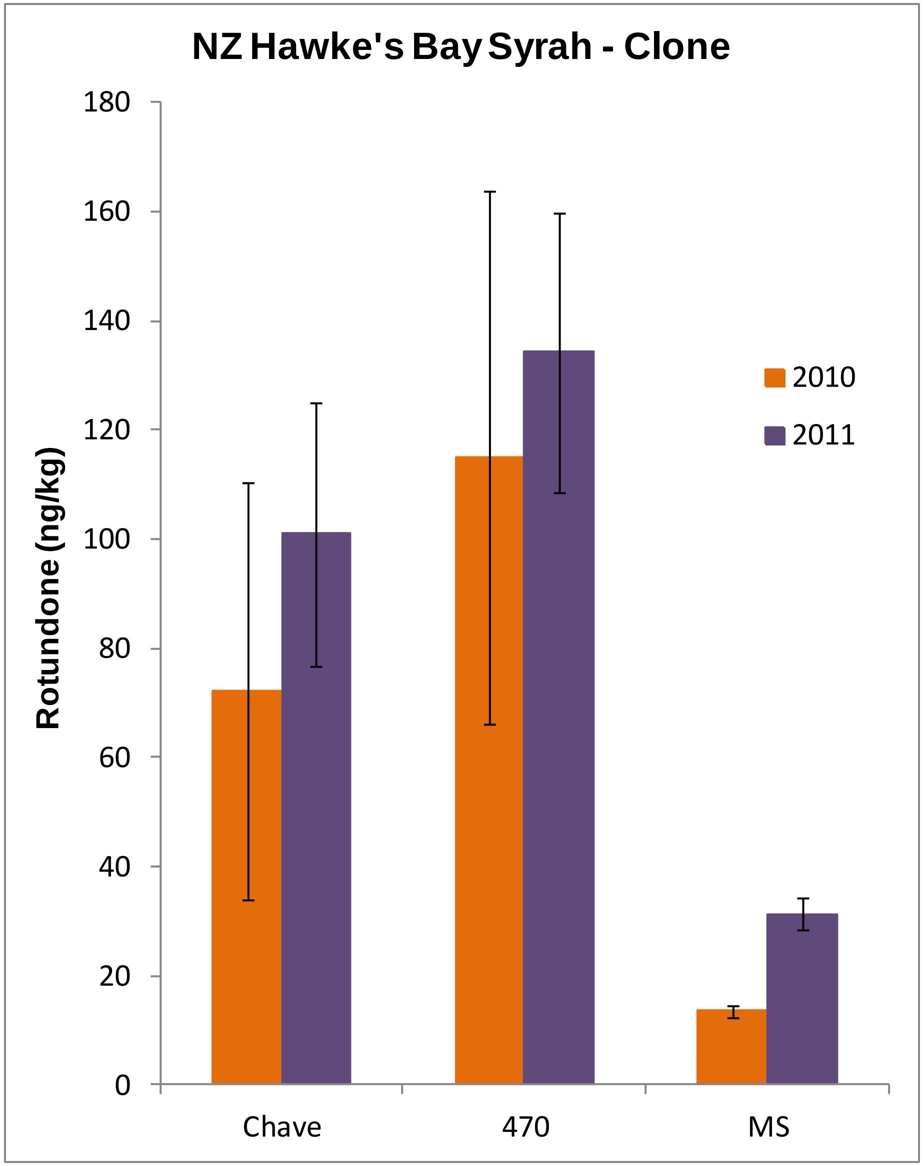
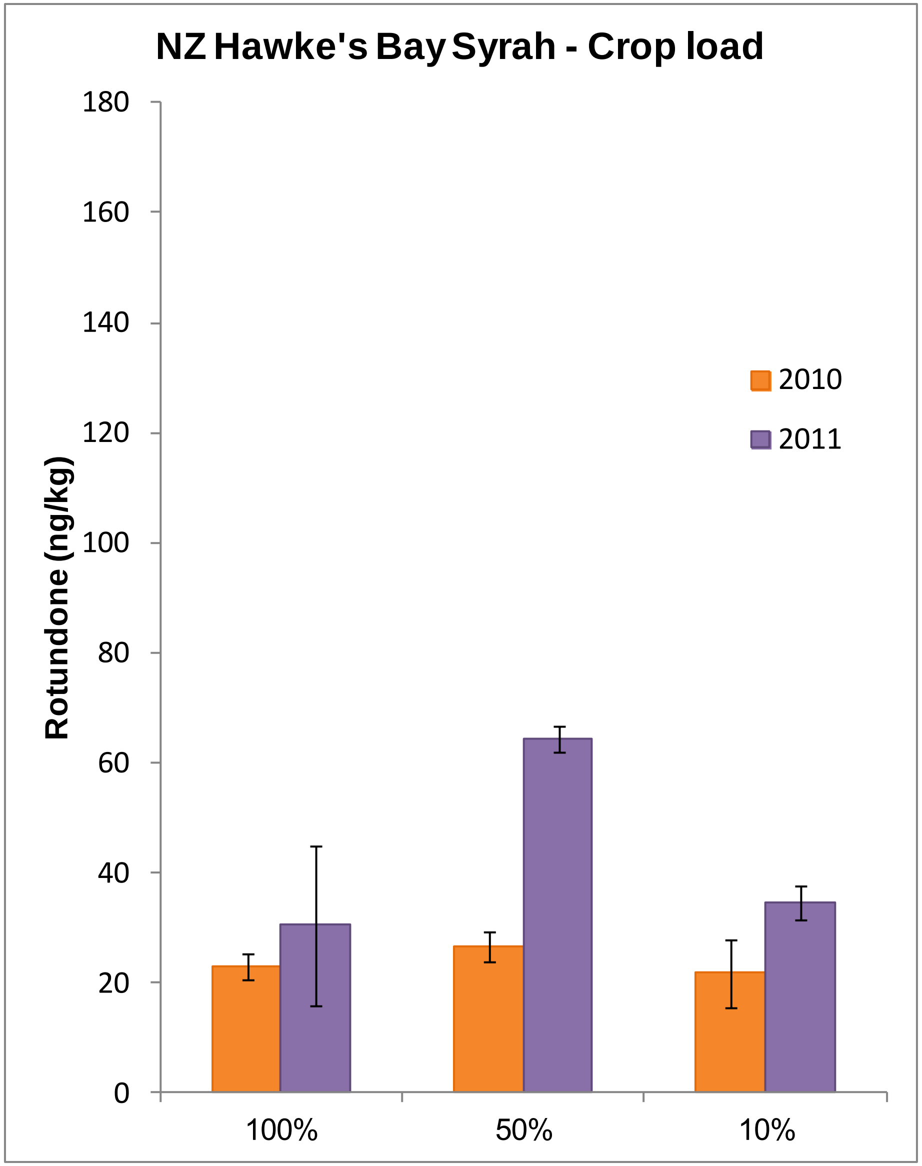
NEW ZEALAND

Viticultural parameters

The Australian Wine Research Institute



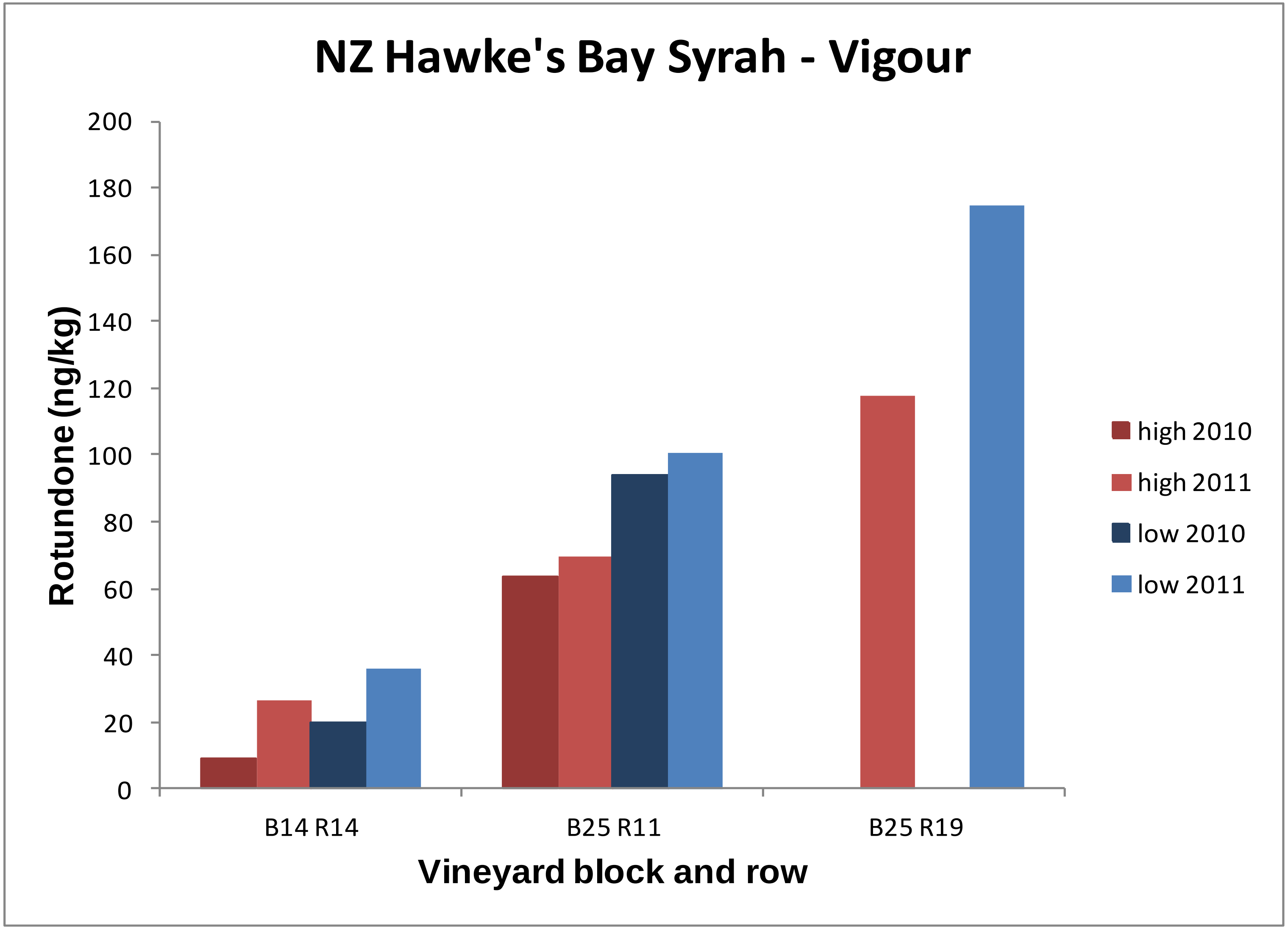



Trunk Circumference: 163mm
LLN: 2.73
Gaps: 1.5%


Trunk Circumference: 129mm
LLN: 0.795
Gaps: 29%

Viticultural parameters

The Australian Wine Research Institute

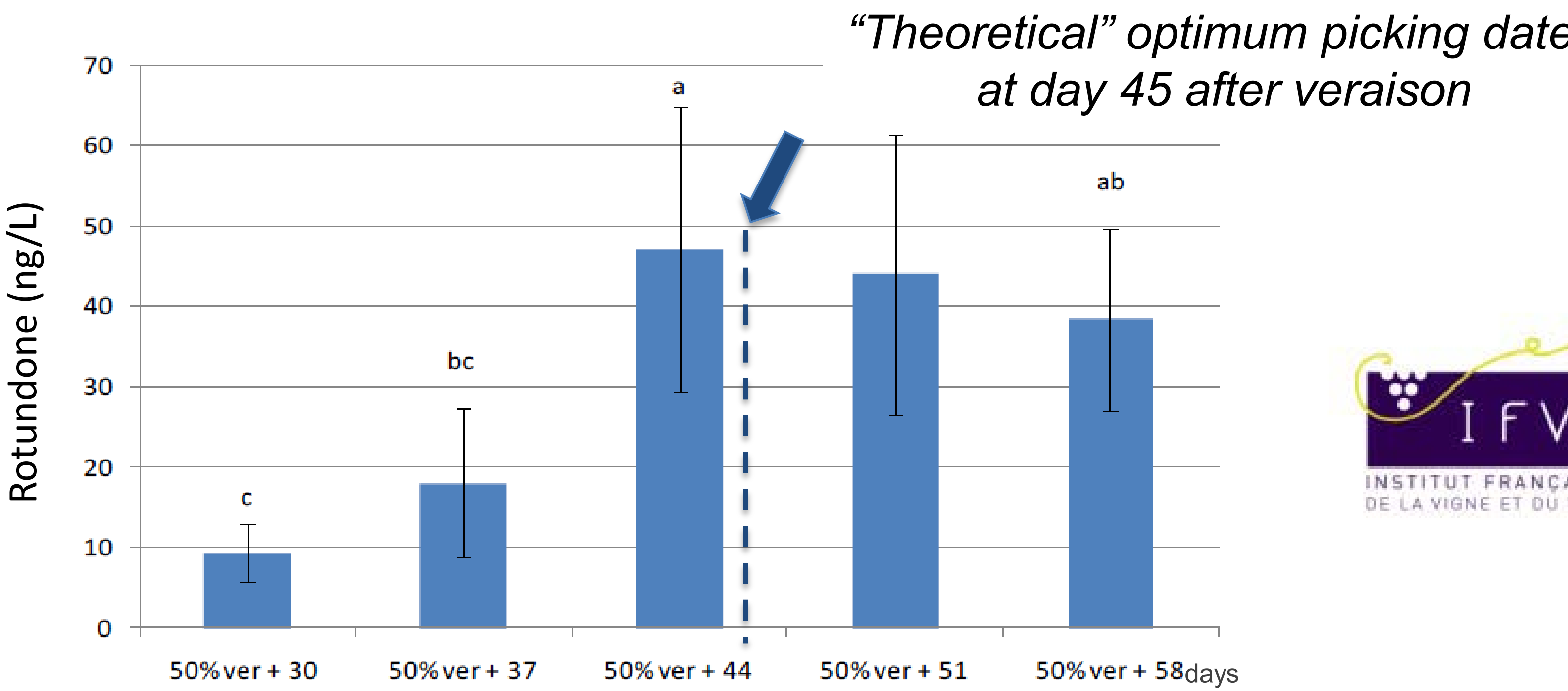


Rotundone in Pyrenees wines

Olivier Geffroy, IFV Sud-Ouest

The Australian Wine Research Institute

2011 Duras microvinification at 5 levels of maturity



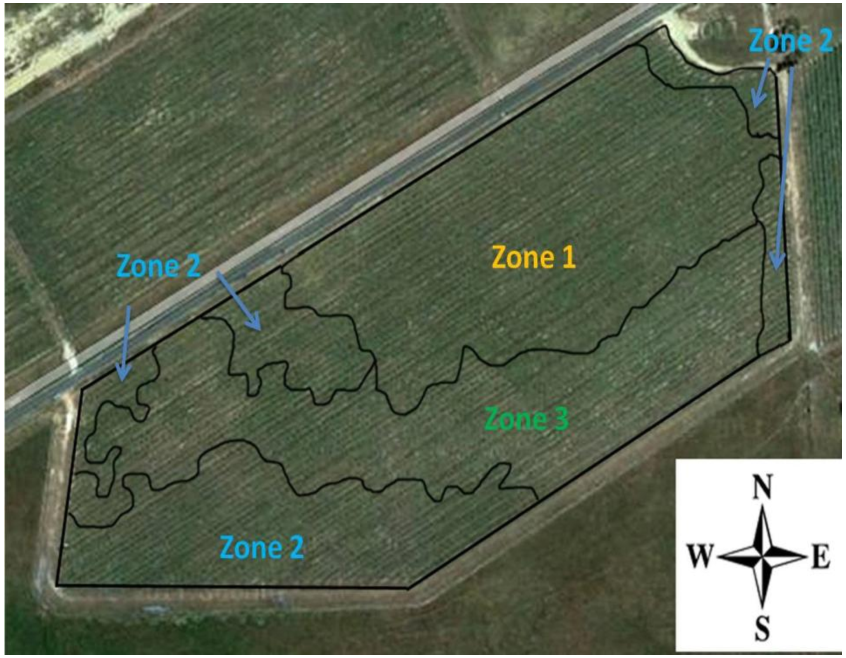
INSTITUT FRANÇAIS DE LA VIGNE ET DU VIN

IFV viticulture trials:	***2011***	***2012***
Irrigation / Elicitor / crop load	43-48 ng/L	29-36 ng/L
Control	37 ng/L	27 ng/L
Leaf removal	12 ng/L	12 ng/L

