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## Managing seasonal heatwave events

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Australian Wine Research Institute

## What is a heat wave?



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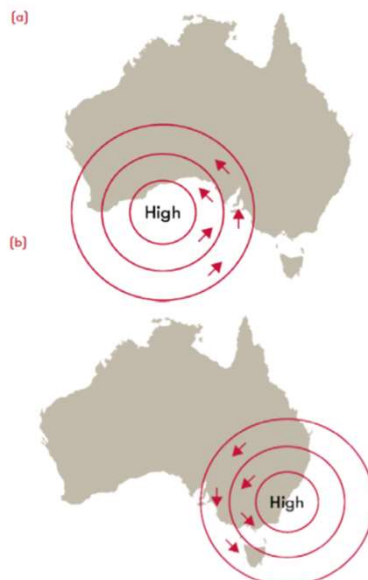
- ❖ Prolonged period of hot weather
- ❖ Three or more days of unusually high maximum and minimum temperatures in any area
  - BoM definition
- ❖ A 30°C day isn't unusual for Renmark but is hot for Hobart

## What causes a heat wave?



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- ❖ High pressure systems move from West to East during summer
- ❖ Heat waves associated with wind bringing heat from the interior
- ❖ High pressure system is 'blocked' in the Tasman sea
- ❖ Sustained period of hot weather

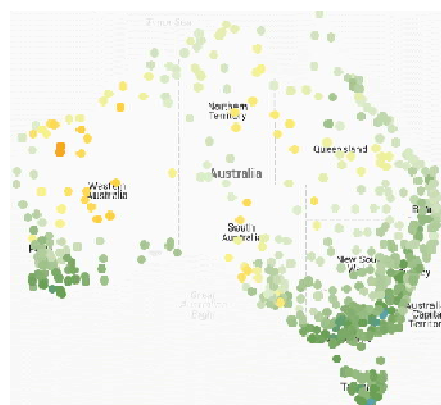


## Forecasting heatwaves



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- ❖ Process well understood
- ❖ Critical to many areas not just viticulture
  - health care
  - transport
  - emergency services
  - energy
- ❖ BoM Heatwave service
  - Next 7 days
  - Start of November and the end of March
  - <http://www.bom.gov.au/australia/heatwave/>



Calculated across current and two following days, BoM

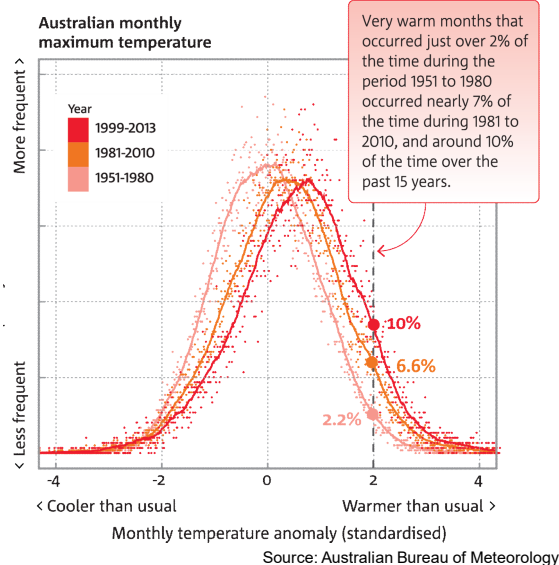
Warmer colours of orange and red to indicate rising severity

## Are heat waves becoming more frequent?



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- ❖ Average temperatures are increasing
- ❖ Larger effect at the tails of the distribution
- ❖ Impacts on extreme events such as heatwaves
- ❖ Our perceptions can also change

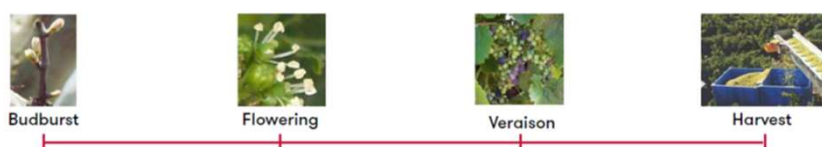


## What damage can occur in the vineyard?



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- ❖ Depends on the stage of the season



