



# Viticulture & Enology Program

WASHINGTON STATE UNIVERSITY  
Text Box 1

## **Isohydric and anisohydric winegrape varieties and stomatal response to water availability**

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# Introduction

## A mild to moderate soil water stress is desirable for wine production:

- ✓ The decrease in leaf water potential  $\Psi$  allows for canopy reduction through cell elongation inhibition
- ✓ A beneficial reduction in stomatal conductance (gs) leading to an increase in the vine water use efficiency

## General guidelines:

- ✓ Mild water stress is usually accompanied by a drop of several bars from well-watered conditions
- ✓ Moderate water stress by a drop of more than several bars but less than 12 Bars (or 1.2 MPa) from well-watered conditions



For example: Well-watered conditions  $\Psi_{\text{midday}} = -0.6$  MPa. A good target would be between  $-1.1$  to  $-1.6$  MPa (!!!)

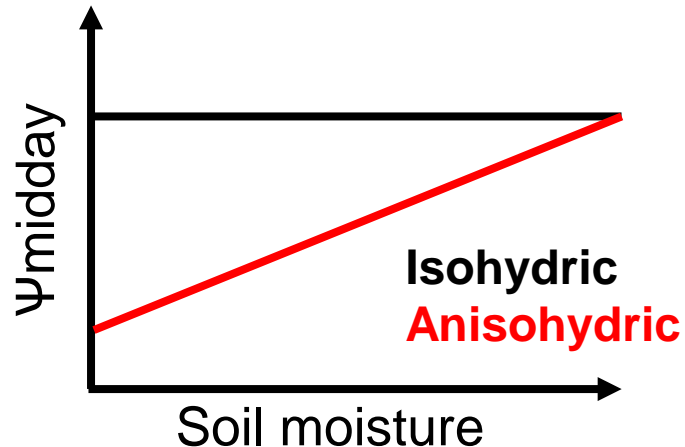
- ✓ Shoot elongation decreases linearly with declining  $\Psi$  and stops completely at  $\Psi = -1.2$  MPa

# Varietal differences

So far 2 main categories of response to water stress have been characterized:  
ISOHYDRIC and ANISOHYDRIC

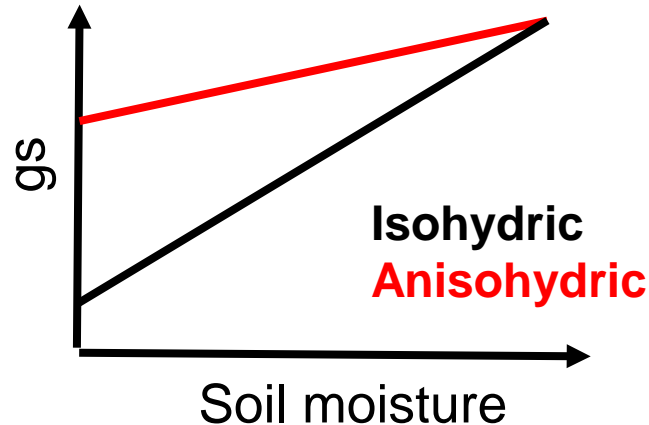
## ISOHYDRIC

- ✓  $\Psi_{\text{midday}}$  is the same in stressed plants and in well-watered plants
- ✓ Stomata sensitive to soil moisture drop and  $g_s$  drops early
- ✓ Risk of photosynthesis inhibition
- ✓ Model variety: Grenache



## ANISOHYDRIC

- ✓  $\Psi_{\text{midday}}$  is lower in stressed plants than in well-watered plants
- ✓ Stomata less sensitive to soil moisture drop and  $g_s$  remains high
- ✓ Lower risk of photosynthesis inhibition
- ✓ Model variety: Syrah



## **Hypothesis**

Instead of 2 extremes, there is a continuum of responses to water availability within *Vitis vinifera*.

More categories can arise showing groups of varieties that can be managed differently in the same vineyard

## **Objectives**

To compare 18 different varieties grown under the same conditions in Eastern Washington State and depict different pattern of responses over a full range of soil moisture such as  $\Psi_{\text{midday}}$  pattern

## **Materials and Methods**

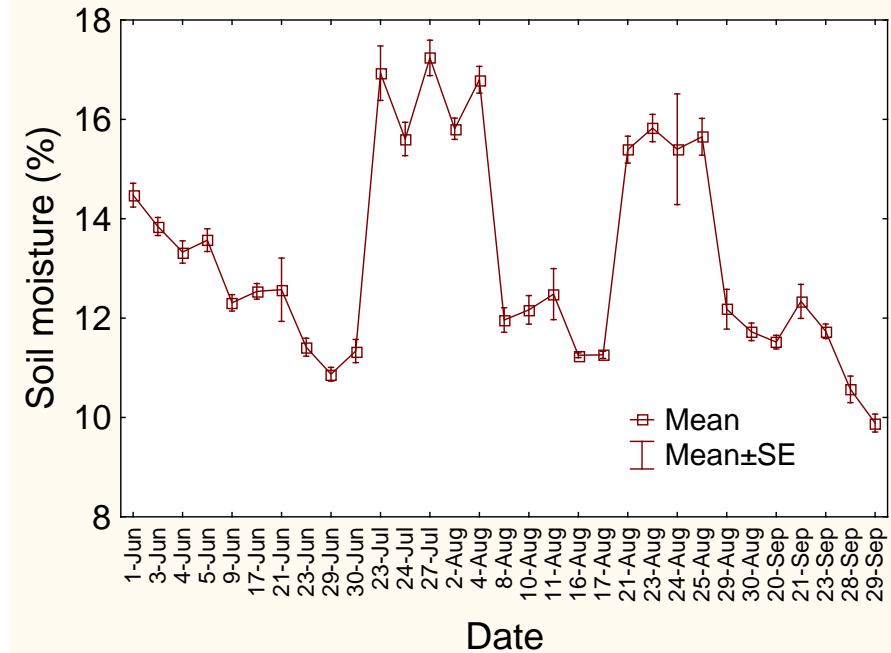
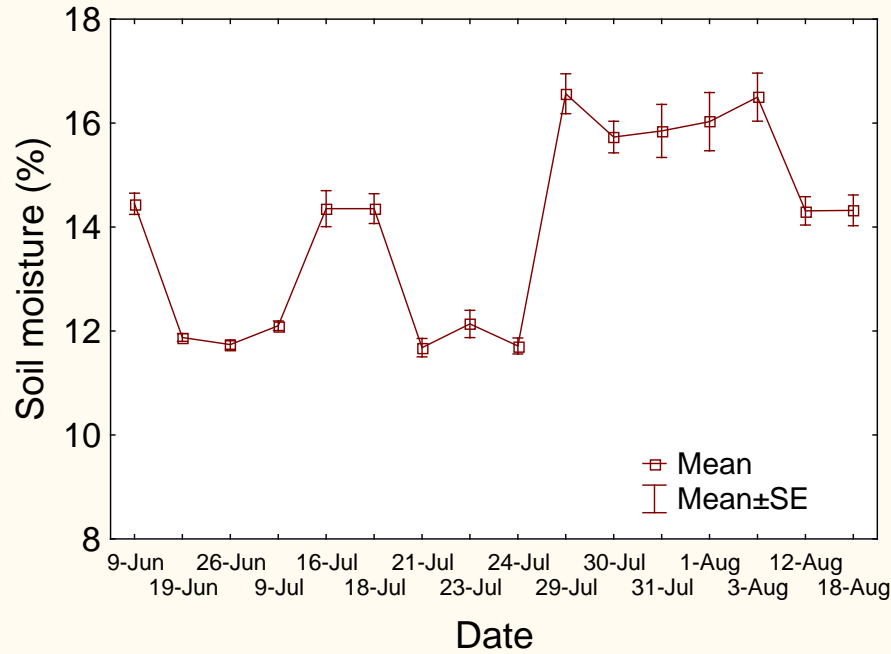
Dry down/recovery cycles for 2015, 2016 2017 at the ROZA experimental vineyard