Variability across the vineyard & vintages:

The Australian Wine Research Institute

Pangzhen Zhang, UoM; Nathan Scarlett, RWG; Damien Sheehan, MLG; Rob Bramley, CSIRO



Rotundone level in bunches (2012)

Top Back

Top Front

Bottom Back

Bottom Front

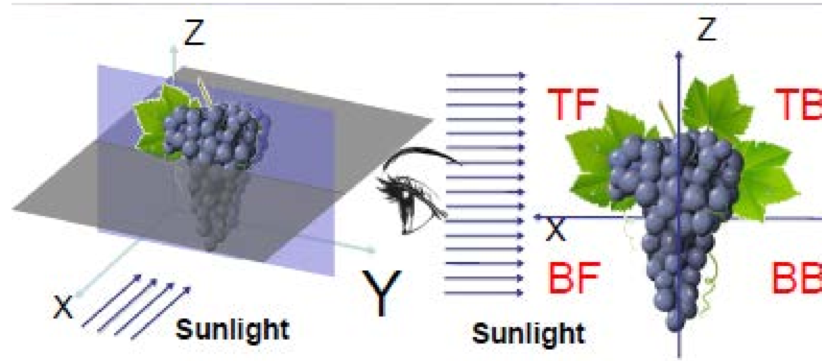


Figure 2: Grape bunch separation: top front (TF) stands for the top 40% of the grape that directly exposed to sunlight; top back (TB) stands for the bottom 60% of the group that exposed to the sunlight; bottom front (BF) stands for the top 40% of the grape that does not have direct sunlight; bottom back (BB) stands for the bottom 60% of the grape with no exposure to sunlight.

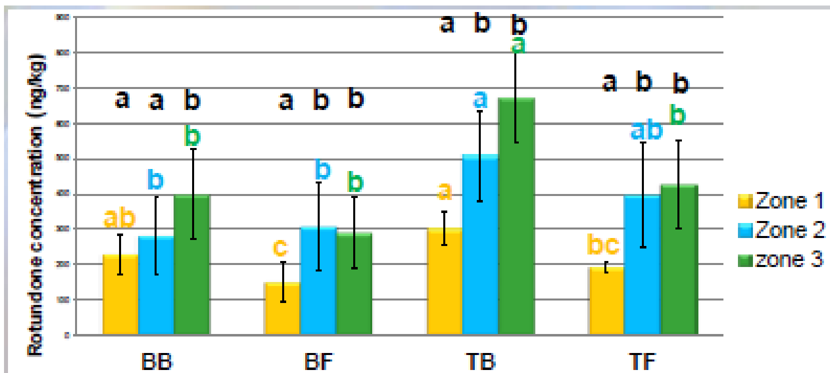


Figure 3 Rotundone concentration of berries from different parts of bunch ($p<0.05$). The coloured label showed differences within each vineyard zone, while the black label showed difference in each part of bunch between zones.

CSIRO

THE UNIVERSITY OF MELBOURNE

1. Conclusions and future directions

The Australian Wine Research Institute

- vineyard **site & vintage** key to rotundone in grapes & wine
- significant **vine-to-vine** and **within bunch** variation
- **Shiraz -** viticulture & rotundone concentration:
  - ripening
  - clone, vigour & crop load

- **Duras -** viticulture & rotundone concentration in wine
  - ripening
  - irrigation, elicitor, crop load & leaf removal

- Limited options to lower rotundone in the winery:
  - yeast?
  - skin contact and cap extraction?

    no effect: *machine picked, crushed, de-stemmed & open fermentation versus hand picked, whole bunch open fermentation*

2. Conclusions and future directions

The Australian Wine Research Institute

- How can we manage our vineyards to increase or decrease rotundone in fruit, or to reduce variability?

- What are the ***environmental factors*** that cause high rotundone in some grapevines & some seasons?

- Why is rotundone found in certain cultivars, e.g. ***Shiraz*** and ***Duras***, compared to other cultivars, i.e. role of ***grapevine genome***?

- What ***biological function*** does rotundone serve?

As Shiraz is Australia's predominant varietal and an important cultivar internationally, it is essential that we investigate impact odorants, such as rotundone, to assist grape growers and winemakers to produce Shiraz to suit their market.

Acknowledgements

The Australian Wine Research Institute

Australian wine industry collaborators

- Nathan Scarlett (RWG), Damien Sheehan & staff (Mt Langi Ghiran)
- Darryl Catlin, Winemaker, and the winery and laboratory staff of Shaw and Smith Wines
- Frank van de Loo, Mt Majura Vineyard
- Jim Lumbers, Lerida Estate and Lumbers Consulting
- Dr Ayalsew Zerihun, Curtin University of Technology
- Allen and Andrea Hart (Treasury Wine Estates), Inca Pearce, Martin Wirper (Orlando Wines), Sue Hodder (Wynns Coonawarra Estate)

AWRI

- Mango Parker & Claudia Wood
- Flavour & Sensory Teams (past & present members)
- Radka Kolouchova, Mark Krstic & Markus Herderich

Germany

- Symrise

New Zealand collaborators

- The University of Auckland & EIT Hawke's Bay
- Craggy Range Vineyards, Mission Estate Wines

CSIRO

- Rob Bramley

University of Melbourne

- Pangzhen Zhang

France

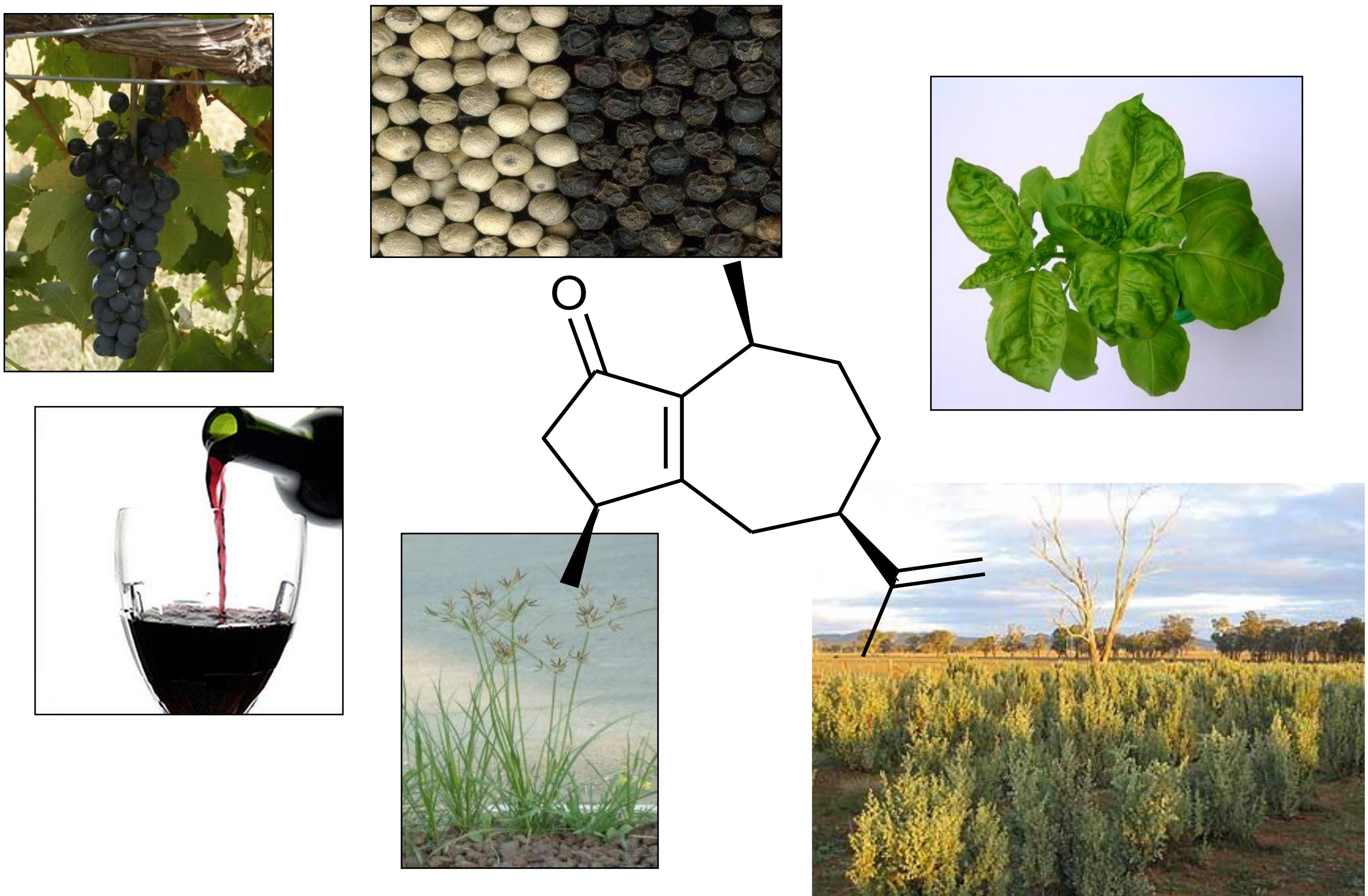
- Olivier Geffroy, IFV Sud-Ouest

GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

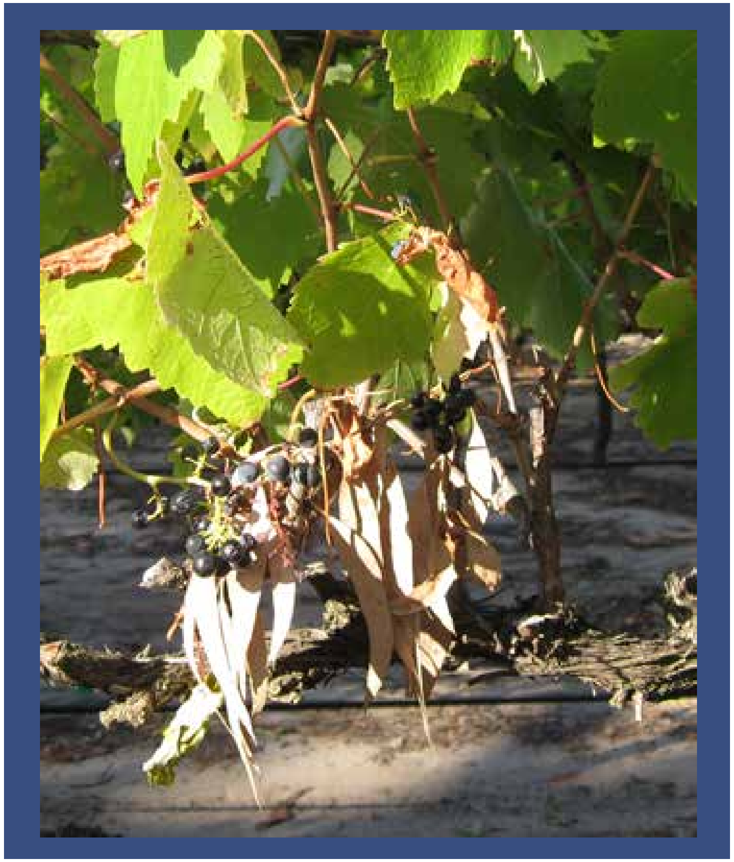
The AWRI, a member of the Wine Innovation Cluster in Adelaide, research is financially supported by Australia's grape growers and winemakers through their investment body the Grape and Wine Research and Development Corporation, with matching funds from the Australian Government.

Thank you!

The Australian Wine Research Institute



The origin of eucalyptol (1,8-cineole) ‘minty’ flavour in wine

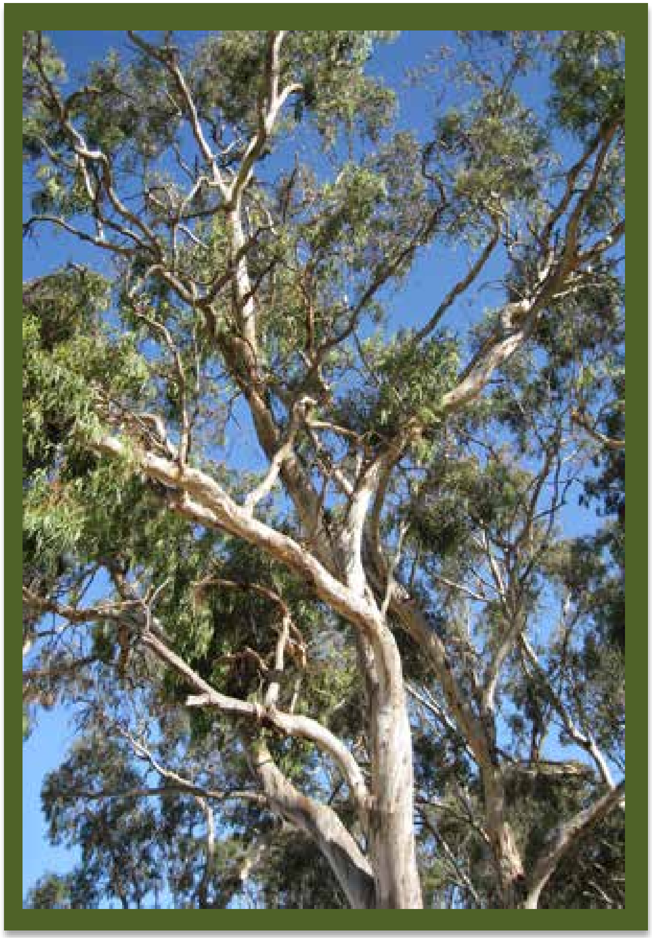


Dr Dimitra L. Capone

1,8 – Cineole (eucalyptol)

The Australian Wine Research Institute

The characteristic aroma is ‘eucalyptus’, ‘fresh’, ‘cool’, ‘minty’, ‘medicinal’ and ‘camphorous’



Aroma detection threshold in a Californian Merlot is 1.1 µg/L

(ETS Laboratory)

Study by the AWRI sensory team found consumers preferred a wine spiked (4 & 30 µg/L) over the unspiked wine. With a cluster (38%) strongly preferring the wine spiked at 30 µg/L.

