



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 Ψ 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 (!!!)

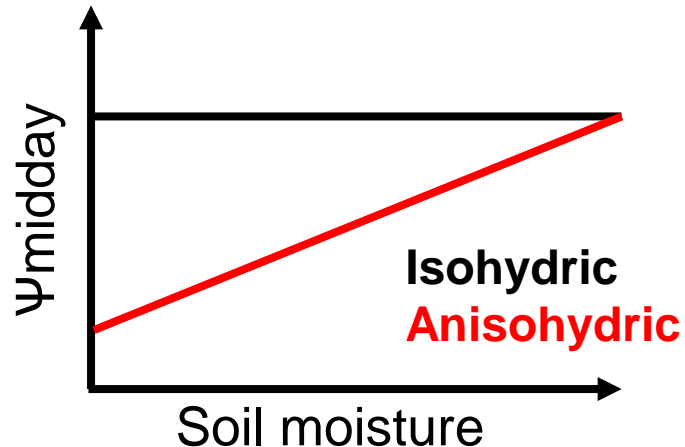
- ✓ Shoot elongation decreases linearly with declining Ψ and stops completely at $\Psi = -1.2$ MPa

Varietal differences

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

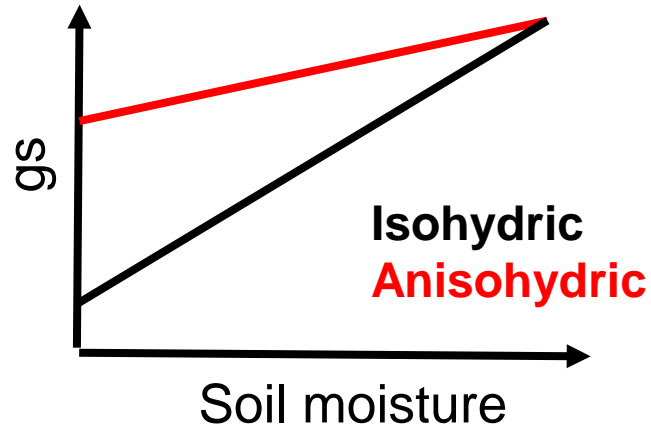
ISOHYDRIC

- ✓ Ψ_{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

- ✓ Ψ_{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 Ψ_{midday} pattern

Materials and Methods

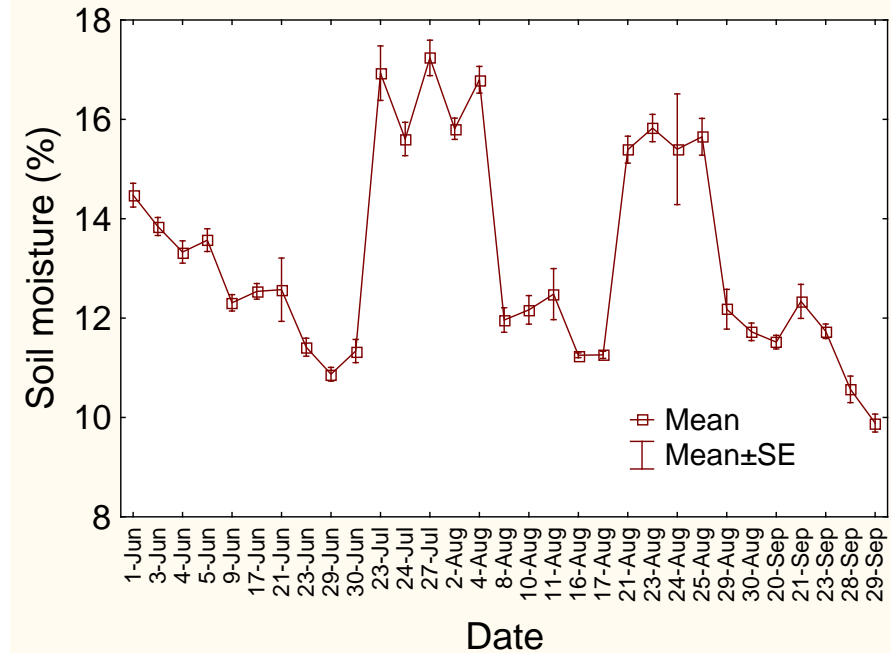
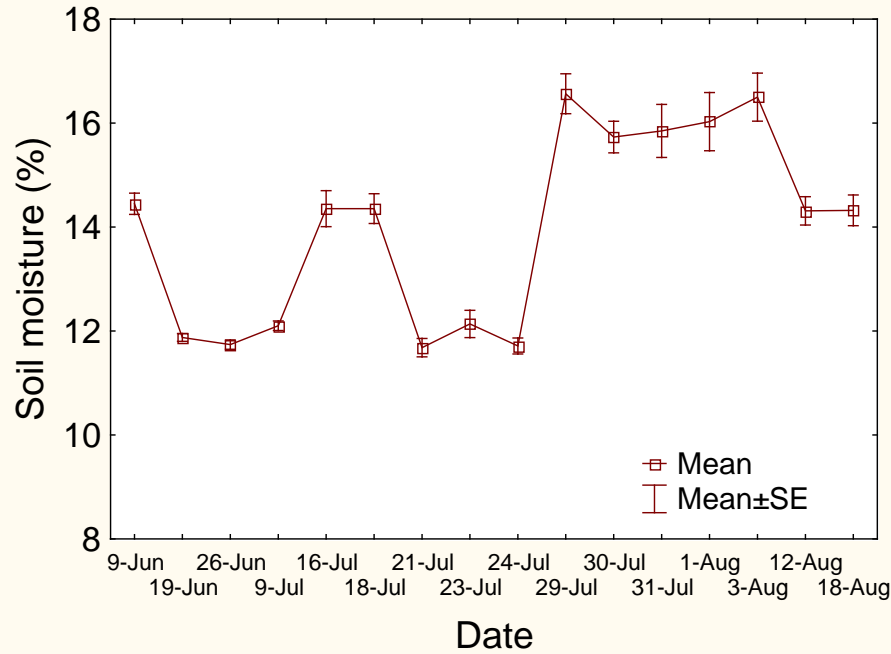
Dry down/recovery cycles for 2015, 2016 2017 at the ROZA experimental vineyard