Measurement of  $\Psi_{\text{midday}}$  (Pressure chamber) and stomatal conductance (Porometer)

Measurement of soil moisture (Neutron probe) for each replicate



## 18 varieties studied at the ROZA vineyard



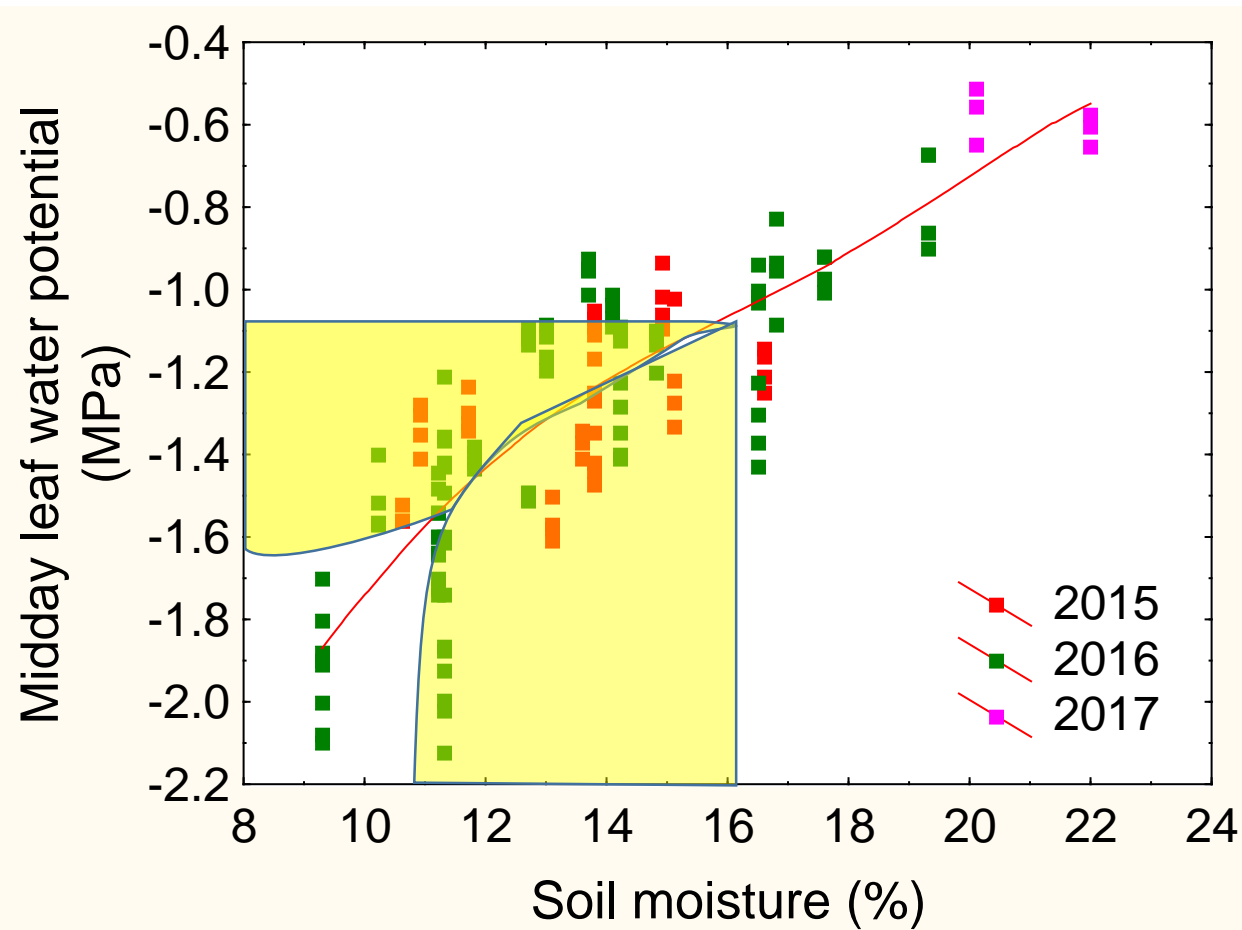
**Soil moisture evolution 2015 (Top)  
and 2016 (Bottom)**

Red varieties	White varieties
Cabernet Sauvignon	Chardonnay
Merlot	Riesling
Grenache	Semillon
Cabernet franc	Pinot Gris
Petit verdot	Auxerrois
Nebbiolo	Muscat Blanc
Lemberger	Sauvignon blanc
Pinot noir	Gewurztraminer
Malbec	Albarino