(AWRI Tech Rev. #189)

Background on 1,8-cineole

The origin of 1,8-cineole in wine is unclear

- Herve et al reported that the ‘eucalypt’ character in wines occurs when vineyards are surrounded by *Eucalyptus* trees

- Farina et al proposed that terpene compounds such as a-terpineol and limonene are possible precursors of 1,8-cineole

We wanted to identify the source of 1,8-cineole in wine and study factors which affect its concentration

Developed a method for measuring 1,8-cineole in wine

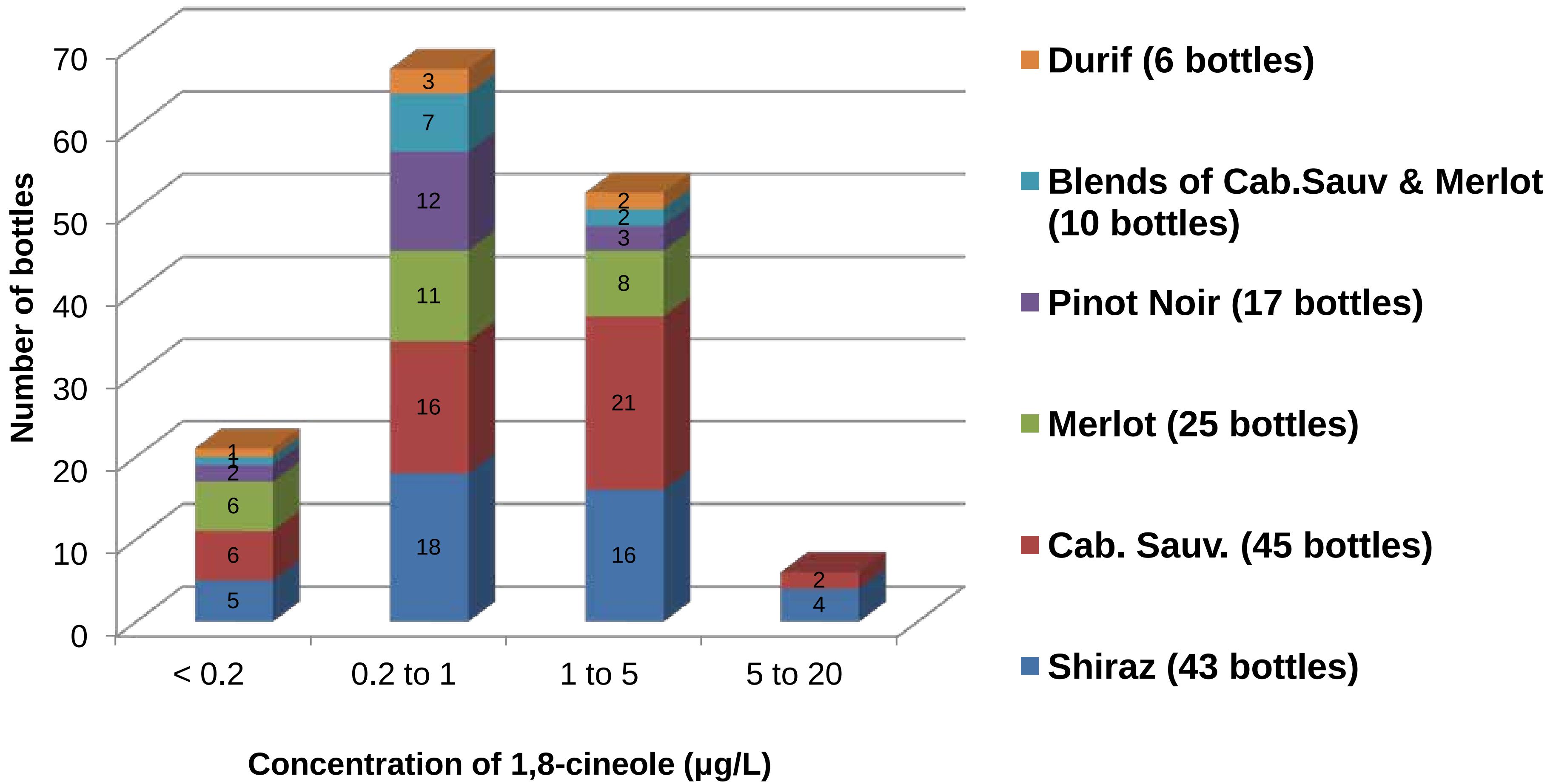
The Australian Wine Research Institute

Solid phase micro-extraction (SPME) + stable isotope dilution analysis (SIDA – with d_6-1,8-cineole) combined with gas chromatography/mass spectrometry (GC/MS)

- This has been used to determine the origin of 1,8-cineole in Australian wines
- Initially examined how widespread this character is in Australian wines

How wide spread is 1,8-cineole in commercial Australian red wines?

The Australian Wine Research Institute

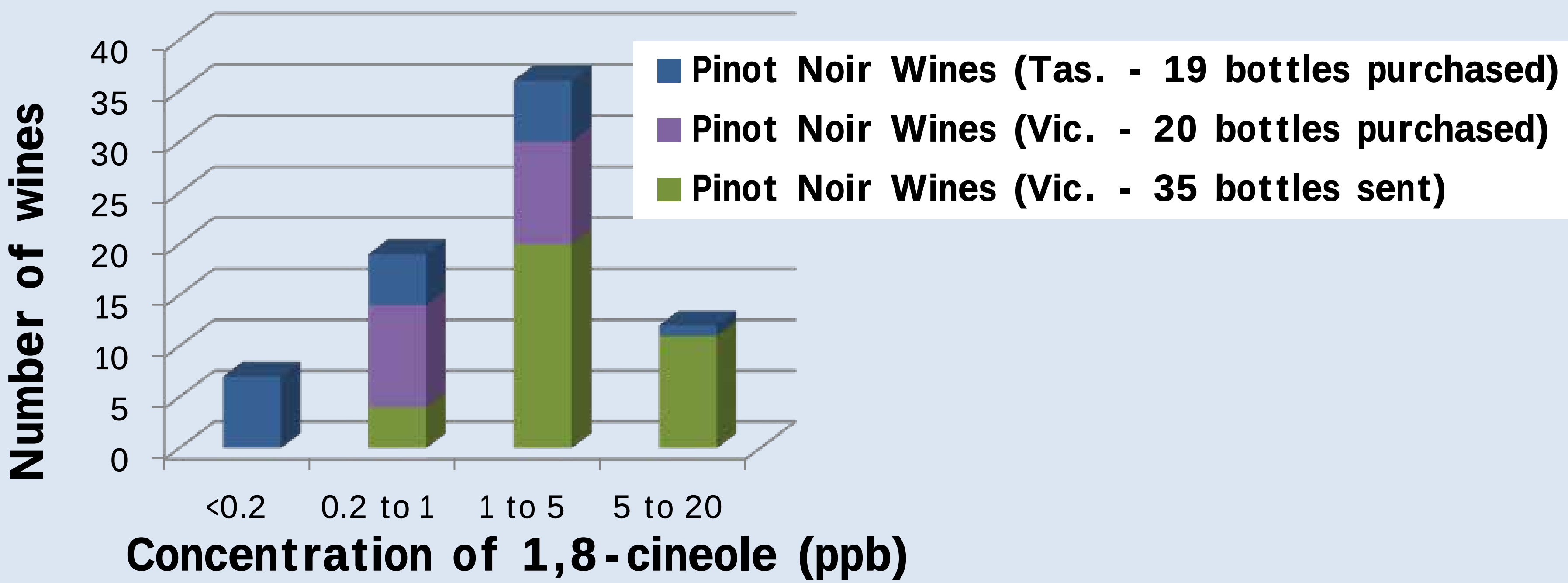


40% contained 1,8-cineole above reported detection threshold.

The highest level of 1,8-cineole found was 19.6 µg/L

1,8-cineole concentration in a New Pinot Noir Wine survey

The Australian Wine Research Institute

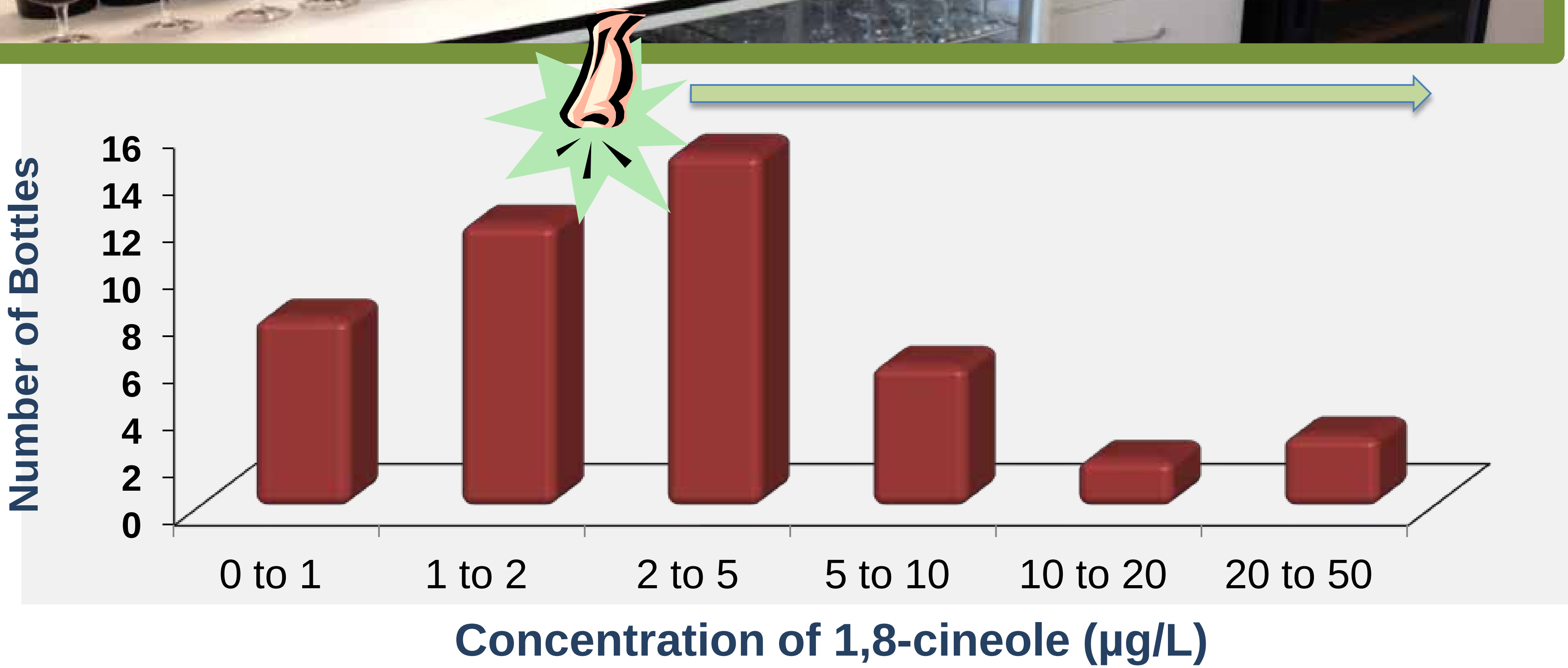


65% of the current Pinot Noir wines analysed contained 1,8-Cineole at or above its aroma detection threshold

50% of the purchased Victorian, 89% of Victorian commercial sent in by industry & 37% of the Tasmanian Pinot Noir wines analysed had 1,8-Cineole at or above its aroma detection threshold

1,8-cineole in commercial Australian Coonawarra Cabernet Sauvignons

The Australian Wine
Research Institute



Is 1,8-cineole found in significant concentrations in Australian white wine?

The Australian Wine Research Institute

NO!