Measurement of Ψ_{midday} (Pressure chamber) and stomatal conductance (Porometer)

Measurement of soil moisture (Neutron probe) for each replicate



18 varieties studied at the ROZA vineyard



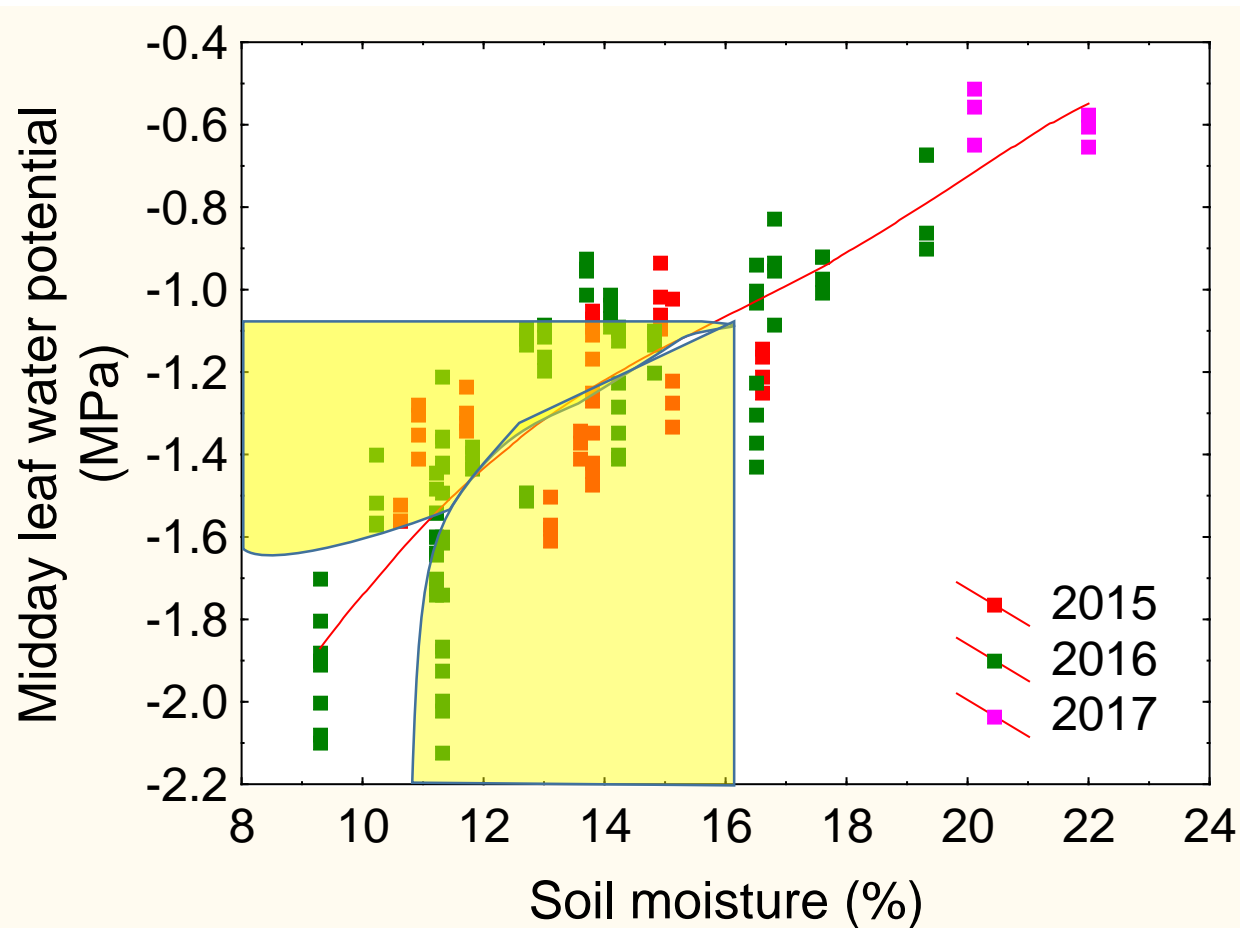
**Soil moisture evolution 2015 (Top)
and 2016 (Bottom)**