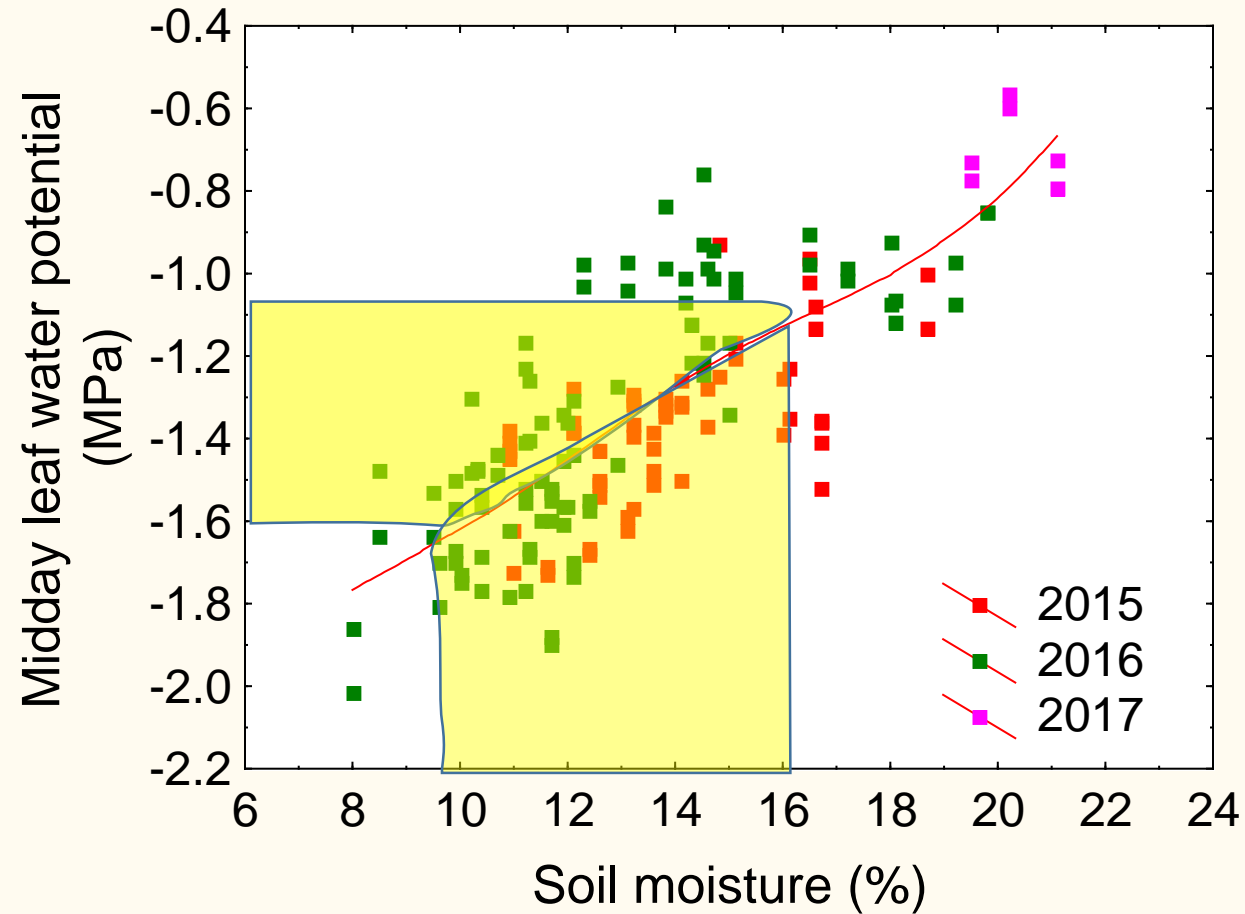
# Results

3 categories of  $\Psi_{\text{midday}}$  behavior to water availability have been depicted