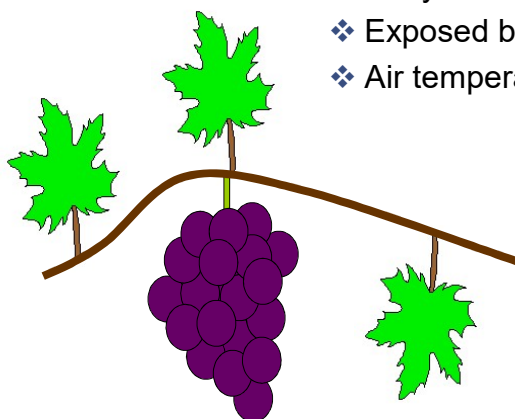
- ❖ Flowers highly susceptible to heat wind and water stress
  - Yield loss
- ❖ Bunches are more susceptible from veraison
  - Dark colour grapes get hotter
  - Sunburn and shrivel

## How do bunches get hot?



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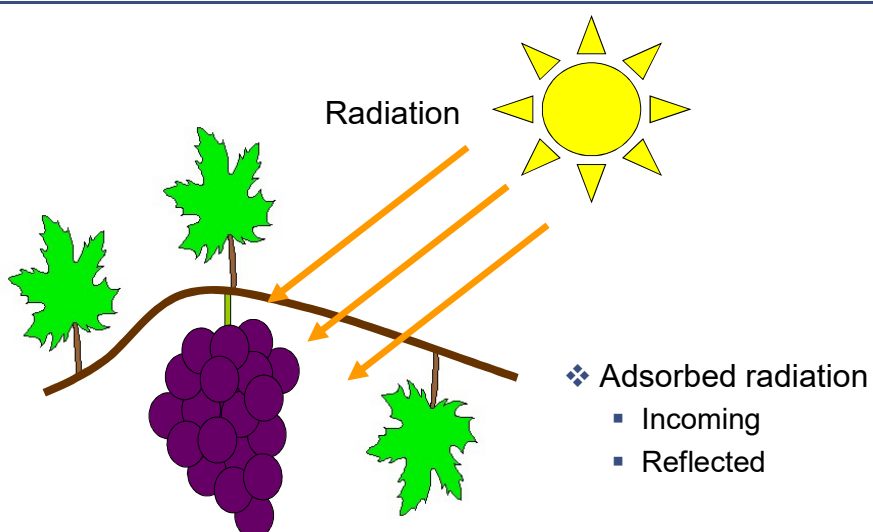
- ❖ Hot day
- ❖ Early afternoon
- ❖ Exposed bunch
- ❖ Air temperature 35°C



## How do bunches get hot?



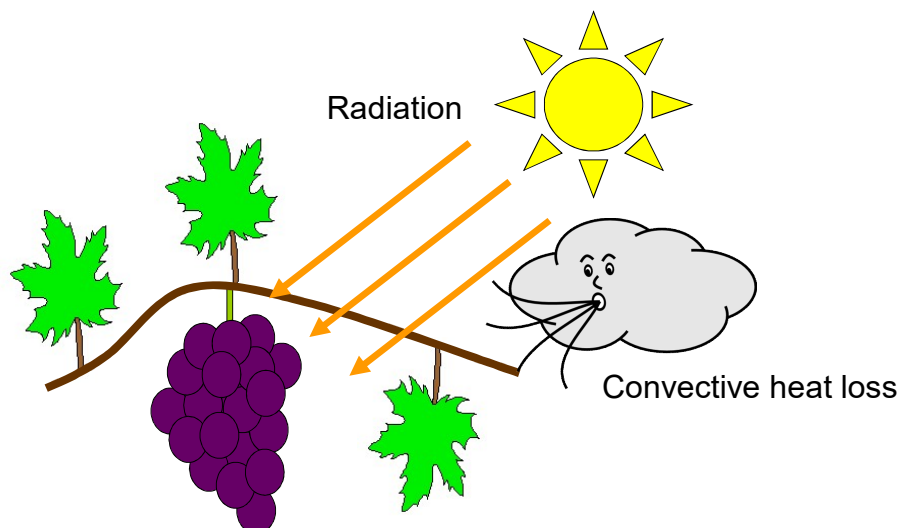
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## How do bunches get hot?