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

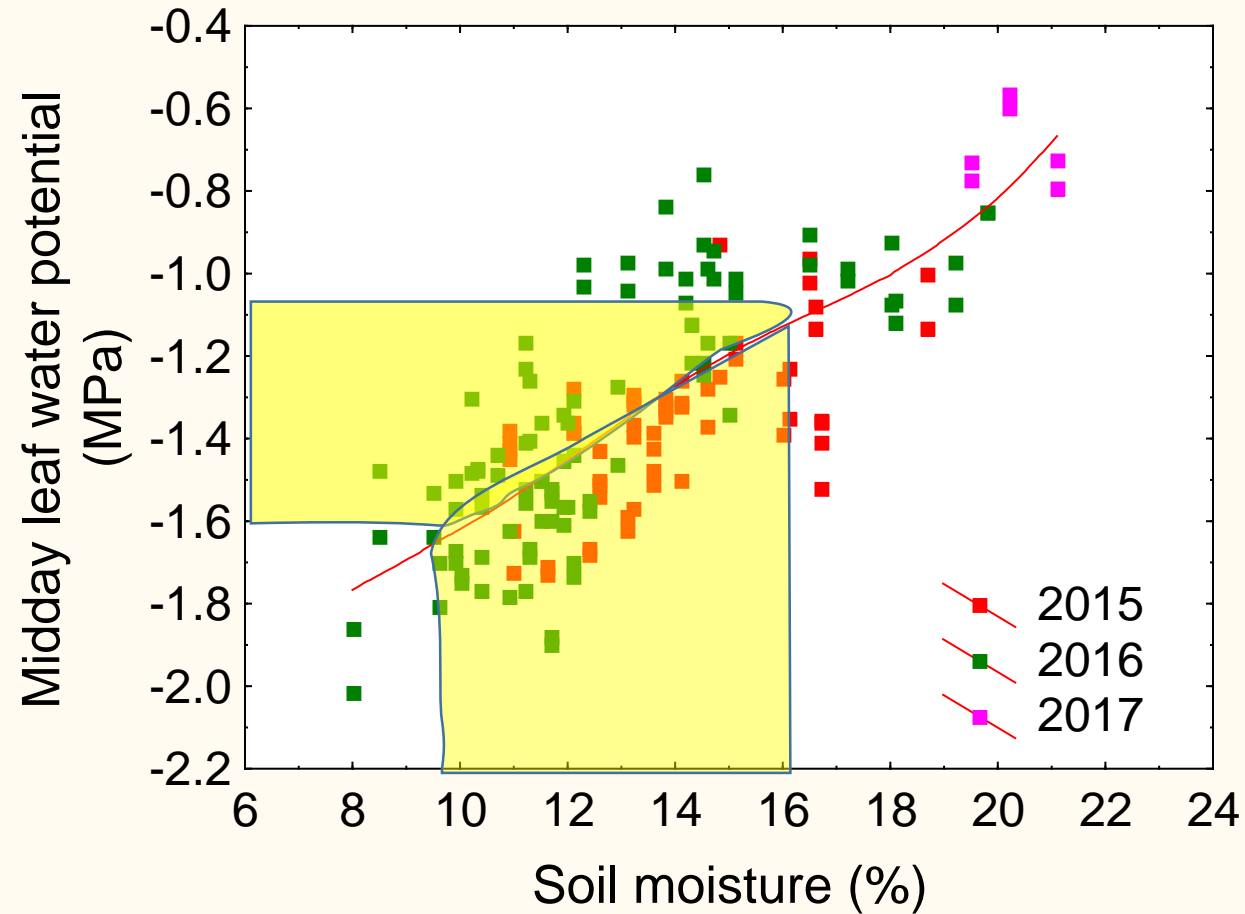
Results

3 categories of Ψ_{midday} behavior to water availability have been depicted

Category 1: Linear drop or near-anisohydric varieties