Out of 44 white wines

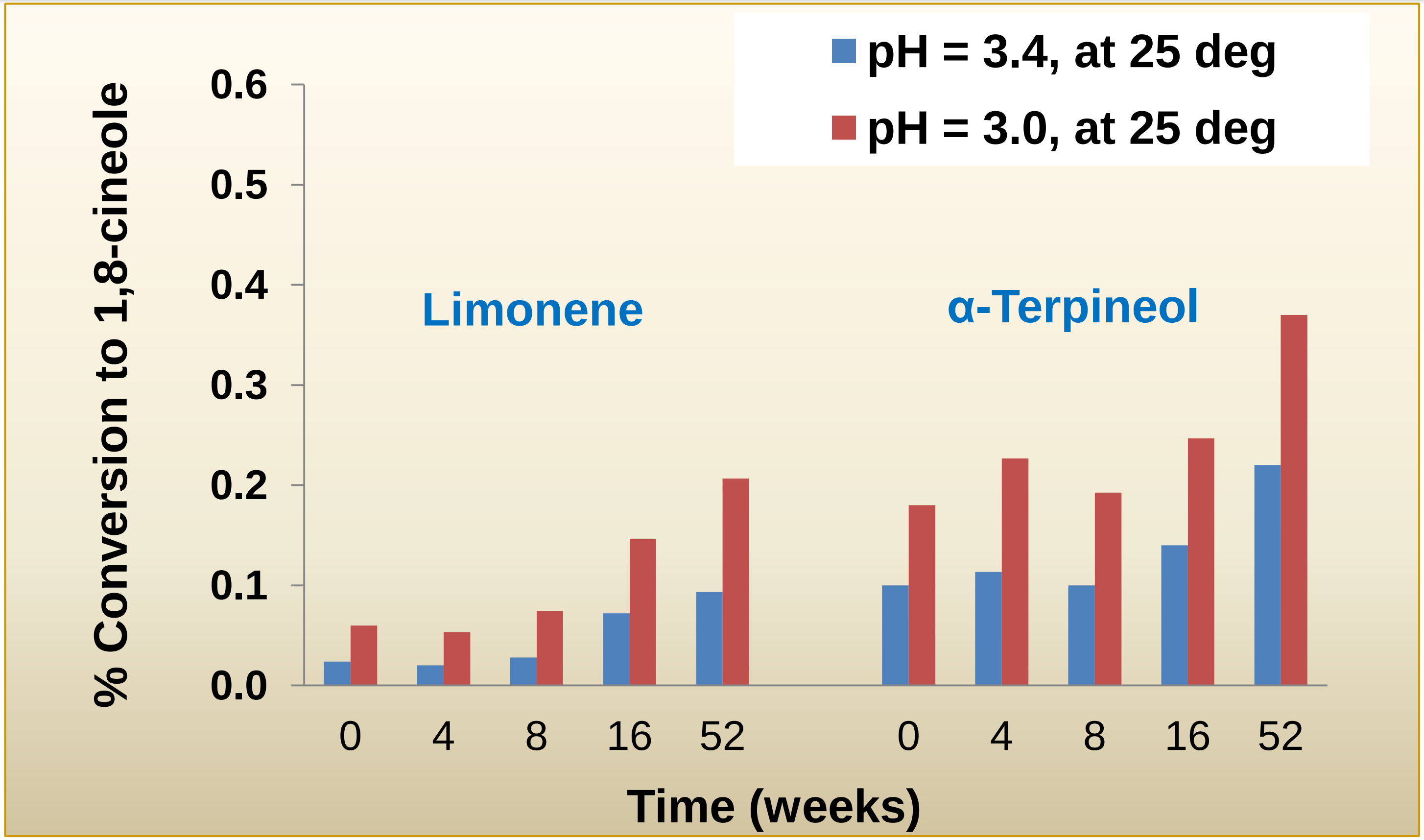
(12 Rieslings, 10 Sauvignon Blancs, 10 Semillons and 12 Chardonnays)

1,8-cineole was not detected above 0.8 µg/L in any wine

Formation of 1,8-cineole from precursors?

The Australian Wine Research Institute

% Conversion to 1,8-Cineole from terpenoid precursors

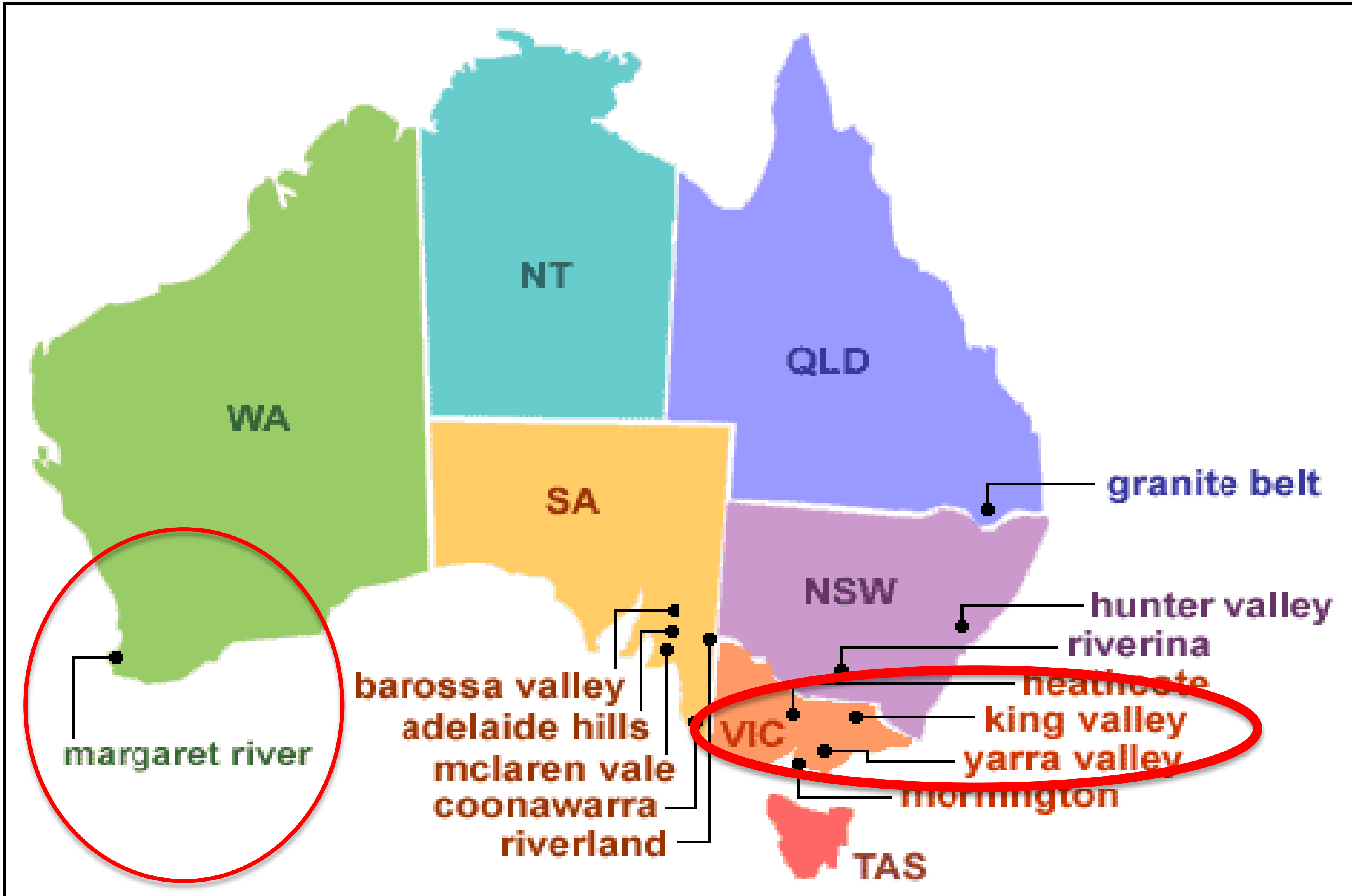


limonene and α-terpineol not significant precursors

After 12 months of storing model wine spiked with unnaturally high amounts of terpenoid there was less than 0.4% conversion to 1,8-cineole (i.e. sub-threshold formation) at two different pH

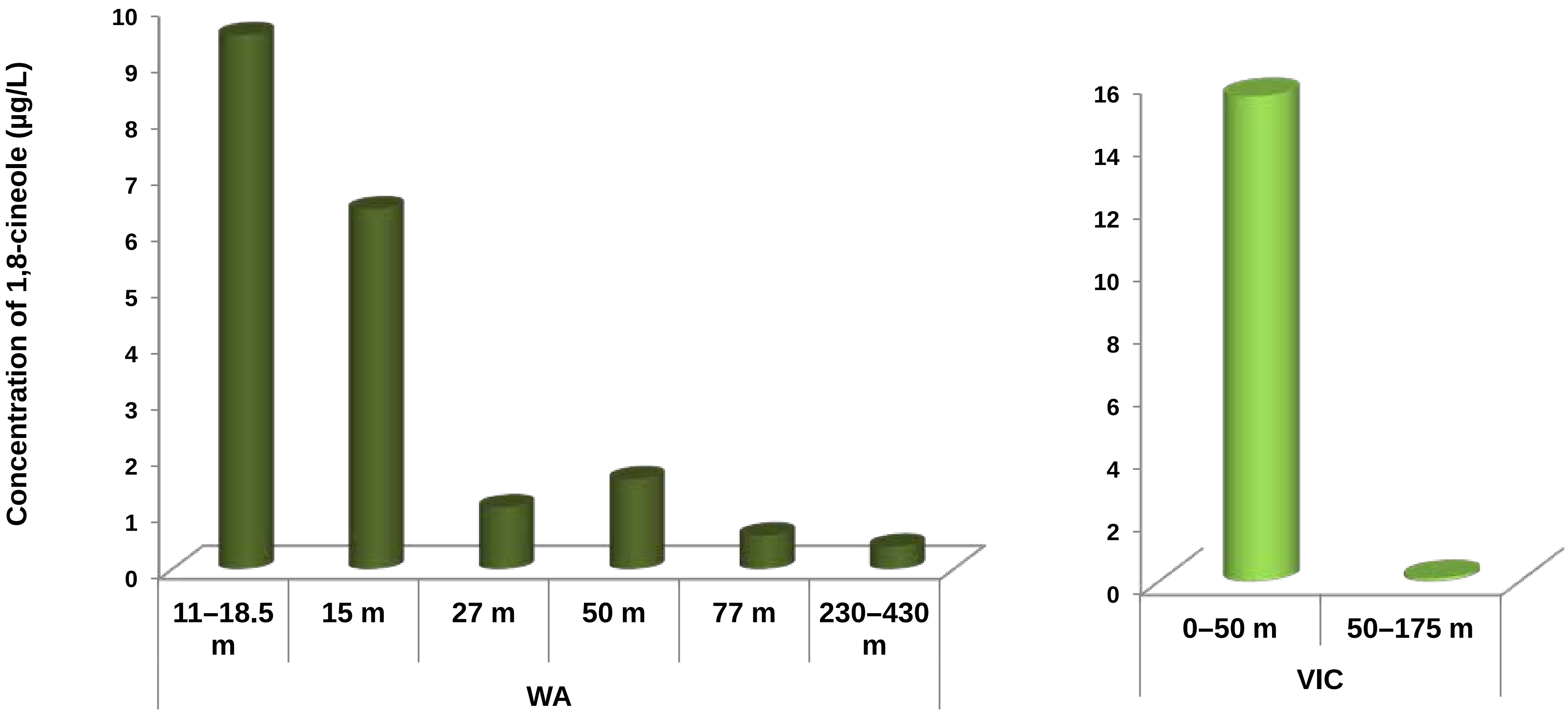
Wines obtained from a single vineyard in Western Australia & the Yarra Valley

The Australian Wine Research Institute



1,8-Cineole concentration decreases

further away from Eucalyptus trees



Commercial ferments

The Australian Wine Research Institute

- Low concentration found in all white wines – is compound accumulated in the skins and extracted during extended maceration?

  - Therefore two commercial ferments were monitored each day throughout fermentation for 1,8-cineole concentration

Cineole increases during fermentation – with skin contact

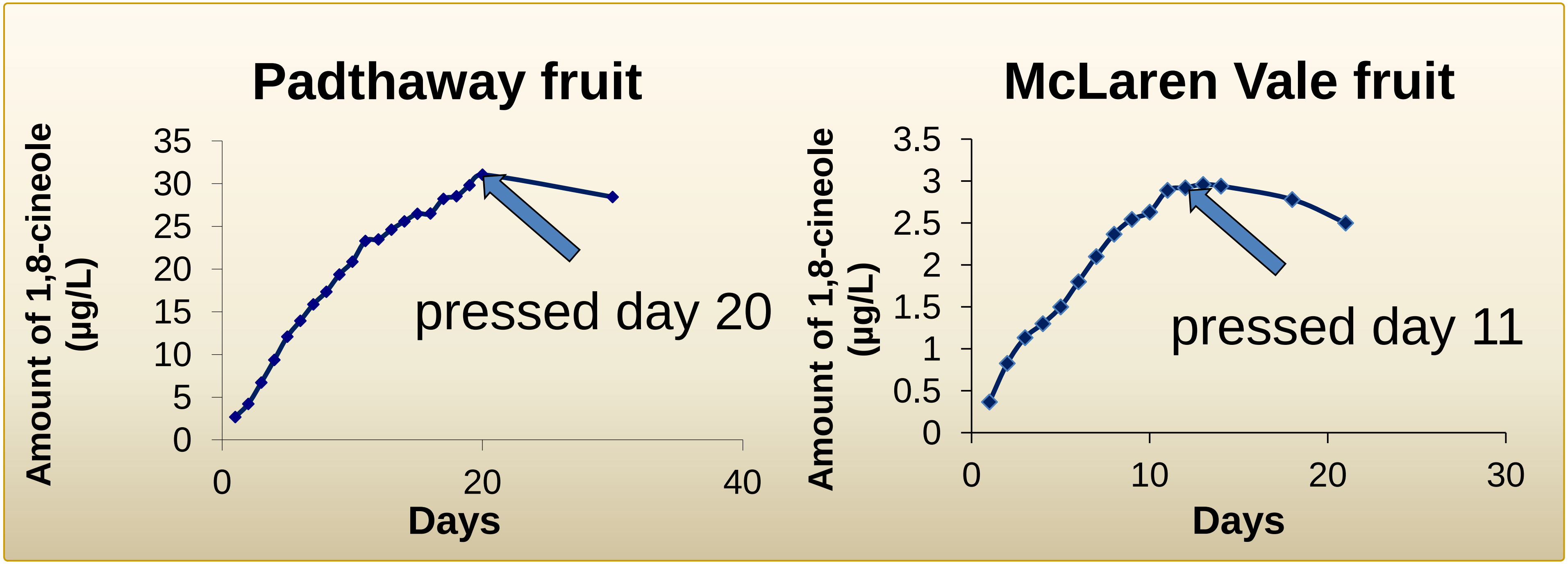
The Australian Wine Research Institute

Changes of 1,8-cineole during fermentation

Two commercial shiraz fermentations - Samples were collected and analysed daily

Ferment (1) 20 tonne closed fermentor with Padthaway fruit and

(2) 10 tonne open fermentor with McLaren Vale fruit



Continuous increase in 1,8-cineole concentration, which ceased at pressing off of the skins. This indicated to us that the compound was extracted from the skins and/or MOG

Vineyard studies

The Australian Wine Research Institute

A more detailed study of the relationship between grape composition and proximity to *Eucalyptus* trees was conducted over three vintages.