## Category 1: Linear drop or near-anisohydric varieties



**Semillon**

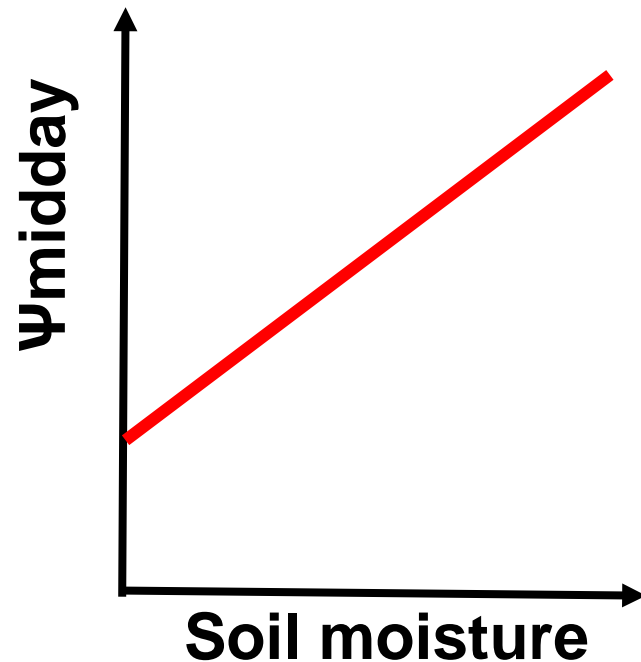


**Cabernet franc**

✓  $\Psi_{\text{midday}}$  drops to low levels

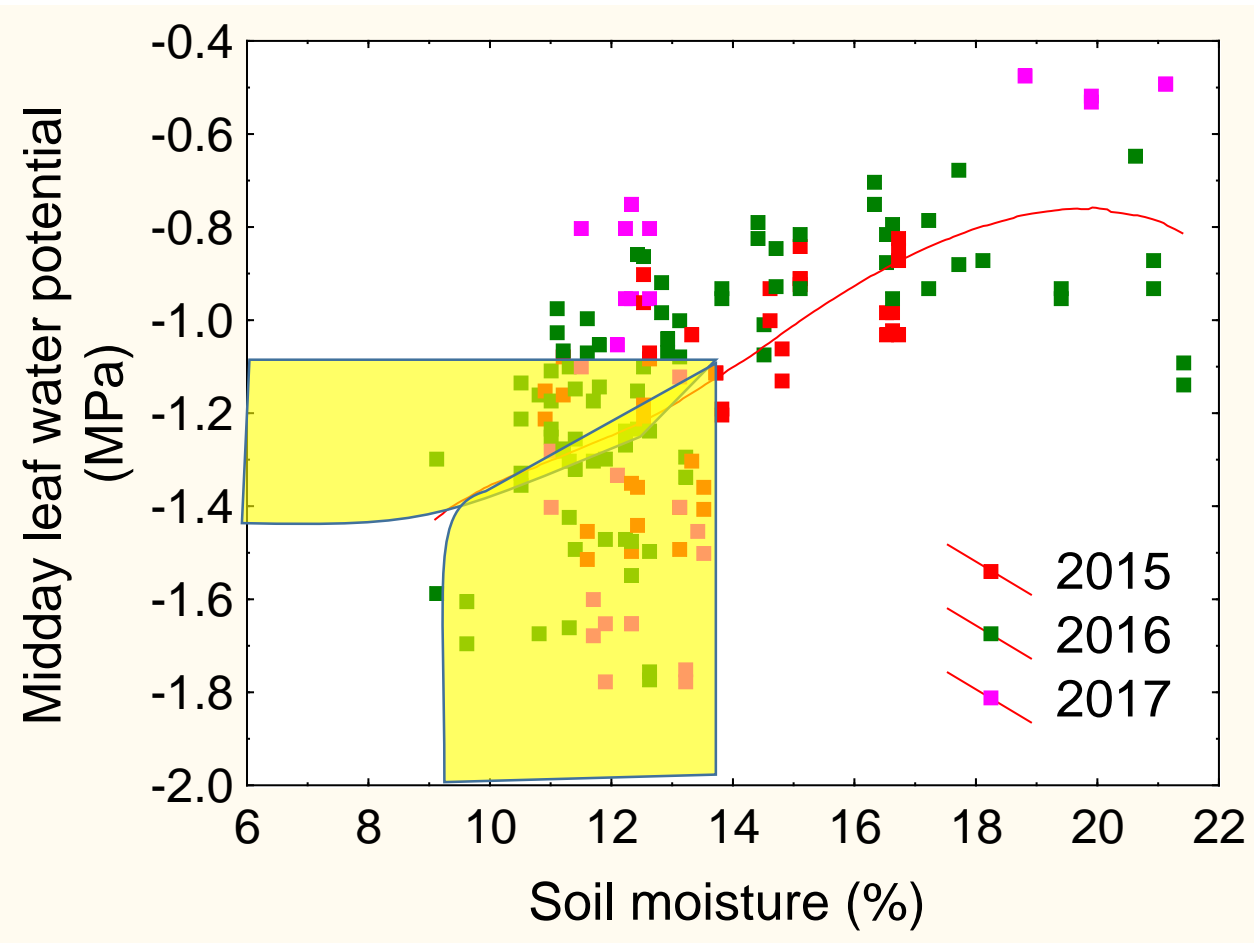
✓ Mild to moderate water stress can occur anywhere between 64% of field capacity (FC) and 44% of FC

✓ Varieties: Cabernet Sauvignon, Cabernet franc, Pinot gris, Pinot noir, Auxerrois, Semillon, Albarino, Sauvignon blanc