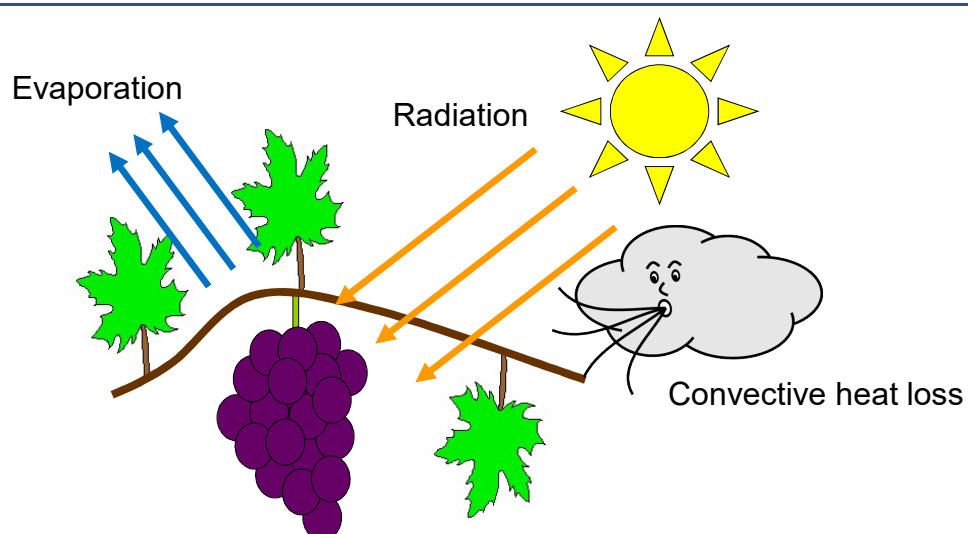
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## How do bunches get hot?



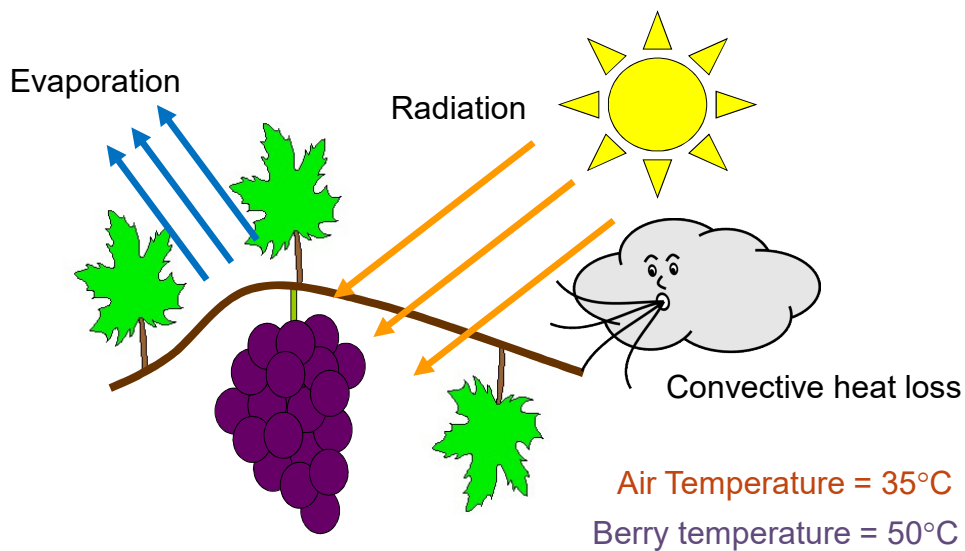
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## How do bunches get hot?



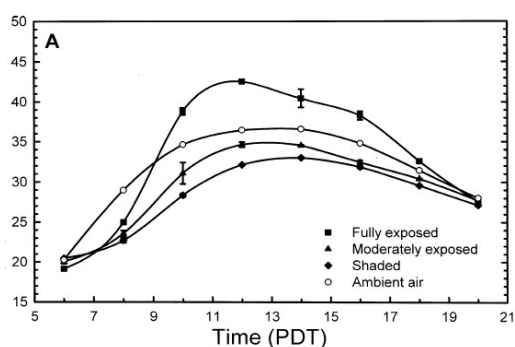
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## How do bunches get hot?