Grape bunches

Grape stems

Grape Leaves

Eucalyptus trees

The Australian Wine
Research Institute

Effect of distance to *Eucalyptus* trees

The Australian Wine Research Institute

Vineyard Study

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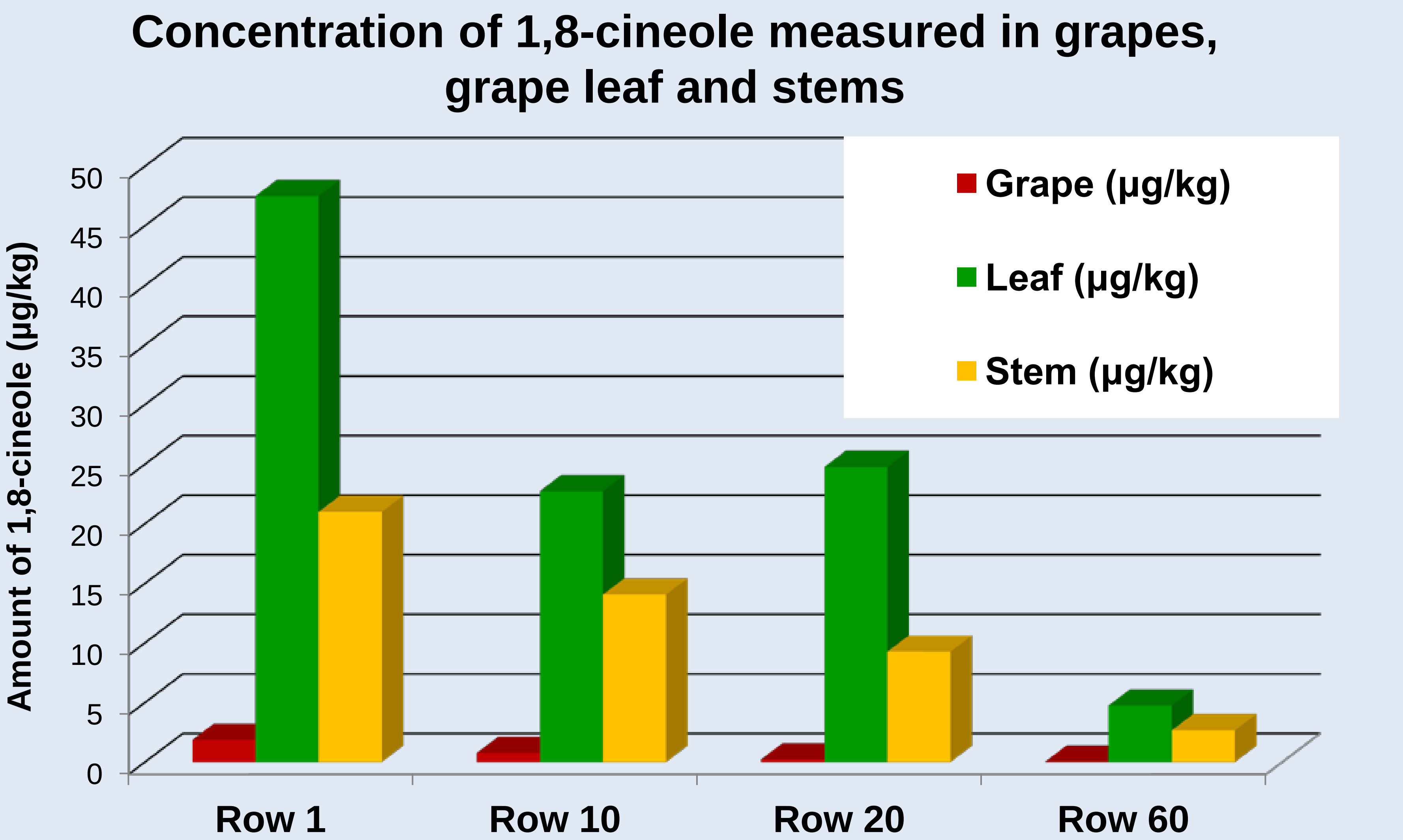

Concentration of 1,8-cineole in grape skins & grape pulp

The Australian Wine Research Institute

0.36 ng/berry in the grape pulp

1.31 ng/berry in the grape skins

Airborne transmission

The Australian Wine Research Institute

To confirm that airborne transmission plausible:

Traps were designed to absorb eucalyptol from the atmosphere

Polyethylene sheets sewn between wire mesh installed again in

Row 1

Row 10

Row 20

Row 60

Traps installed in both vertical and horizontal configurations

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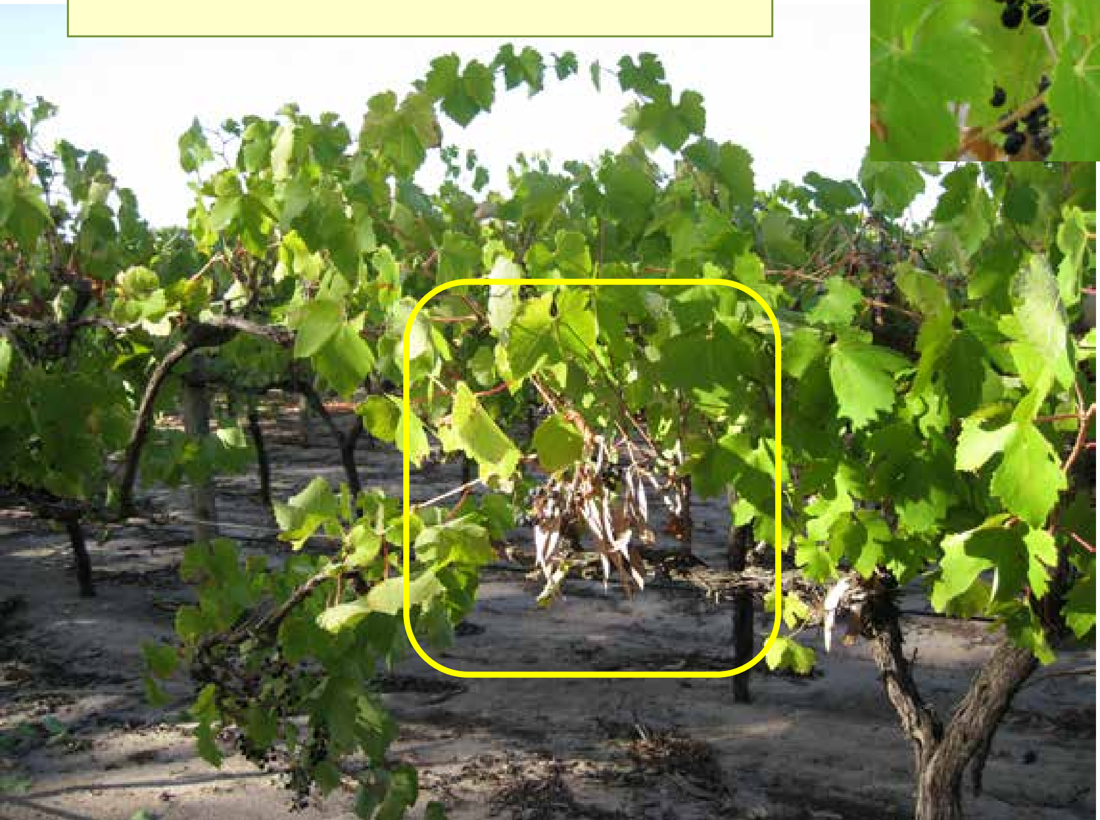
The traps reaffirm the results obtained for the grape, leaf and stem data i.e. greater amounts of 1,8-cineole are found closest to the *Eucalyptus* trees.

Effect of MOG

In Row 1

Found a bunch of *Eucalyptus* leaves and bark in canopy



Total MOG 67.5 gm

in 1 tonne fermenter + with 100% extraction

= 213 µg/L of 1,8-cineole

To determine the effect of MOG on 1,8-cineole concentration

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Block with a history of high 1,8-cineole was chosen

Only the first 3 Rows picked

Rows 1 to 3

- 550 kg of Shiraz Fruit
- Hand picked & randomised
- Duplicate 50 kg lots
- Then Crushed

Fermentation design

The Australian Wine Research Institute

Treatment 1

Rosé Pressed Immediately

Treatment 3

Grape Leaves & Stem

Treatment 2

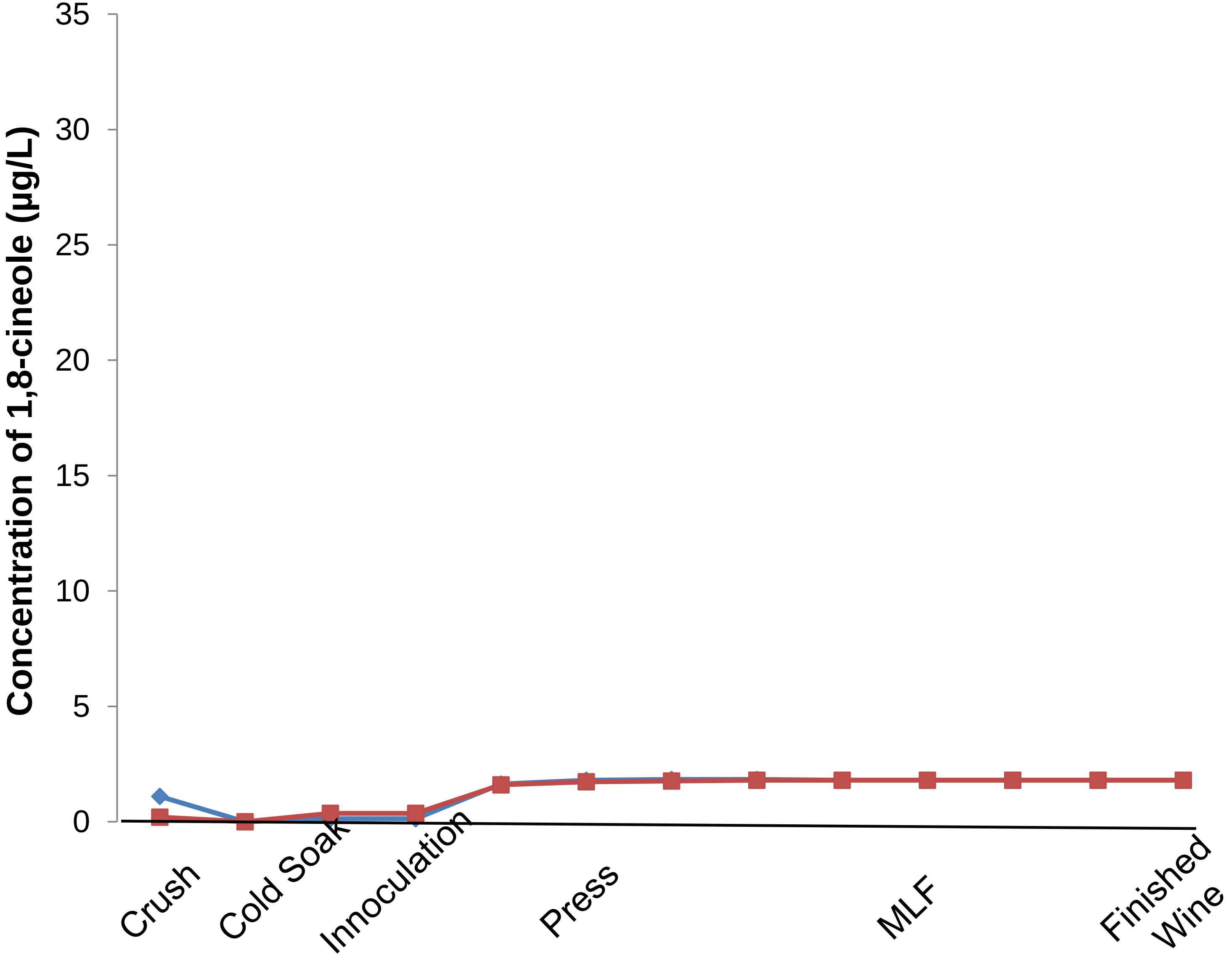
Control Hand Plucked

Treatment 4

***Eucalyptus* Mix**

Fermentation curves: Influence of MOG

The Australian Wine Research Institute



Control
Hand plucked
Rep 1 & 2

Fermentation curves: Influence of MOG

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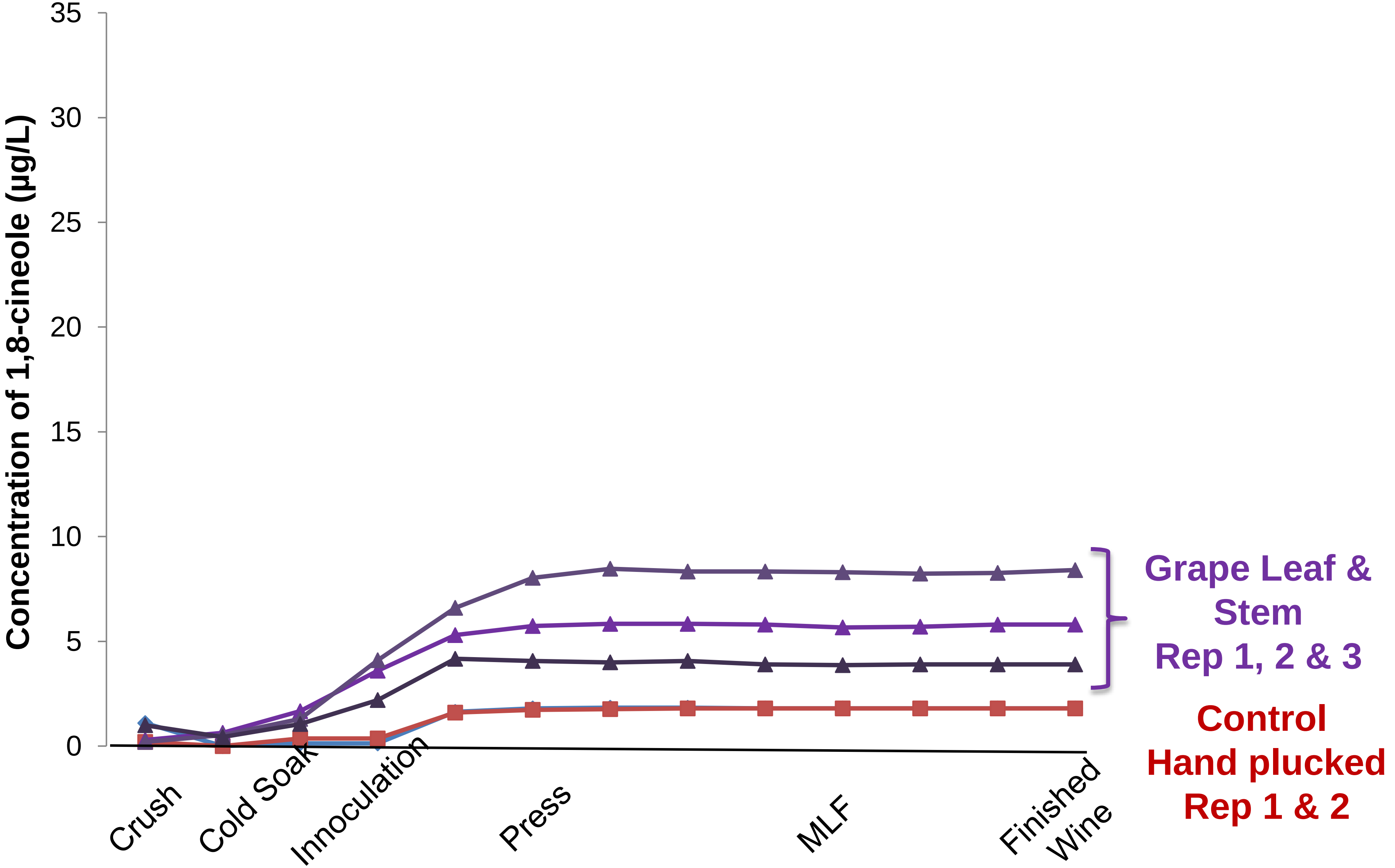