Semillon

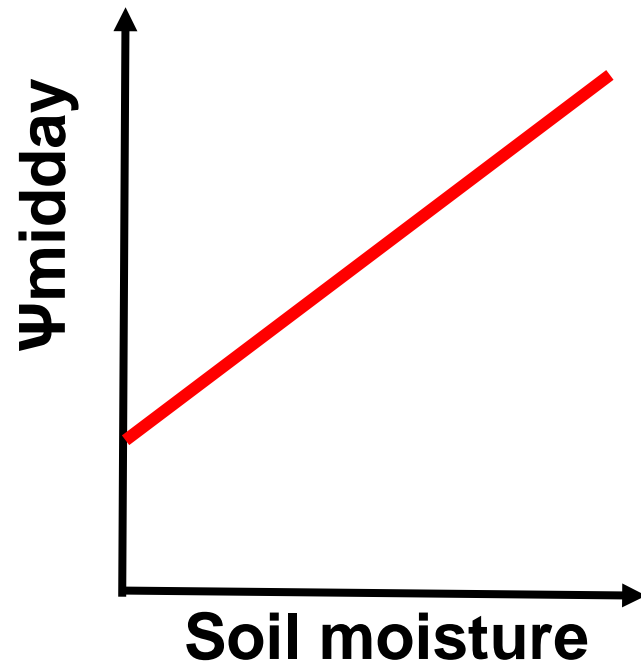


Cabernet franc

✓ Ψ_{midday} drops to low levels

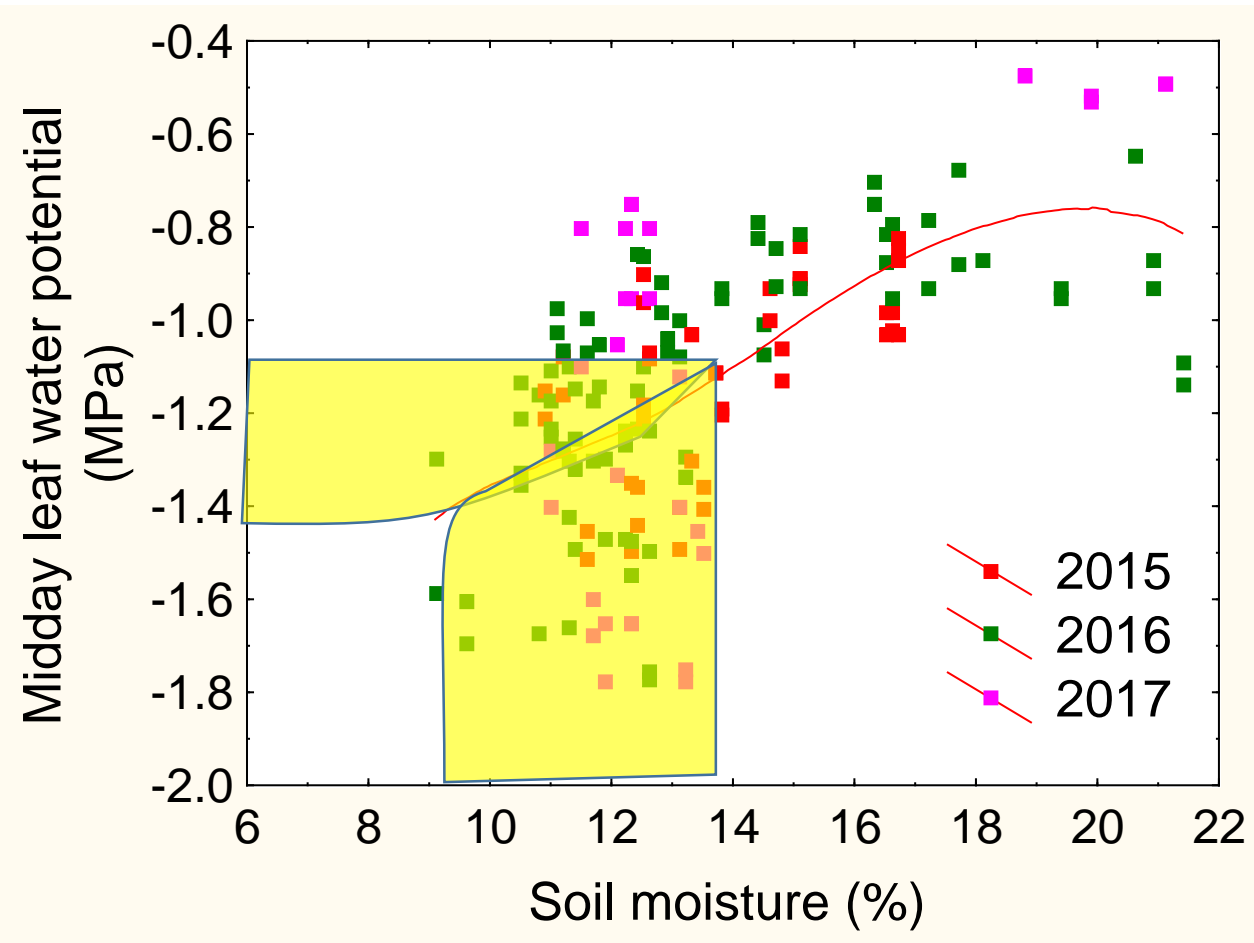
✓ Mild to moderate water stress can occur anywhere between 64% of field capacity (FC) and 44% of FC