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(Bergqvist et al 2001)

- ❖ Impact of bunch exposure on berry temperature
- ❖ Exposed berries over 43°C
- ❖ Ambient air approximately 37°C

## How do bunches get hot?



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- ❖ Vine water status
- ❖ Radiation load
- ❖ Wind velocity
- ❖ Degree of exposure
- ❖ Berry/bunch size and compactness
- ❖ Berry colour
  - Darker is hotter



Composite thermal image of grape bunch  
(Moffat 2013)

## Effects of bunch overexposure



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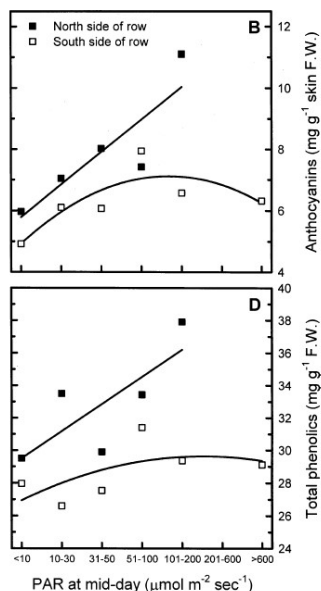
- ❖ Physical damage
- ❖ Sunburn browning = skin injury
- ❖ Increased bitterness
- ❖ Invasion by secondary bunch rots



## Effects of bunch overexposure



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- ❖ 'Chemical' damage
- ❖ Absence of physical symptoms
- ❖ Reduced colour in reds
- ❖ Cabernet Sauvignon in California
  - South side of the row afternoon sun (hotter)
  - Bunches that receive similar amount of light
  - More anthocyanins and phenolics on the morning exposed side

(Bergqvist et al 2001)

## Management strategies to protect bunches



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- ❖ Reduce bunch exposure



- ❖ Increase cooling





## Managing exposure



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### Established Vineyards

- ❖ Canopy management
- ❖ Artificial shading
- ❖ Chemical sprays
- ❖ Vineyard floor management
- ❖ Increased shoot growth
  - Pruning, nutrition, irrigation

### New Vineyards

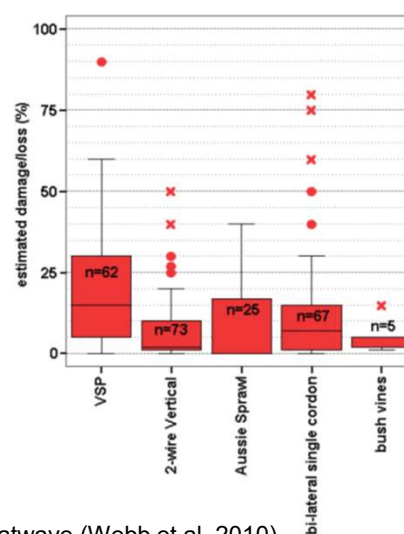
- ❖ Row orientation
- ❖ Increased shoot growth
  - Rootstocks

## Managing exposure



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- ❖ Training systems
- ❖ Sprawling, non-positioned canopies reduce heat damage
- ❖ VSP trellis result in higher heat damage

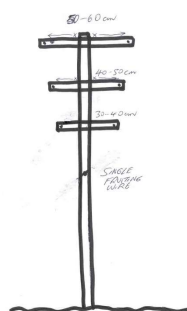


Grower survey post 2009 summer heatwave (Webb et al. 2010)

## Managing exposure



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V-VSP trellis  
(Rahn 2007)



- ❖ VSP has other benefits
  - Disease management
- ❖ Shoots sprawl from top of VSP for shade
- ❖ Popular in Napa

## Managing exposure



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*Full lift on both W and  
E sides of N-S row*

*Foliage wire lift to first  
position only on W side:  
both wires lifted on E side*



## Managing exposure



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- ❖ Leaf removal
- ❖ Try and avoid
- ❖ Only on E side of N-S rows