Fermentation curves: Influence of MOG

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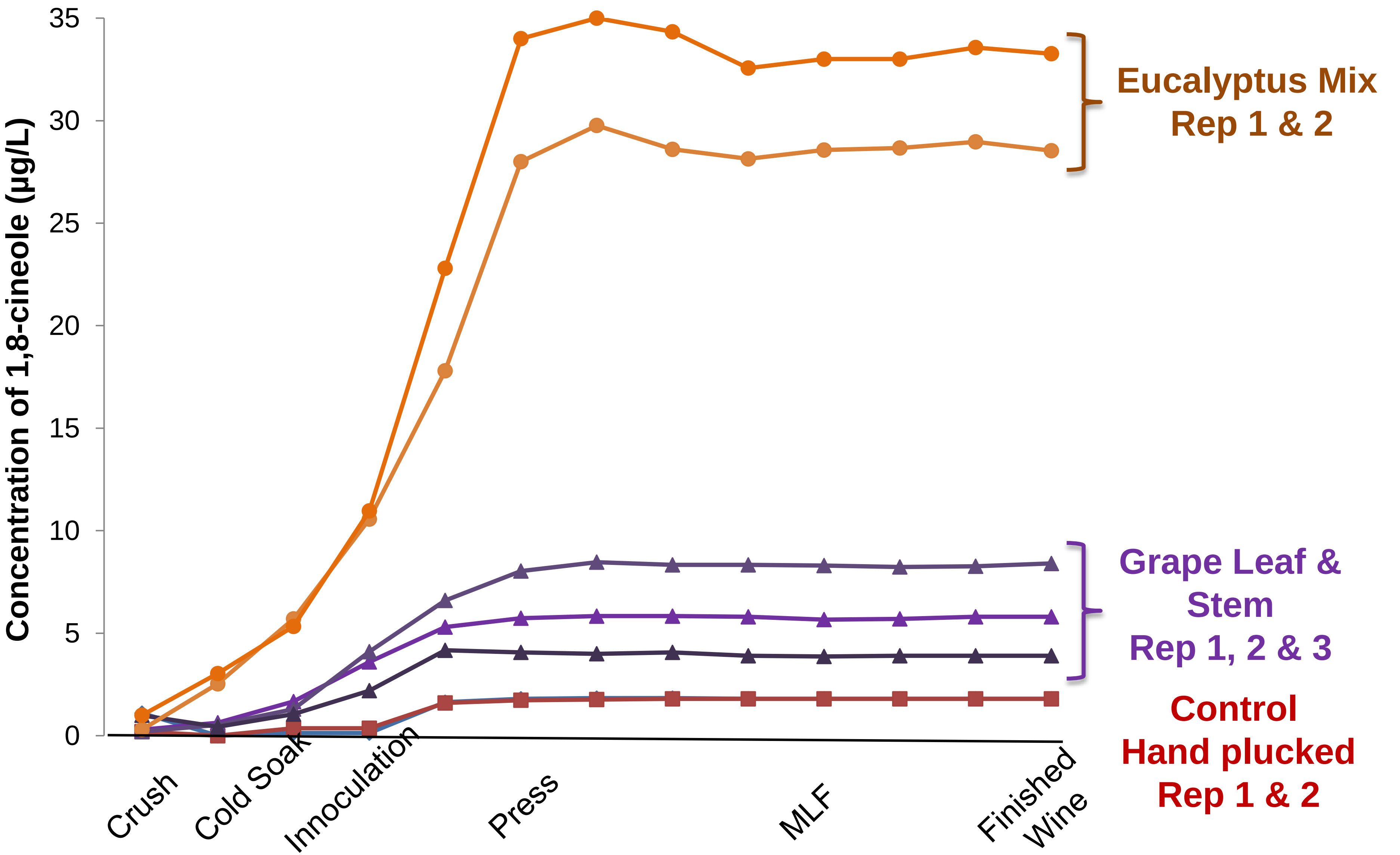

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33 *Eucalyptus* leaves found –

In 550 kg of hand picked fruit

Yet fruit is often harvested mechanically

Concentration of rotundone in ferment treatments

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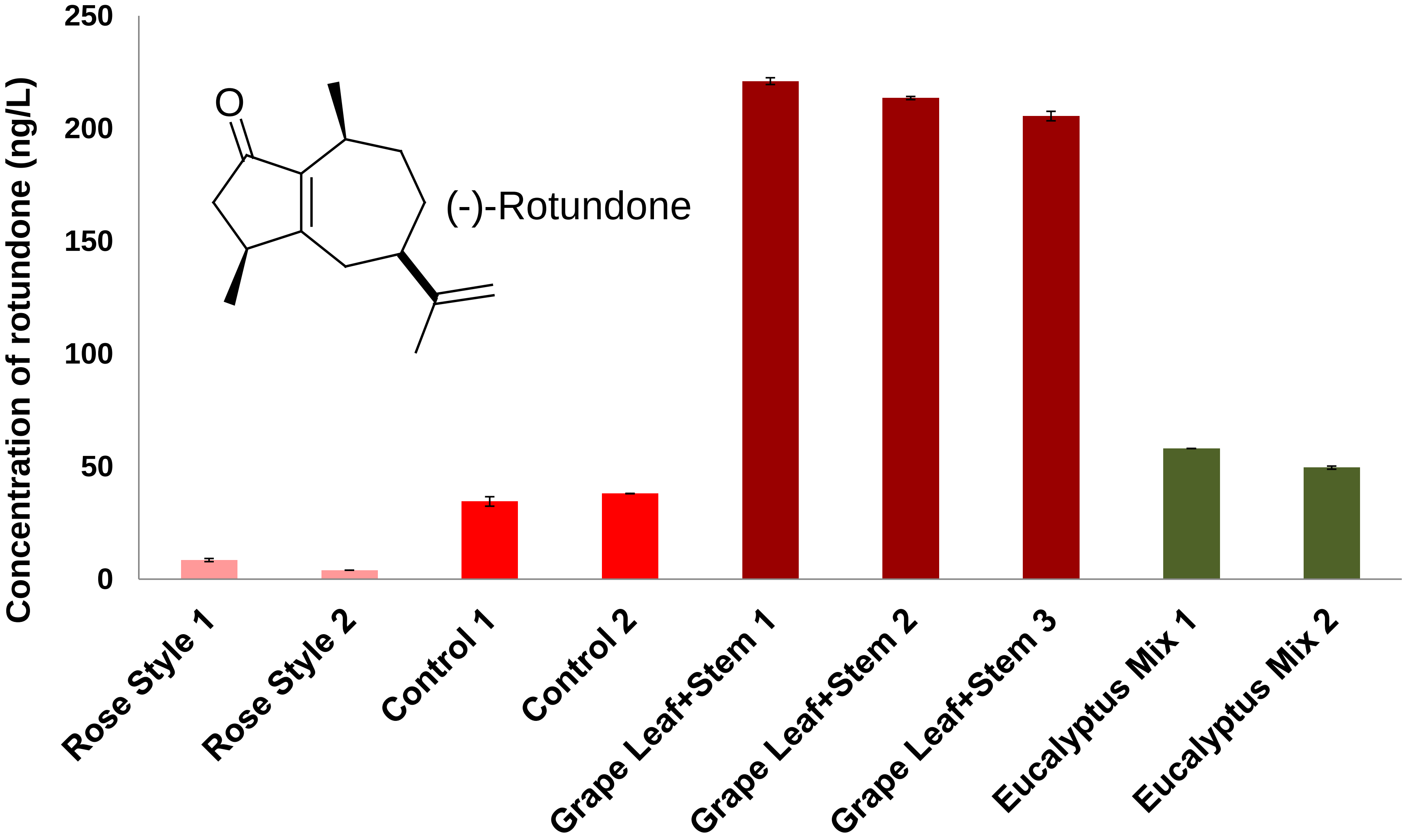

Concentration of rotundone in Grape Leaf and Grape Stem

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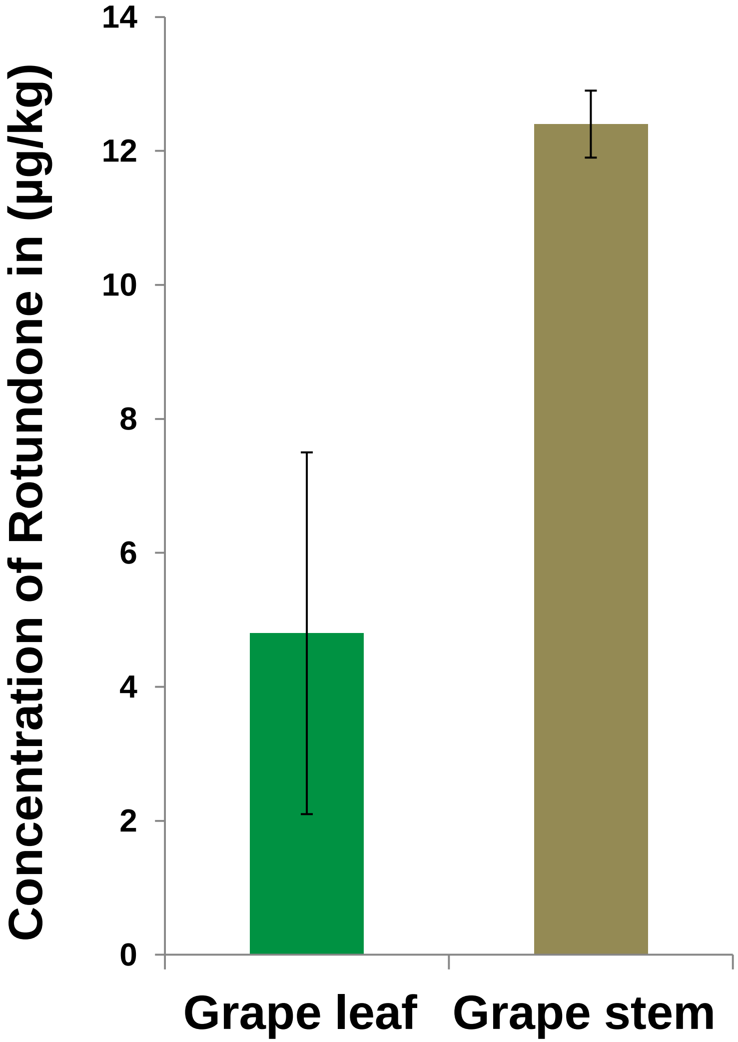


Leaf (100% Extraction) in 50 kg Ferment ≈ 85 ng/L

Stem with (100% Extraction) in 50 kg Ferment ≈ 500 ng/L

Leaf + Stem with 100% Extraction in 50 kg Ferment ≈ 585 ng/L

The presence of Grape Leaves & Stems

The Australian Wine Research Institute

- Not only impact 1,8-cineole levels: can also impact wine rotundone concentrations
- These can lead to altered wine sensory characteristics
- More to consider than grape berry composition alone when investigating wine aroma

Additional Experiments

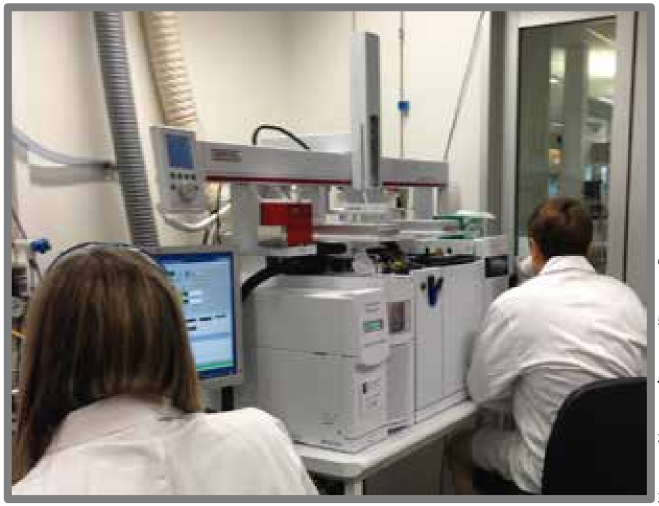
The Australian Wine Research Institute

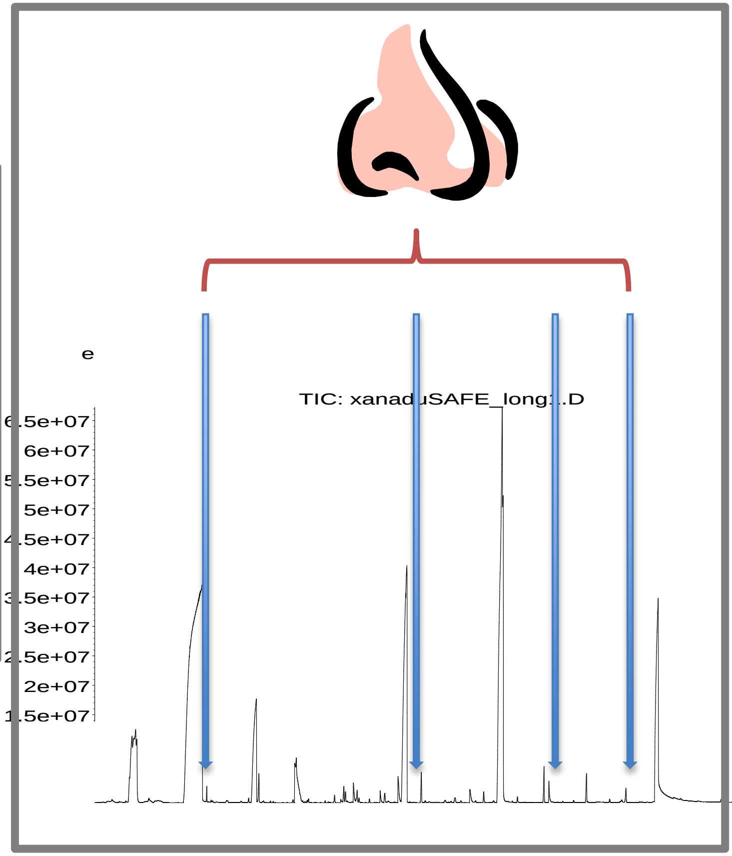
- Translocation is not occurring from the roots of the vine or the grape leaves to the grapes.
- 1,8-Cineole is extremely stable in wine
- Minimal scalping observed for natural cork or screw cap closures and a 14% reduction of 1,8-cineole under synthetic closure over a 12 month period

Additional Experiments

The Australian Wine Research Institute

Investigated whether other compound(s) contribute to 'minty' aroma in red wine or is it purely an effect of 1,8-cineole concentration ?