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

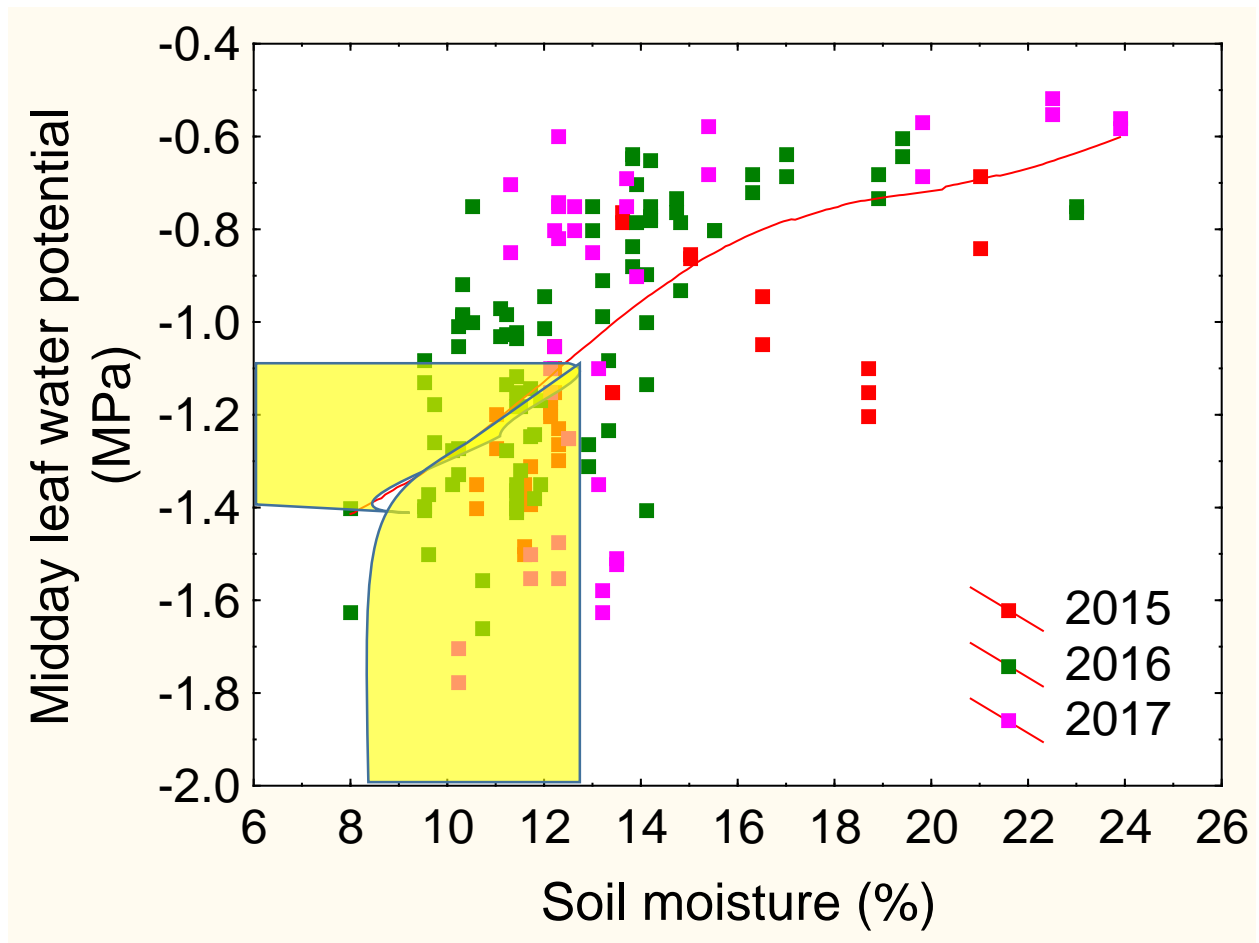


Category 1:
Linear drop or
near-anisohydric
varieties

Category 2: Linear drop after a threshold of soil moisture