W side

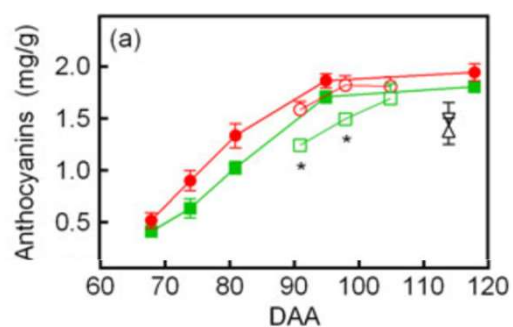


## Artificial shading



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- ❖ Trailed in Shiraz in McLaren Vale and at the Waite
- ❖ Small reduction in Baume
  - Less shrivel
- ❖ Minimal impact on wine quality



Red – Control, Green – Shaded (Carava et al 2016)



Tablegrape vineyard near Mildura

## Anti-transpirants



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- ❖ Anti-transpirants work by either
  - ❖ Block stomata with a film (typically wax)
- or
- ❖ Causing stomata to close (e.g. abscisic acid).
- ❖ Reduce water loss by vine
- ❖ Specific applications
  - Planting potted vines
- ❖ Transpiration critical for cooling
- ❖ Reduce photosynthesis
- ❖ Confirm with winery



## Particle films



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- ❖ Spray on products
- ❖ Light/UV reflecting particles
  - kaolin clays
  - Calcium carbonate crystals
- ❖ Reduce radiative heating of plant tissues
- ❖ Don't directly effect transpirational cooling or photosynthesis

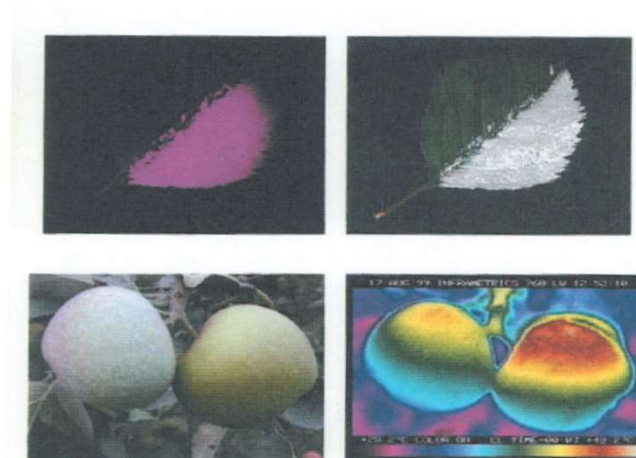


## Particle films



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- ❖ Can reduce tissue temperature
- ❖ Used for dessert fruit
  - Less sunburn
- ❖ Less conclusive on wine quality



## Vineyard floor management



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- ❖ Bare soil radiates more heat
- ❖ Increases heat damage



Permanent sward

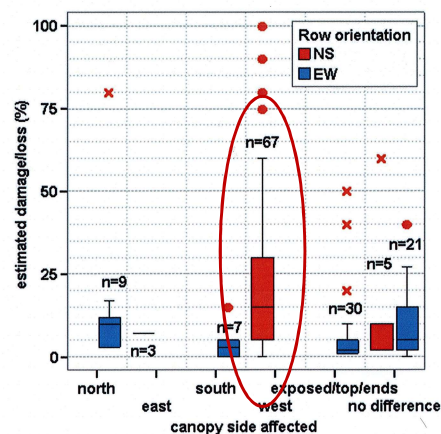


## Row orientation



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- ❖ Most bunch damage on N-S rows, particularly with VSP
- ❖ In the same cool climate vineyard
  - 40% bunch damage on N-S rows
  - 10% bunch damage on E-W rows