Conclusions

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- The greatest amount of 1,8-cineole in grapes, grape leaf and stem is found in the samples closest to the *Eucalyptus* trees
- The amount of 1,8-cineole increases during fermentation with skin contact
- The presence of *Eucalyptus* leaves, and to a lesser extent grape vine leaves and stems can be a major contributor to 1,8-cineole concentration in wine

Tips to modulate 1,8-cineole in wine

The Australian Wine Research Institute

- Keep fruit harvested close to trees separate from the rest and blend if desired

To decrease concentrations of 1,8-cineole if desired you could-

- Remove *Eucalyptus* leaves & twigs from canopy close to trees before machine-harvesting
- Eliminate other MOG (especially from rows close to trees) from ferments i.e. sorting fruit on a conveyer belt

Acknowledgements

The University of Adelaide Australia

The Australian Wine Research Institute

Dr Mark Sefton, Dr David Jeffery & Dr Leigh Francis

Industry partners – vineyard/ferment samples

Samantha Anderson, Katryna van Leeuwen & Natoiya Lloyd

Kevin Pardon & Dr Gordon Elsey

The Australian Wine Research Institute, a member of the Wine Innovation Cluster in Adelaide, is supported by Australia's grapegrowers and winemakers through their investment body, the Grape and Wine Research Development Corporation, with matching funds from the Australian Government.

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www.awri.com.au

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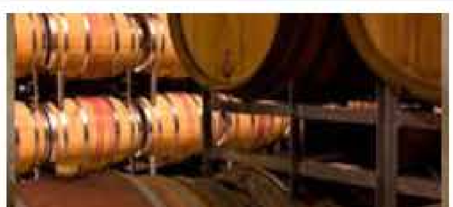

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New resources navigation

The Australian Wine Research Institute

Resources for vineyards

Information on agrochemicals and related analytical services, advice and support, fact sheets and more.

Resources for wineries

Includes permitted additives, winemaking calculators, laboratory setup and method, Frequently Asked Questions, and products and suppliers.

Resources for wine exporters

Information for exporters such as factsheets and publications, analytical services and more.

Resources for consumers

Factsheets and publications, library resources, links to other websites, research projects and wine and health

Sign up for new website account

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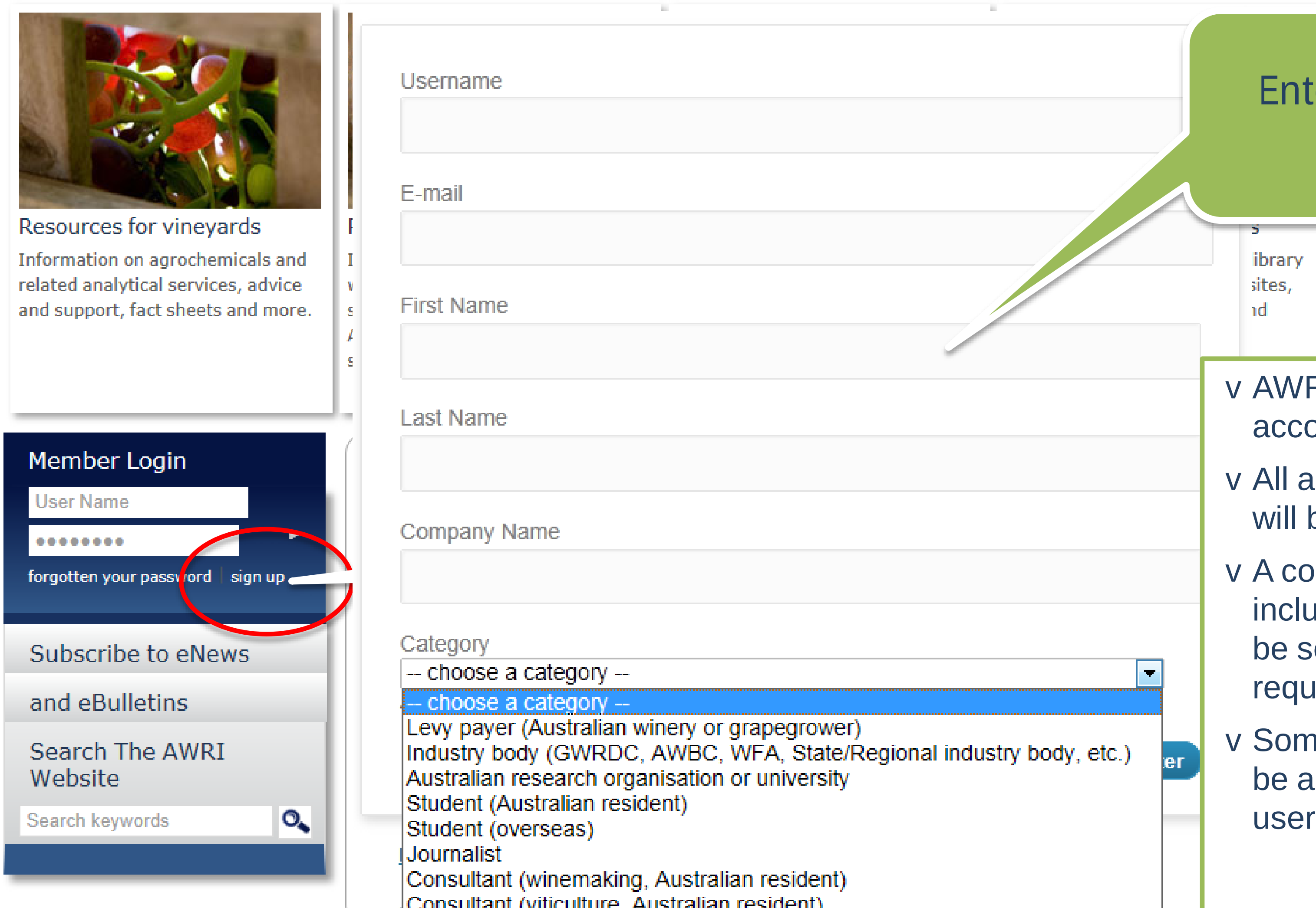

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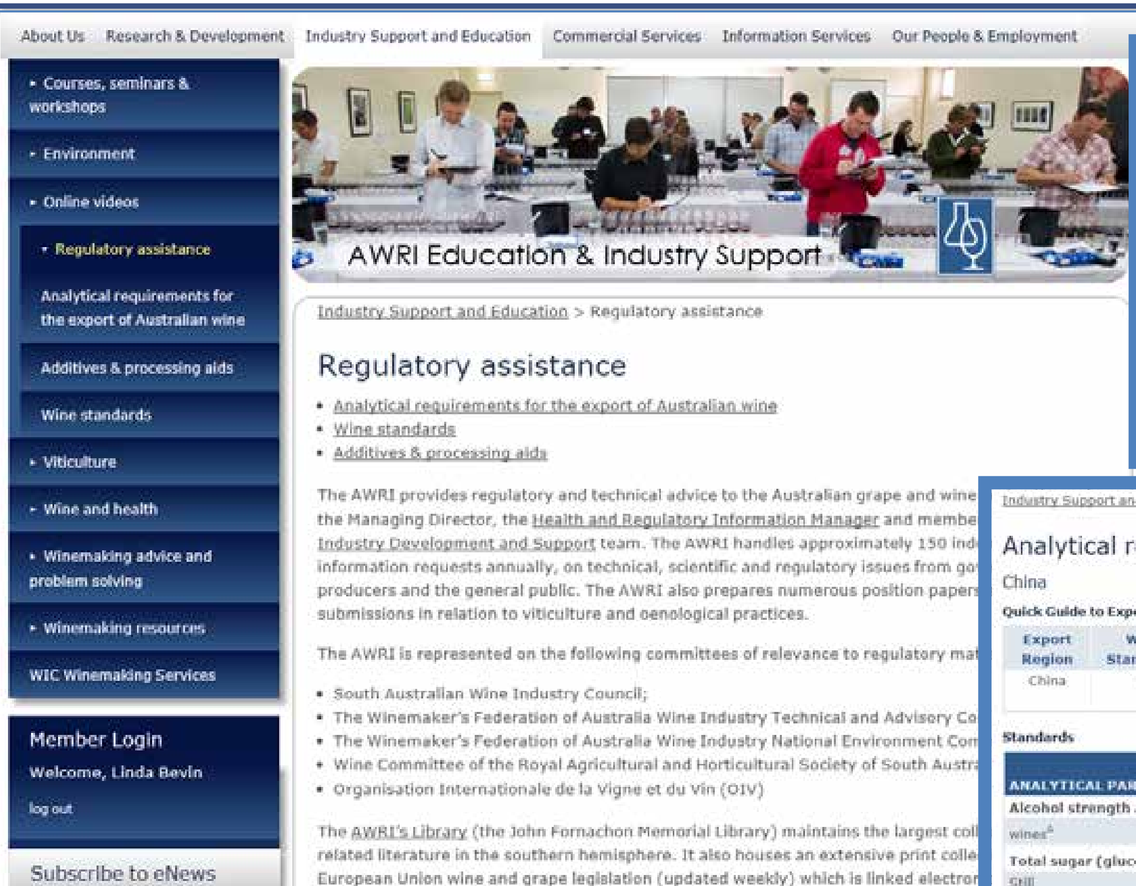

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Regulatory assistance

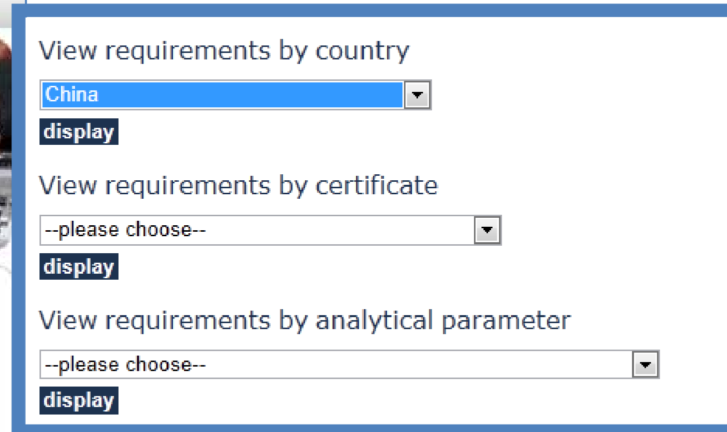
- Analytical requirements for the export of Australian wine
- Wine standards
- Additives & processing aids

The AWRI provides regulatory and technical advice to the Australian grape and wine the Managing Director, the Health and Regulatory Information Manager and membe Industry Development and Support team. The AWRI handles approximately 150 ind information requests annually, on technical, scientific and regulatory issues from go producers and the general public. The AWRI also prepares numerous position papers submissions in relation to viticulture and oenological practices.

The AWRI is represented on the following committees of relevance to regulatory mat

- South Australian Wine Industry Council;
- The Winemaker's Federation of Australia Wine Industry Technical and Advisory Co
- The Winemaker's Federation of Australia Wine Industry National Environment Com
- Wine Committee of the Royal Agricultural and Horticultural Society of South Austr
- Organisation Internationale de la Vigne et du Vin (OIV)

The AWRI's Library (the John Fornachon Memorial Library) maintains the largest coll related literature in the southern hemisphere. It also houses an extensive print colle European Union wine and grape legislation (updated weekly) which is linked electron



View requirements by country

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Industry Support and Education > Regulatory assistance > Analytical requirements for the export of Australian wine

Analytical requirements for the export of Australian wine

China

Quick Guide to Export Requirements

Export Region	Wine Standards	Minimum Specification	Maximum Specification	Continuing Approval Application	Certificate of Origin	Other Requirements
China	Y	Y	Y	Y	Y	Certificate of Free Sale

Standards

ANALYTICAL PARAMETER	SPECIFICATION MINIMUM	SPECIFICATION MAXIMUM
Alcohol strength at 20°C		
wines[A]	7.0 % v/v	–
Total sugar (glucose)*		
Still	–	–
Dry wines*	–	4.0 g/L
Semi-dry*	4.1 g/L	12.0 g/L
Semi-sweet	12.1 g/L	45.0 g/L
Sweet	45.1 g/L	–
Sparkling	–	–
Brut*	–	12.0 g/L
Extra-dry*	12.1 g/L	17.0 g/L
Dry	17.1 g/L	32.0 g/L
Semi-dry	32.1 g/L	50.0 g/L
Sweet	50.1 g/L	–
Dry extract		
White	16 g/L	–
Rosé	17 g/L	–

Searchable databases on permitted additives and processing aids, and export analytical requirements

Winemaking calculators

The Australian Wine Research Institute

- Acid addition
- Ascorbic acid addition
- Bentonite addition
- Carbon addition
- Copper sulfate addition
- Crème of Tartar addition
- Deacidification
- Diammonium phosphate additions
- Ferro Cyanide trial
- Fining trial
- Fortification
- Gelatine addition
- General conversion calculators
- Grape juice concentrate (GJC) addition using Pearson Square
- Hydrogen peroxide addition
- Interconversion of acidity units
  - Acetic acid
  - Citric acid
  - Lactic acid
  - Malic acid
  - Sulfuric acid
  - Tartaric acid
  - Tartaric acid (meq/L)
- Isinglass addition
- Laboratory stock solution
- Methanol expressed as proportion of ethanol calculator
- Micro-ox addition
- Molecular sulfur dioxide addition
- Number of standard drinks
- Paired preference
- PMS addition
- PVPP addition
- Same/Different
- Sensory difference test
  - Duo-trio
  - Paired comparison
  - Triangle
- Sorbic acid addition
- Sulfur dioxide addition
- Tannin addition
- Winery stock solution

Industry Support and Education > Winemaking resources > Winemaking calculators > Number of standard drinks

Number of standard drinks

Suggestions / questions / comments? email the calculator services staff

Approximate standard drinks		
Container volume	750	mL
Alcohol content	14.5	% v/v
Calculate number of standard drinks	8.6	standard drinks