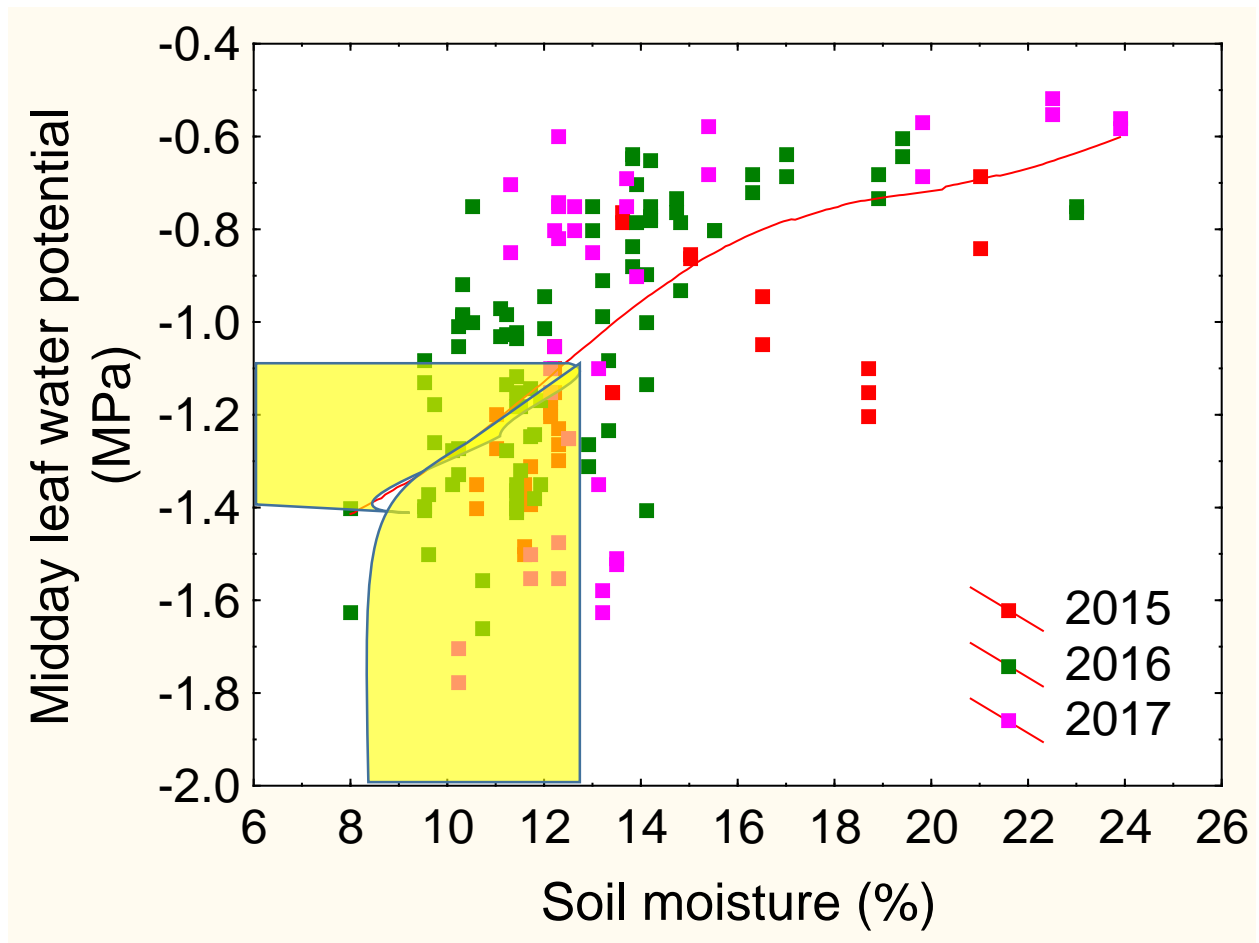


Category 1:  
Linear drop or  
near-anisohydric  
varieties

## Category 2: Linear drop after a threshold of soil moisture



**Grenache**

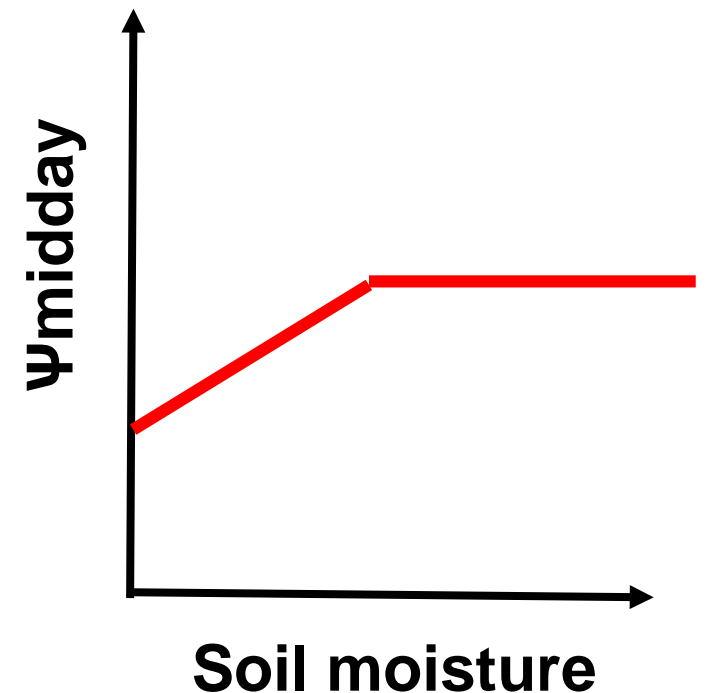


**Petit Verdot**

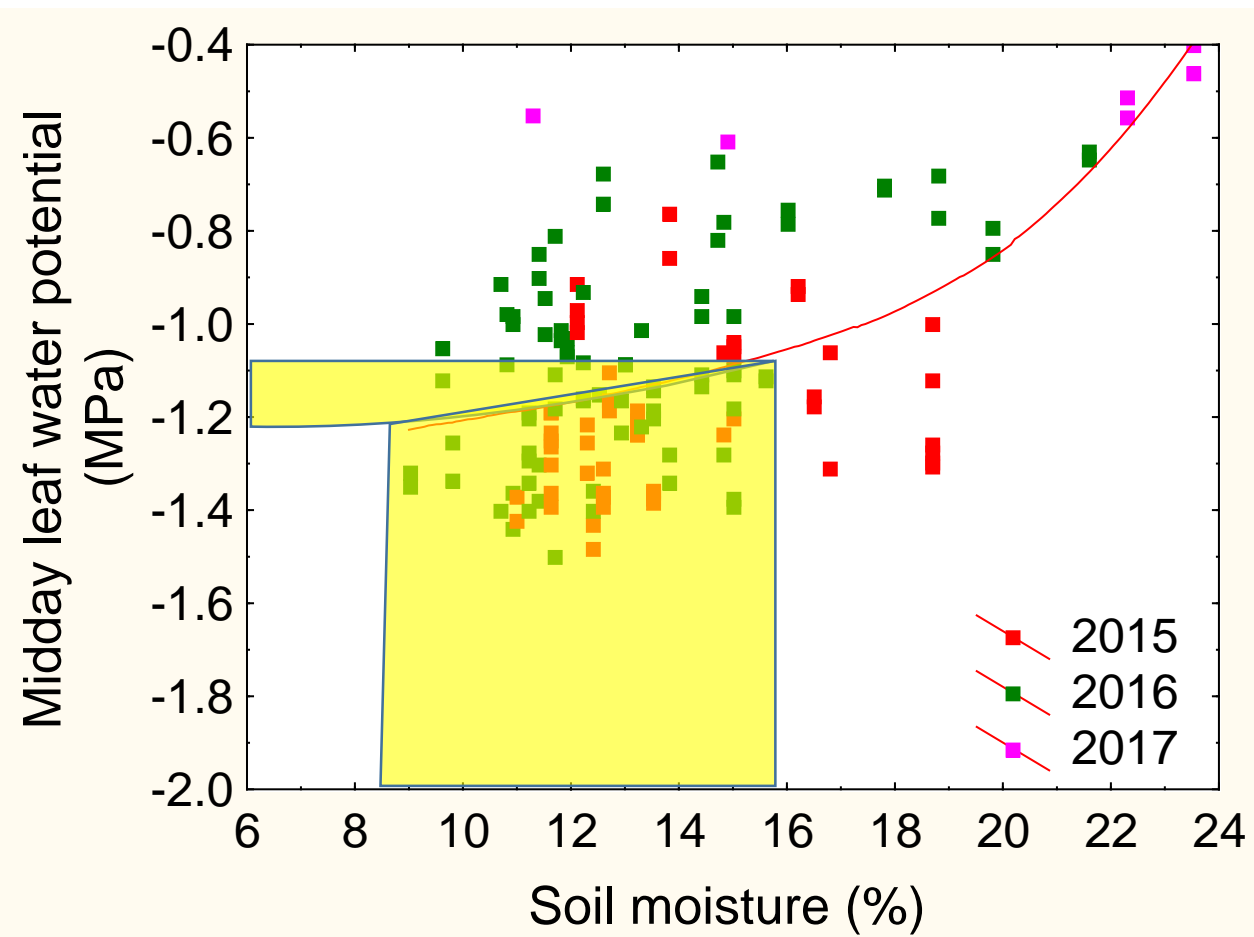


- ✓ These are more conservative varieties that do not on average allow for  $\Psi_{\text{midday}}$  to drop to low values as soil moisture declines
- ✓ Moderate water stress is barely attained
- ✓ Mild water stress to moderate water stress can occur at lower soil moisture of 56% til Permanent Wilting Point PWP (40% FC in Sandy loam soil)
- ✓ Varieties: Merlot, Grenache, Petit Verdot, Nebbiolo, Malbec, Gewurztraminer