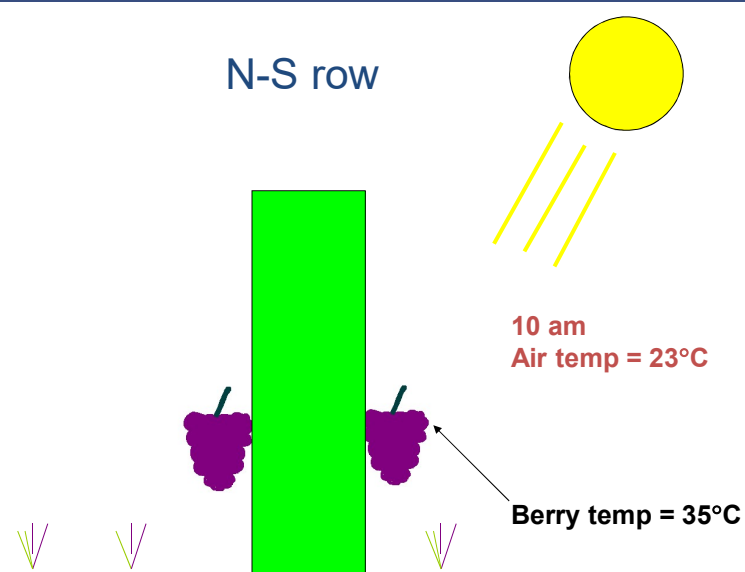


Grower survey post 2009 summer heatwave (Webb et al. 2010)

## Row orientation



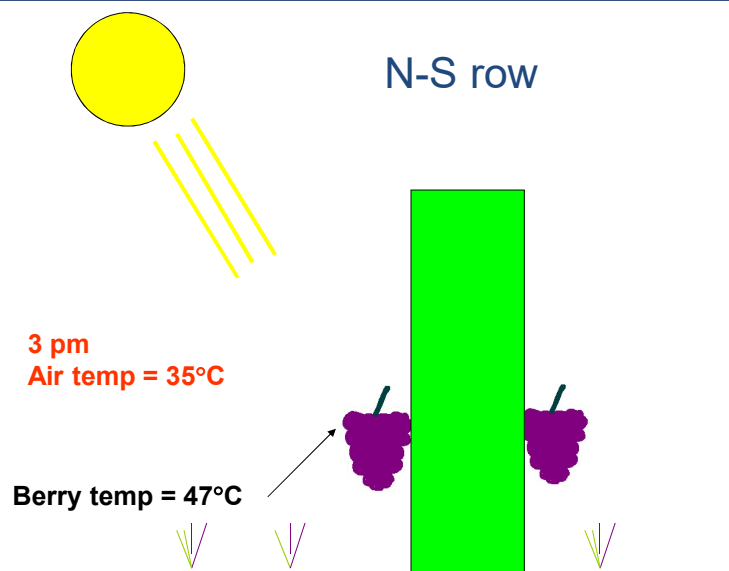
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## Row orientation



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## Row orientation



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- ❖ Fruit on Western side gets hotter than Eastern side
- ❖ Most exposed during hottest part of day
- ❖ Row orientation can be altered to provide protection
- ❖ Consider **E-W or NW-SE\*** row orientation for VSP

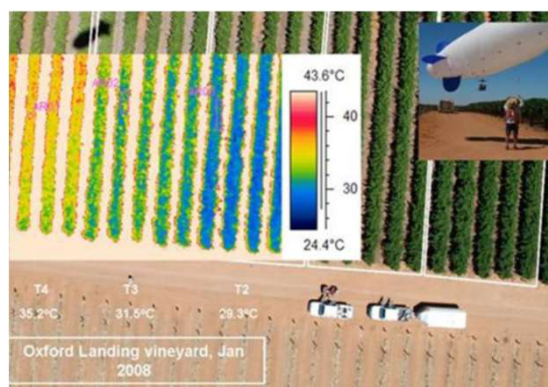


## Increase cooling



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- ❖ Irrigation affects the vineyard microclimate
- ❖ Transpirational cooling is critical
- ❖ Active transpiration must occur prior to heat event



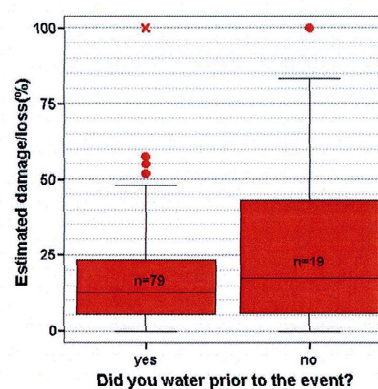
(Loveys 2008)