Clear

Information Services

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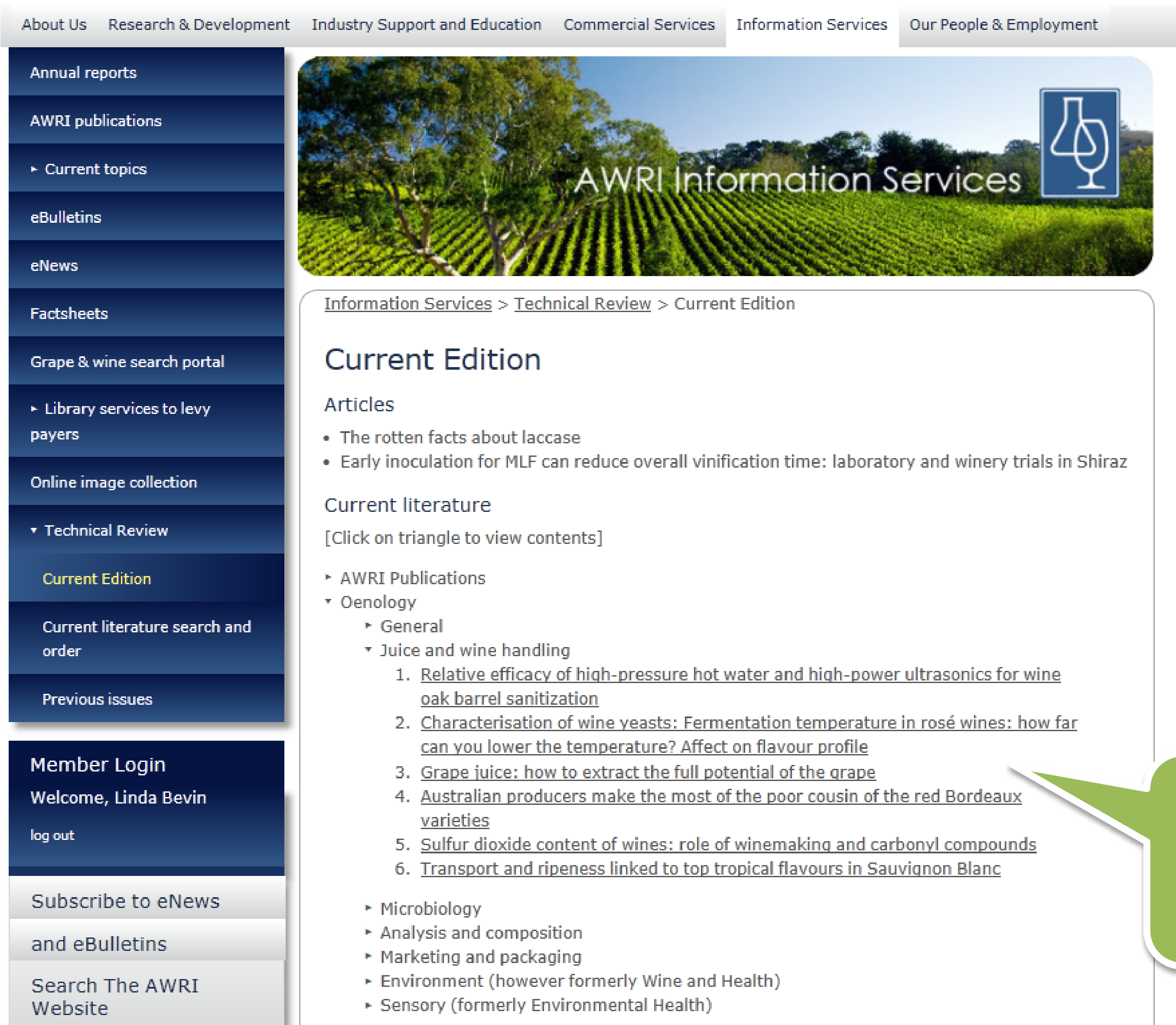

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Current Edition

Articles

- The rotten facts about laccase
- Early inoculation for MLF can reduce overall vinification time: laboratory and winery trials in Shiraz

Current literature

[Click on triangle to view contents]

- ▸ AWRI Publications
- ▾ Oenology
  - ▸ General
  - ▾ Juice and wine handling
    1. Relative efficacy of high-pressure hot water and high-power ultrasonics for wine oak barrel sanitization
    2. Characterisation of wine yeasts: Fermentation temperature in rosé wines: how far can you lower the temperature? Affect on flavour profile
    3. Grape juice: how to extract the full potential of the grape
    4. Australian producers make the most of the poor cousin of the red Bordeaux varieties
    5. Sulfur dioxide content of wines: role of winemaking and carbonyl compounds
    6. Transport and ripeness linked to top tropical flavours in Sauvignon Blanc
  - ▸ Microbiology
  - ▸ Analysis and composition
  - ▸ Marketing and packaging
  - ▸ Environment (however formerly Wine and Health)
  - ▸ Sensory (formerly Environmental Health)

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Click on article name to view more information and to order a copy of the article

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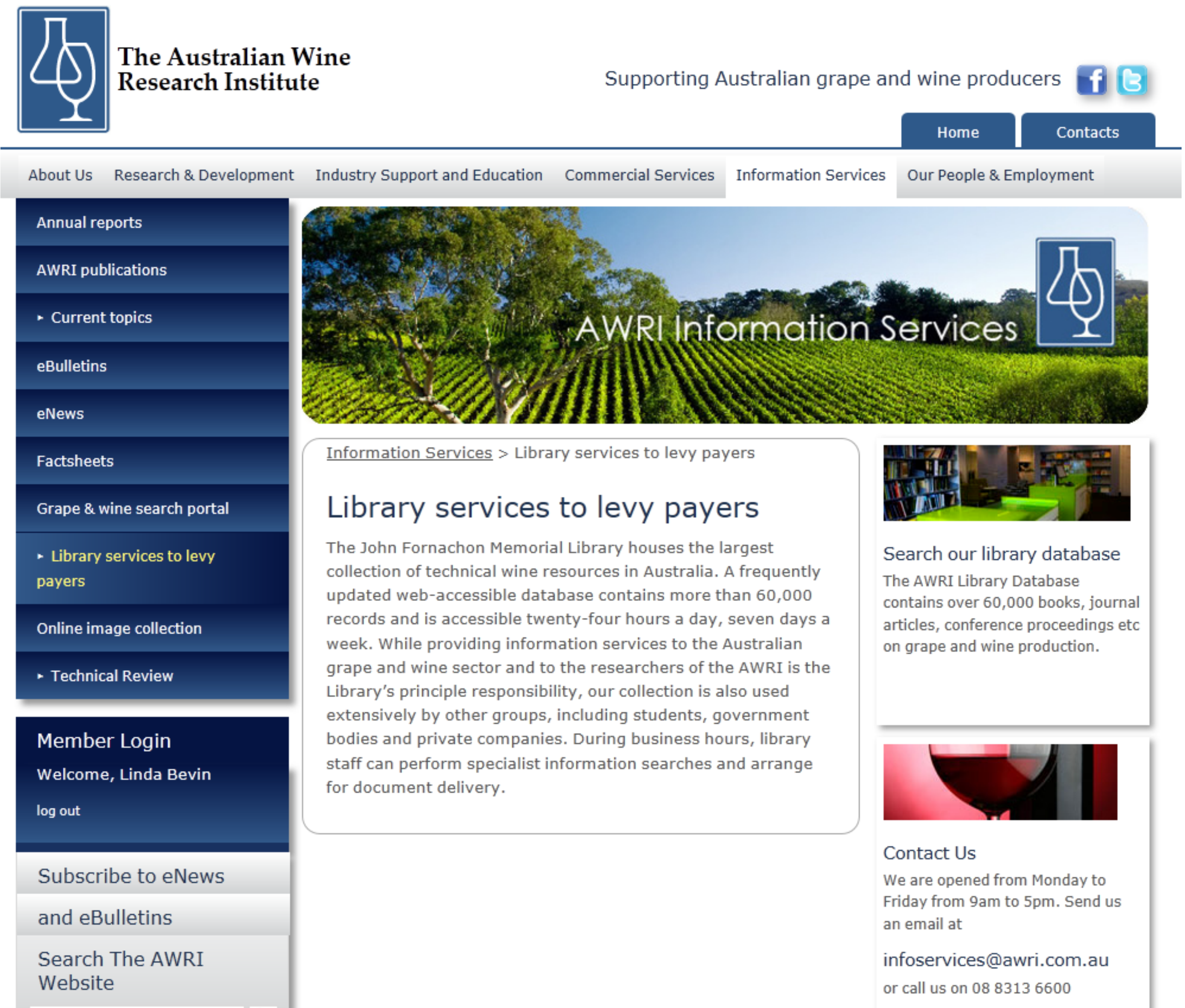


- Free library service to Australian grape and wine producers
- Over 65,000 books, journal articles, conference proceedings etc
- Online library database
- *Fast response time (1 to 3 days)*

Mobile website

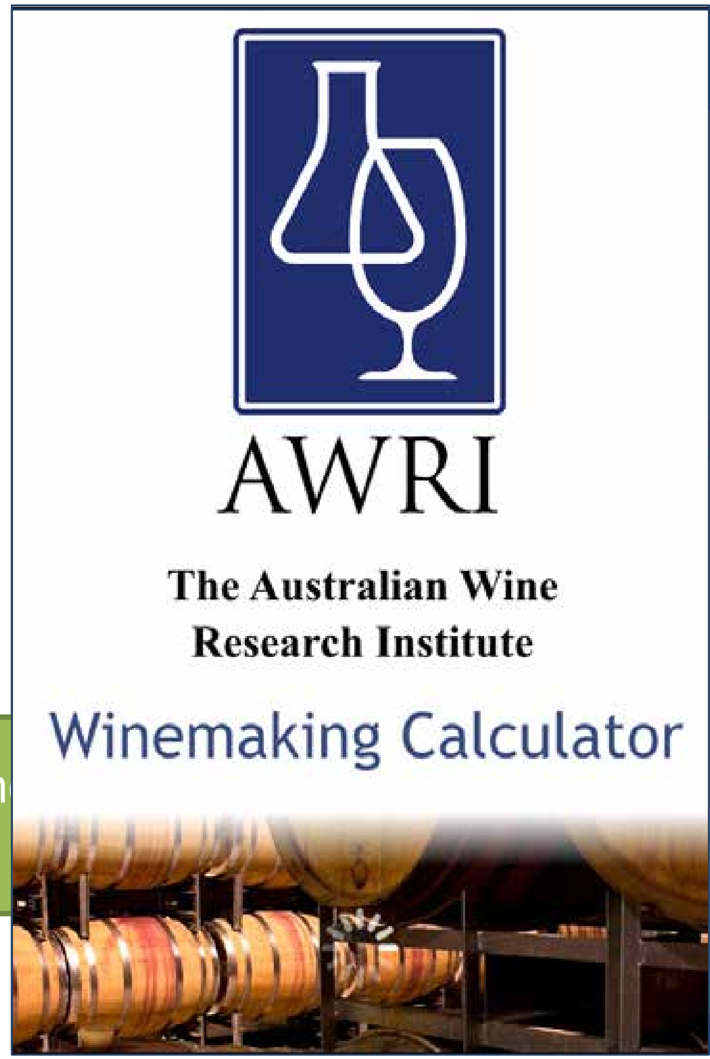
The Australian Wine Research Institute

Mobile-friendly website launched in October 2012.

Provides content to key projects and services offered by the AWRI.

Linked to full website for detailed information.

Winemaking calculator app



Calculators grouped for easy access

Enter the search an
select 'Calculate'

http://www.awri.com.au/industry_support/winemaking_resources/winemaking-calculators-app/

Webinars

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2013 webinar program

Presentation	Description	Presenter	Date	Register
Optimising your laboratory for the best results	Laboratories are a critical, and often expensive, part of modern wine production. This webinar will highlight a number of areas that are important to not only ensure results are accurate, but to achieve them in an efficient and cost effective manner. Some of the topics that will be discussed include basic lab quality systems; LIMS; lab design; lean systems and troubleshooting common laboratory issues.	Eric Wilkes (The AWRI)	23/07/2013	Register
Strategies for reducing alcohol levels in wine	The AWRI has taken a holistic approach to the development of strategies for the reduction of alcohol concentration in wine. Several viticultural and fermentation practices show considerable promise for the production of good quality reduced-alcohol wines. This session will present our latest findings and point to the need to evaluate a combinatorial approach to reducing alcohol concentration in wine.	Cristian Varela (The AWRI)	30/07/2013	Register
The latest on CMCs	Carboxymethylcellulose is becoming an important part of the winemaker's tool box for white wine tartrate stabilisation. However, like all wine additives, there is more to the successful use of CMCs than sales brochures might suggest. This webinar will look at how CMC works; when it is appropriate to use; what precautions you need to take and the best ways to test the wine when using it.	Eric Wilkes (The AWRI)	6/08/2013	Register
Till death do us part: Cell death in the grape berry as a quality measure	TBA	Steve Tyerman (The University of Adelaide)	20/08/2013	Register
Climate influence and trends for the wine industry	TBA	Darren Ray (Bureau of Meteorology)	27/08/2013	Register

http://www.grapeandwineevents.com.au/home

The Australian Wine Research Institute

australian grape & wine events calendar

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Date	Event
14 May 2013	AWRI Hunter Valley Seminar *Mercure Resort Hunter Valley, Pokolbin NSW*
14 May 2013	New Technologies in Grapegrowing and Winemaking *Treasury Wine Estates vineyards, Padthaway SA*
15 May 2013	AWRI Barossa Adapting to difficult vintages workshop *Vine Inn, Nuriootpa SA*
21 May 2013	AWRI Clare Adapting to difficult vintages workshop *The Artisan Table, Clare SA*
21 May 2013	AWRI Langhorne Creek and Adelaide Hills Seminar *Langhorne Creek Football Clubrooms, Langhorne Creek SA*
22 May 2013	Regional Smoke Taint Update *Gum San Chinese Heritage Centre, Ararat VIC*
23 May 2013	GWRDC #INseries workshop - China Insights: McLaren Vale
23 May 2013	Regional Smoke Taint Update *Yarra Glen Memorial Hall, Yarra Glen VIC*
24 May 2013	GWRDC #INseries workshop - China Insights: Barossa
24 May 2013	Regional Smoke Taint Update *Oxley Shire Hall, Oxley VIC*
27 May 2013	GWRDC #INseries workshop - China Insights: Hunter Valley
28 May 2013	GWRDC #INseries workshop - China Insights: Yarra Valley
30 May 2013	GWRDC #INseries workshop - China Insights: Margaret River
30 May 2013	Margaret River Wine in Sydney *The Barnet Long Room, Customs House, Circular Quay NSW*

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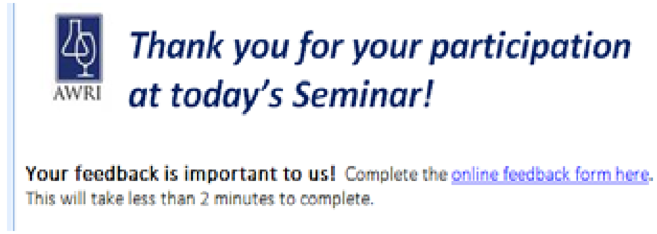

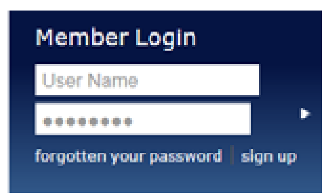

Instructions will be emailed after today's seminar

Thank you for your participation today!