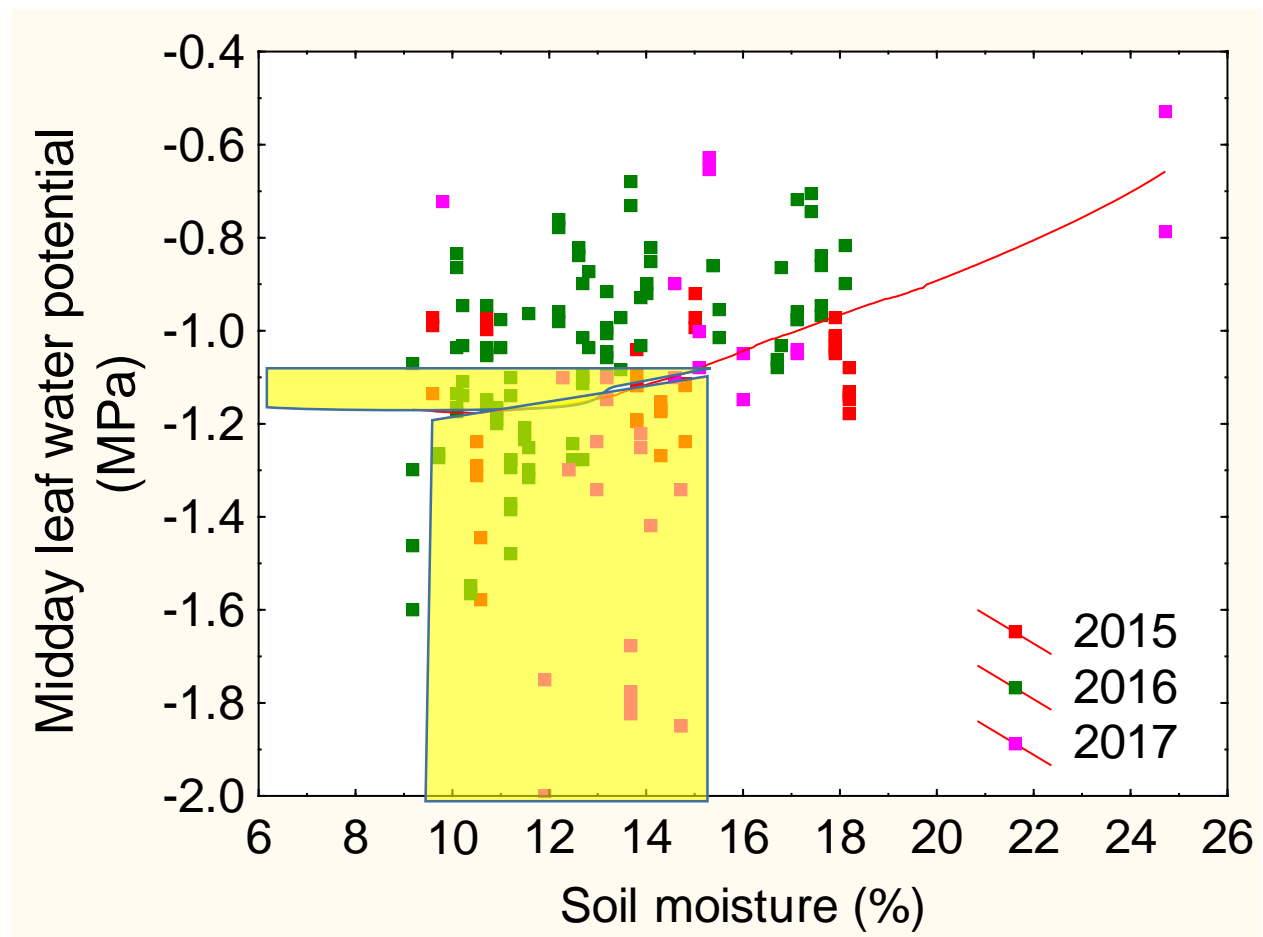
Category 2: Linear drop after a threshold of soil moisture