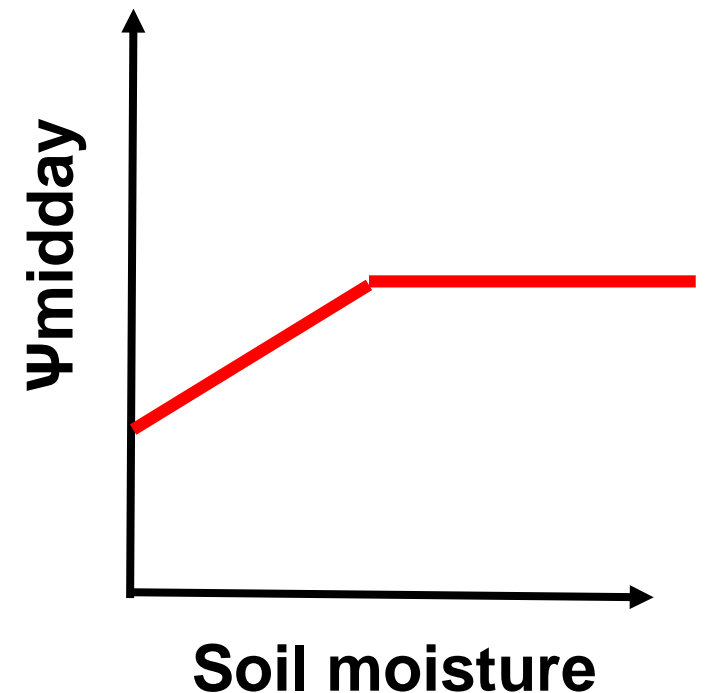
Grenache



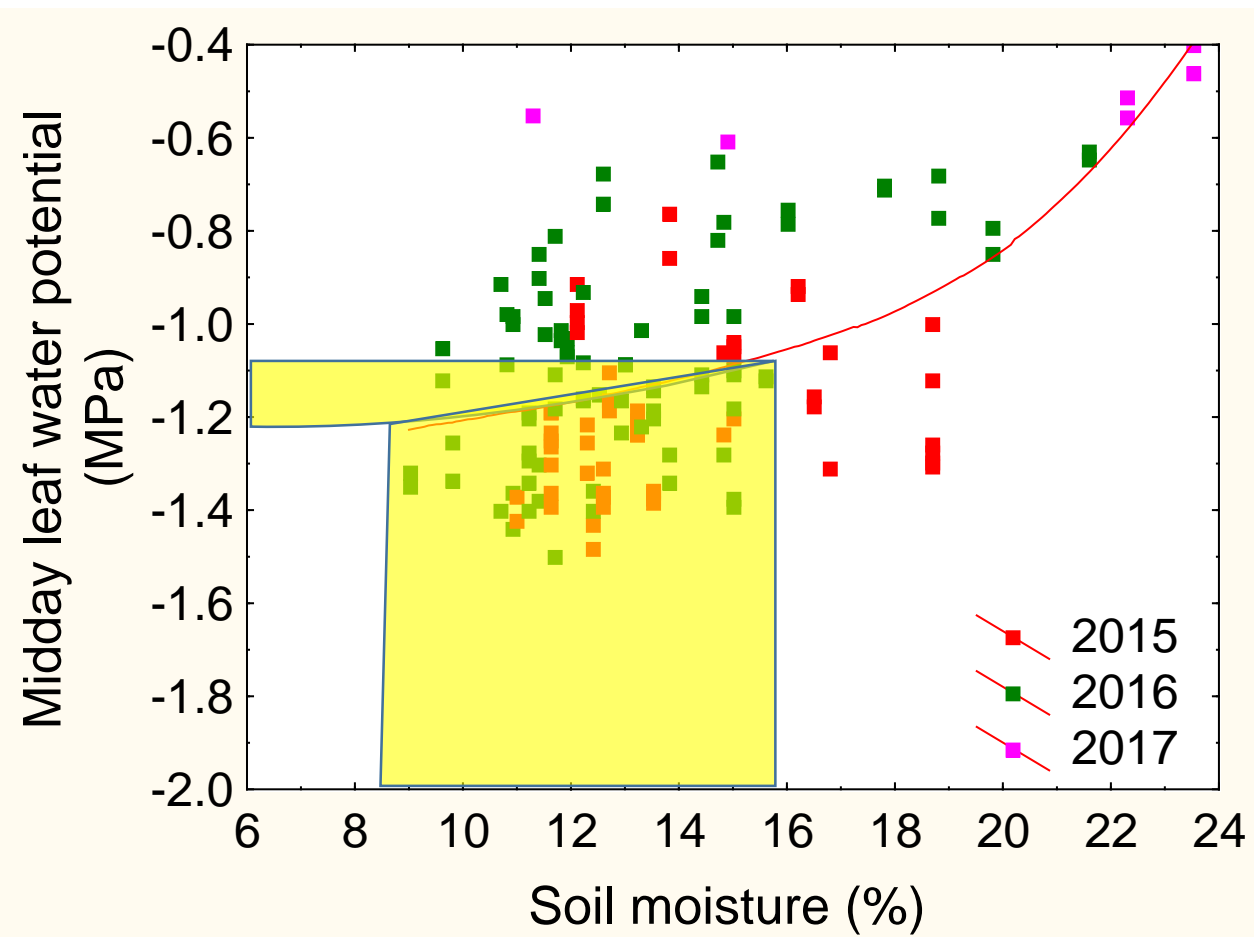
Petit Verdot

- ✓ These are more conservative varieties that do not on average allow for Ψ_{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