## Increase cooling



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- ❖ Damage occurs where water is limited prior to heatwaves
- ❖ Drought or 'severe' deficit irrigation
- ❖ Extra irrigation when heatwave is forecast
- ❖ Need good water supply and appropriate infrastructure



Grower survey post 2009 summer heatwave (Webb et al. 2010)



## Vine Water Stress App



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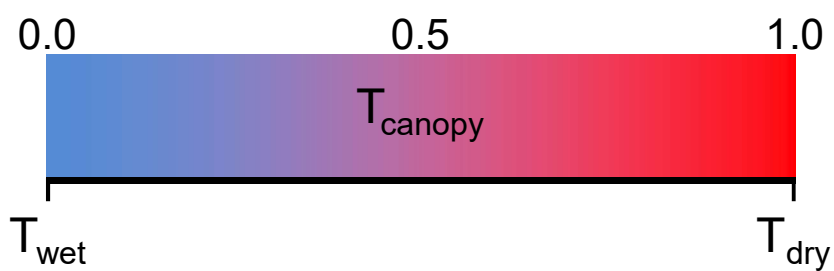


## Crop Water Stress Index



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$$CWSI = \frac{T_{canopy} - T_{wet}}{T_{dry} - T_{wet}}$$



## Wet Leaf Temperature



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## Dry Leaf Temperature



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## Artificial Reference Leaves



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## Vine Water Stress App



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## Vine Water Stress App



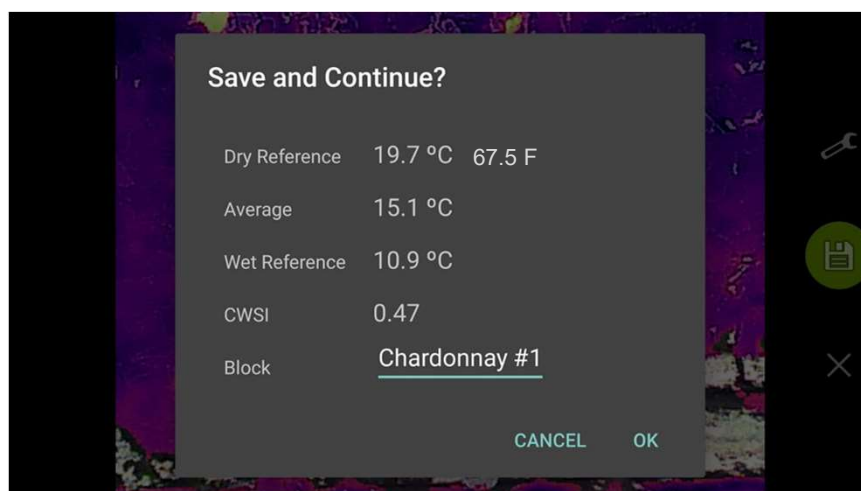
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## Vine Water Stress App



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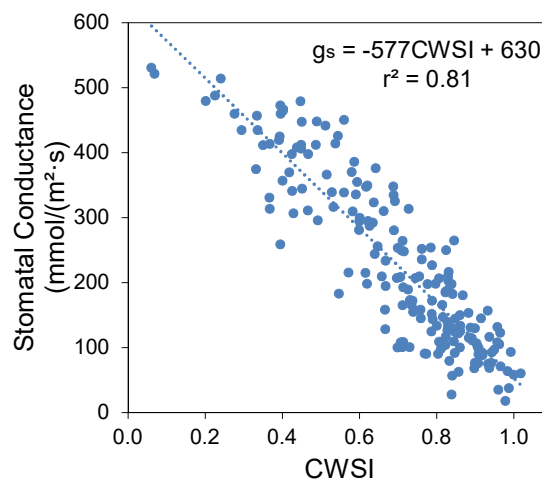






## Accuracy

- Cabernet Sauvignon
  - 1, 0.75, 0.5 & 0.25 Et
- Chardonnay
  - + and - irrigation
- 31 sample days
- 2 days excluded
  - Windy
  - Light rain



## Further reading



- ❖ AWRI information pack
- ❖ [https://www.awri.com.au/information\\_services/information-packs/heatwave-management/](https://www.awri.com.au/information_services/information-packs/heatwave-management/)

[illegible]