## Category 3: Near-isohydric varieties

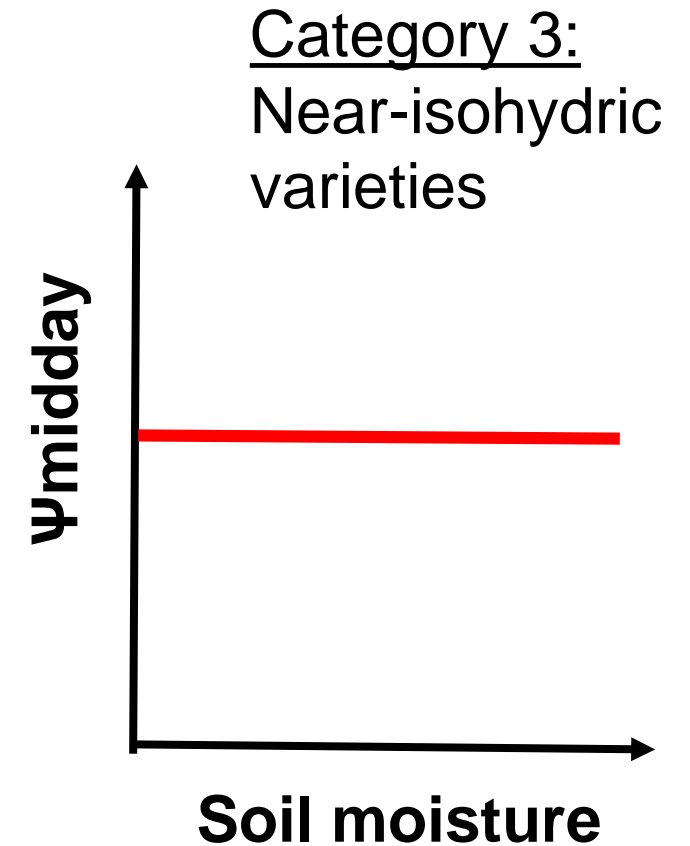


**Lemberger**



**Riesling**

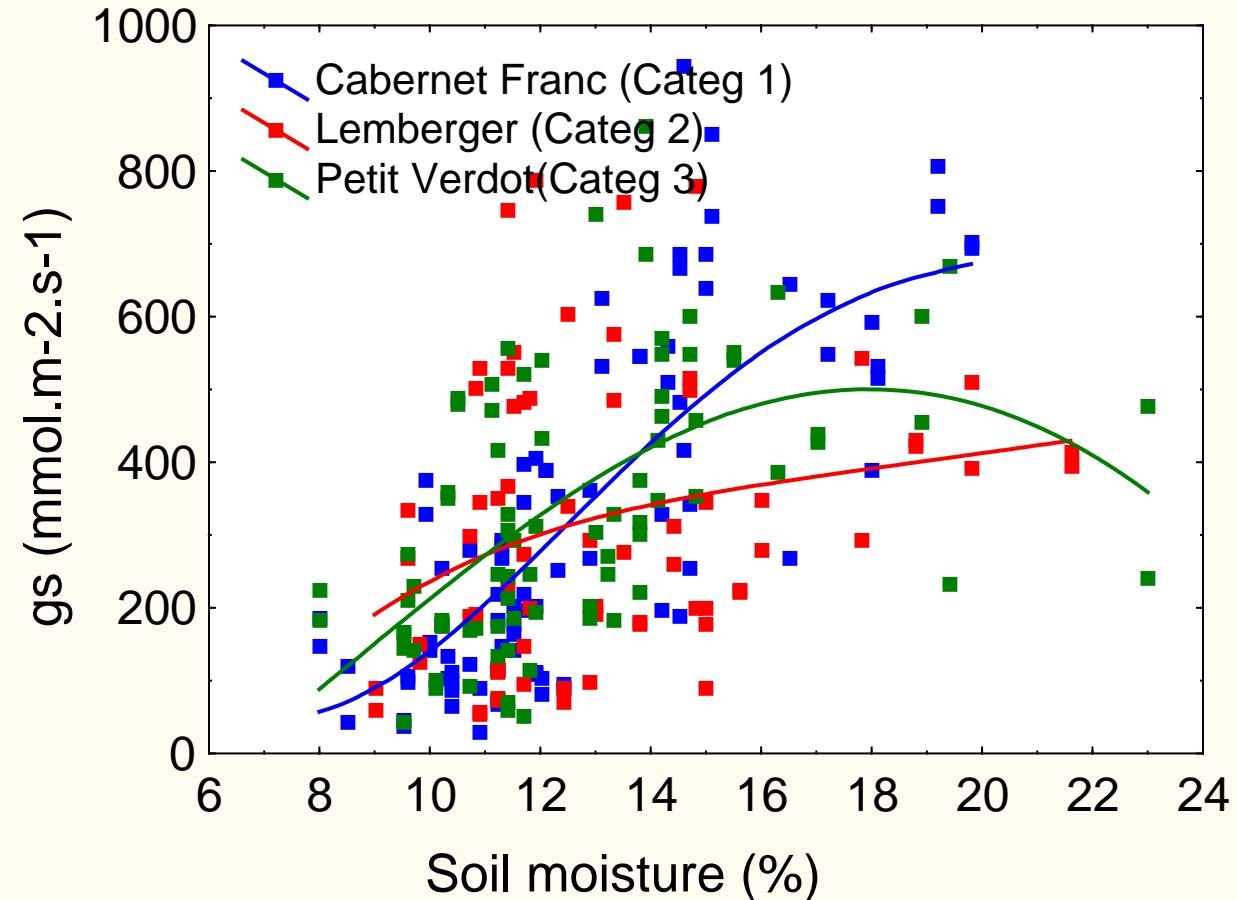
- ✓ A plateau of  $\Psi_{\text{midday}}$  values occur over a large range of declining soil moisture values
- ✓  $\Psi_{\text{midday}}$  remains high despite soil drought
- ✓ It is difficult to attain a moderate stress
- ✓ Mild water stress can occur at soil moisture of 64% til below Permanent Wilting Point PWP (40% FC in Sandy loam soil), which is a very wide range
- ✓ Varieties: Lemberger, Riesling and Muscat blanc



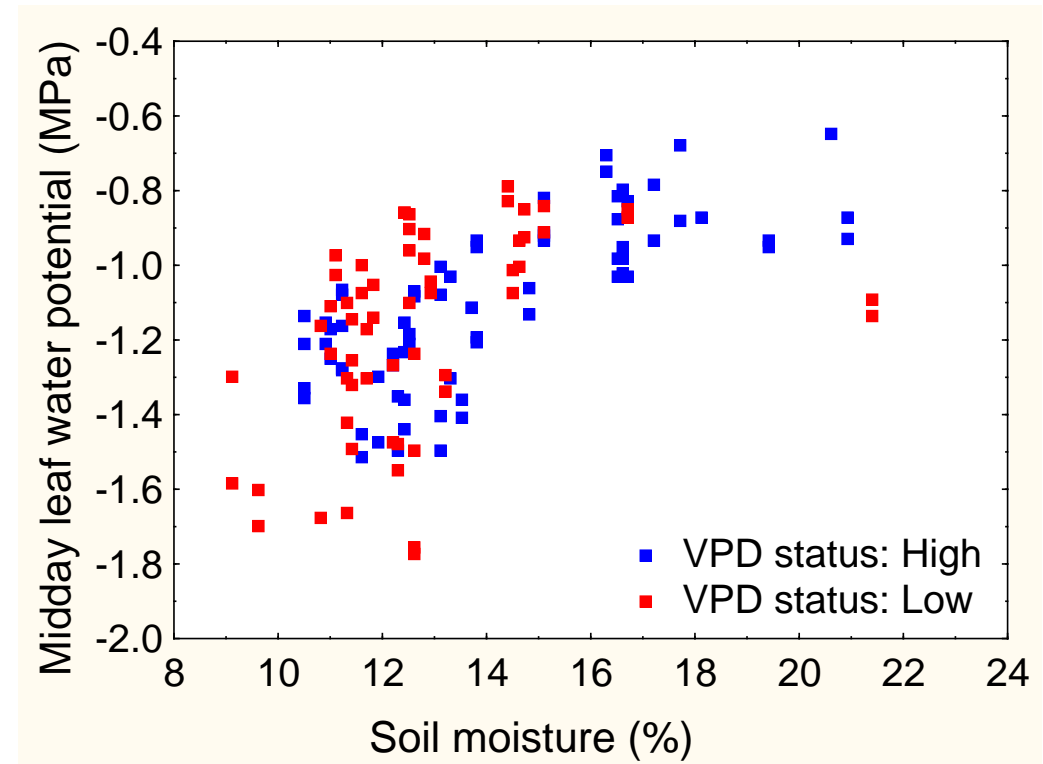
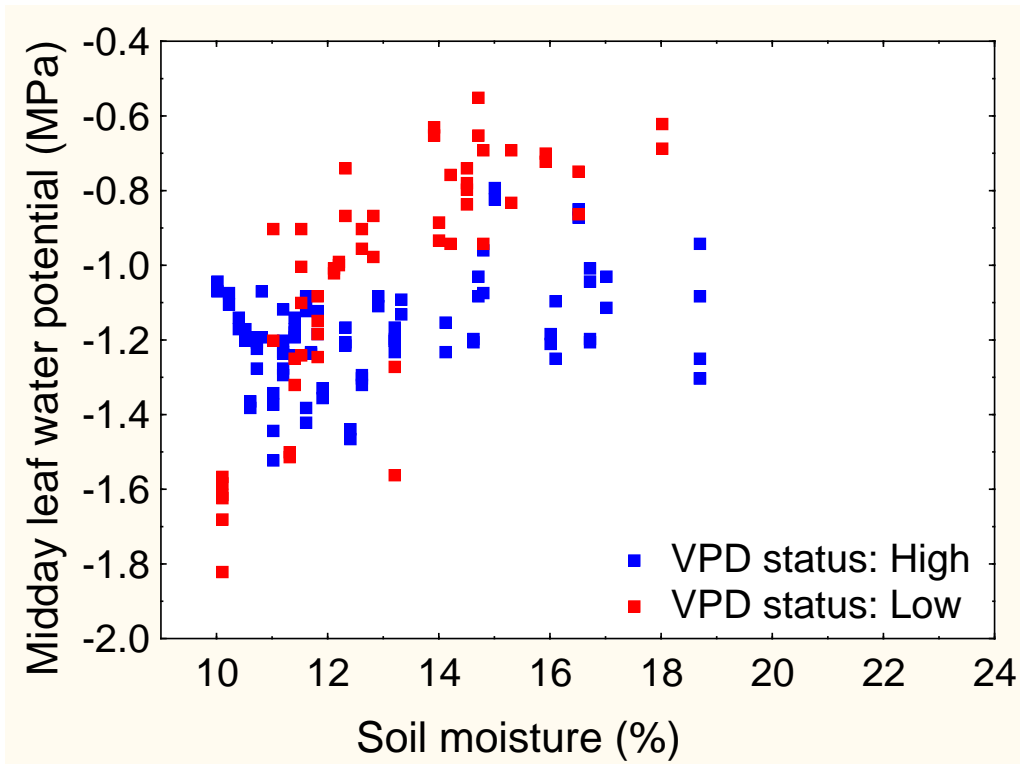
## Stomatal conductance and its sensitivity to soil moisture depletion

Variety	$\Psi_{\text{midday}}$ pattern	$\Psi_{\text{midday}}$ sensitivity to soil moisture (R value)	gs sensitivity to soil moisture (R value)
Semillon	Category 1	0.82	0.87
Cabernet franc	Category 1	0.78	0.76
Chardonnay	Category 1	0.58	0.61
Gewurztraminer	Category 2	0.53	0.79
Merlot	Category 2	0.51	0.78
Petit Verdot	Category 2	0.59	0.47
Riesling	Category 3	0.33	0.56
Muscat blanc	Category 3	0.46	0.53
Lemberger	Category 3	0.52	0.25

- ✓ Unlike what is reported, all varieties in Category 1 did not have insensitive stomata to soil moisture
- ✓ Allowing soil moisture to drop to moderate levels of water stress is to be done carefully for such varieties in order to keep the photosynthesis unaffected
- ✓ Unlike what is reported, the varieties that maintain their water status do not have more insensitive stomata for eg. Category 3 (and some of the varieties in category 2)
- ✓ Allowing soil moisture to enter a mild stress mode can be more safely done for those varieties



## Other factors affecting the response: Vapor pressure deficit VPD

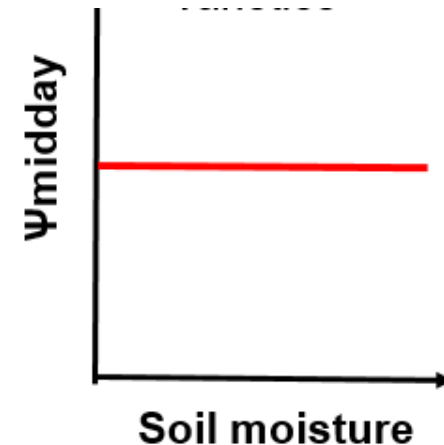
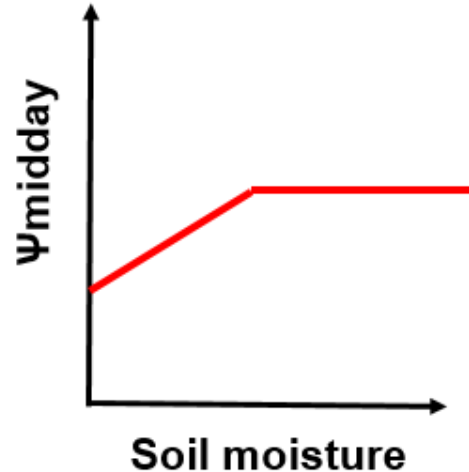
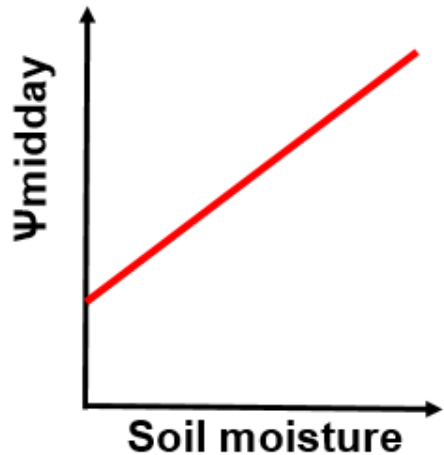


**VPD can be an additional factor affecting the  $\Psi_{\text{midday}}$  in some varieties.**

**In Malbec (Left),  $\Psi_{\text{midday}}$  decreased even under high soil moisture when VPD was high recorded compared to a low VPD. This was not seen in Grenache (Right)**

# Take home messages

- ✓ There are 3 patterns of  $\Psi_{\text{midday}}$  over the full range of soil moisture that can be depicted among winegrape varieties



- ✓ Some varieties can reach desired moderate water stress state at higher soil moisture than others. Some varieties will have hard time to reach a moderate stress stage
- ✓ Varieties that can lower their  $\Psi_{\text{midday}}$  do not always have insensitive stomata neither do the varieties that maintain  $\Psi_{\text{midday}}$  always have the most sensitive stomata. This lead to further attention to a photosynthesis inhibition risk
- ✓ VPD is a factor than can affect the response of vines and explain some variability in measurements

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