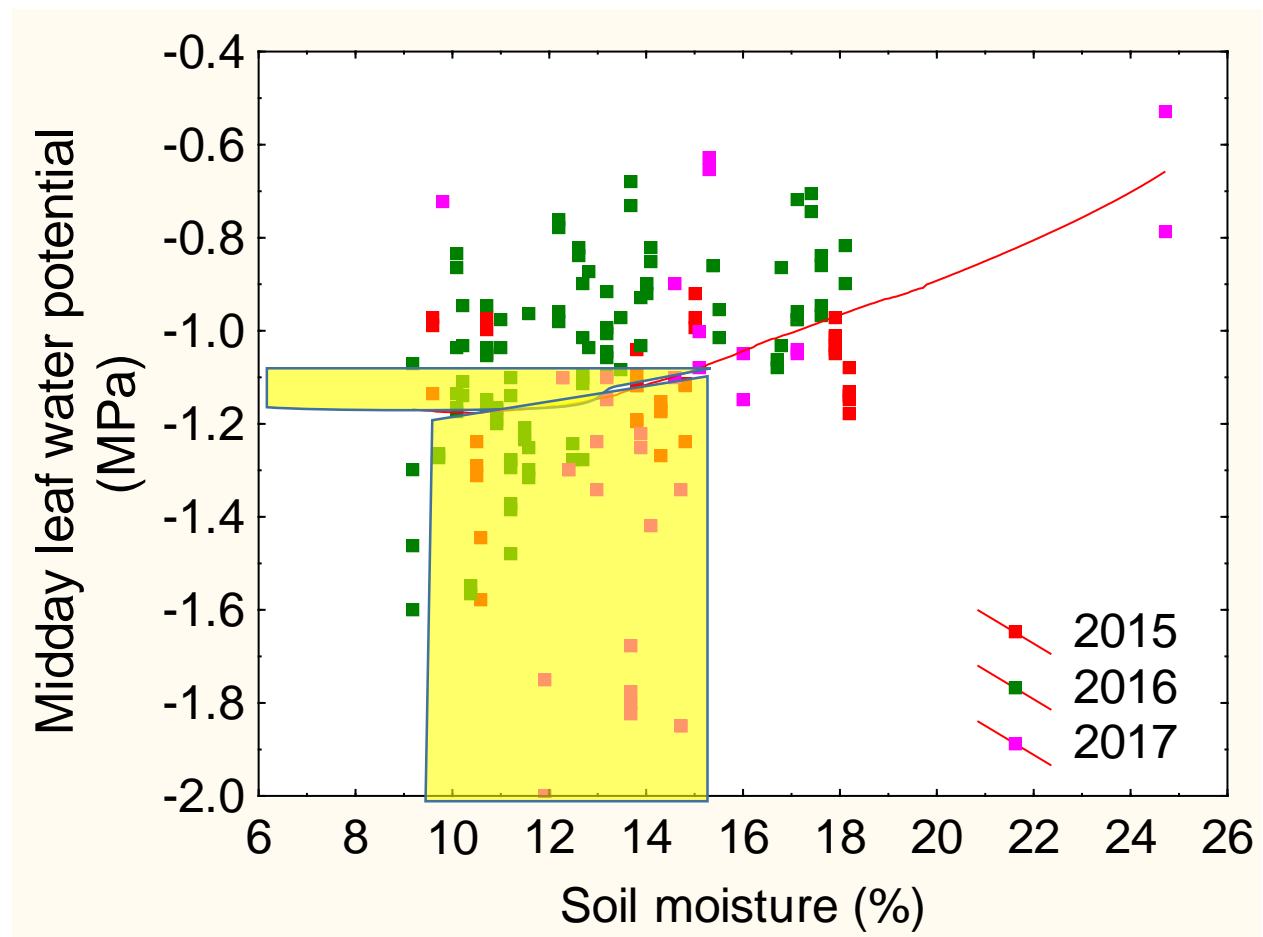
Category 2: Linear drop after a threshold of soil moisture



Category 3: Near-isohydric varieties

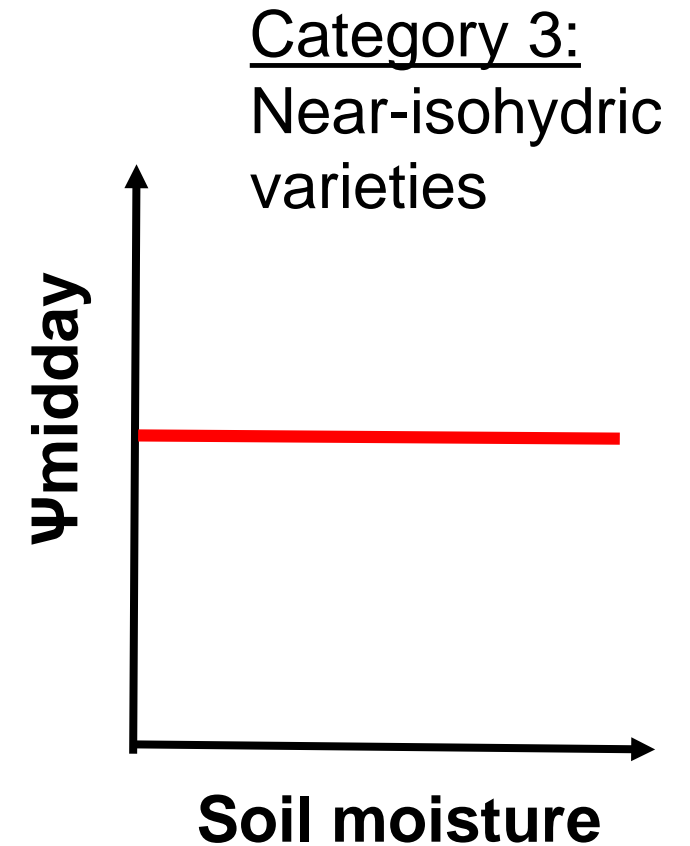


Lemberger



Riesling

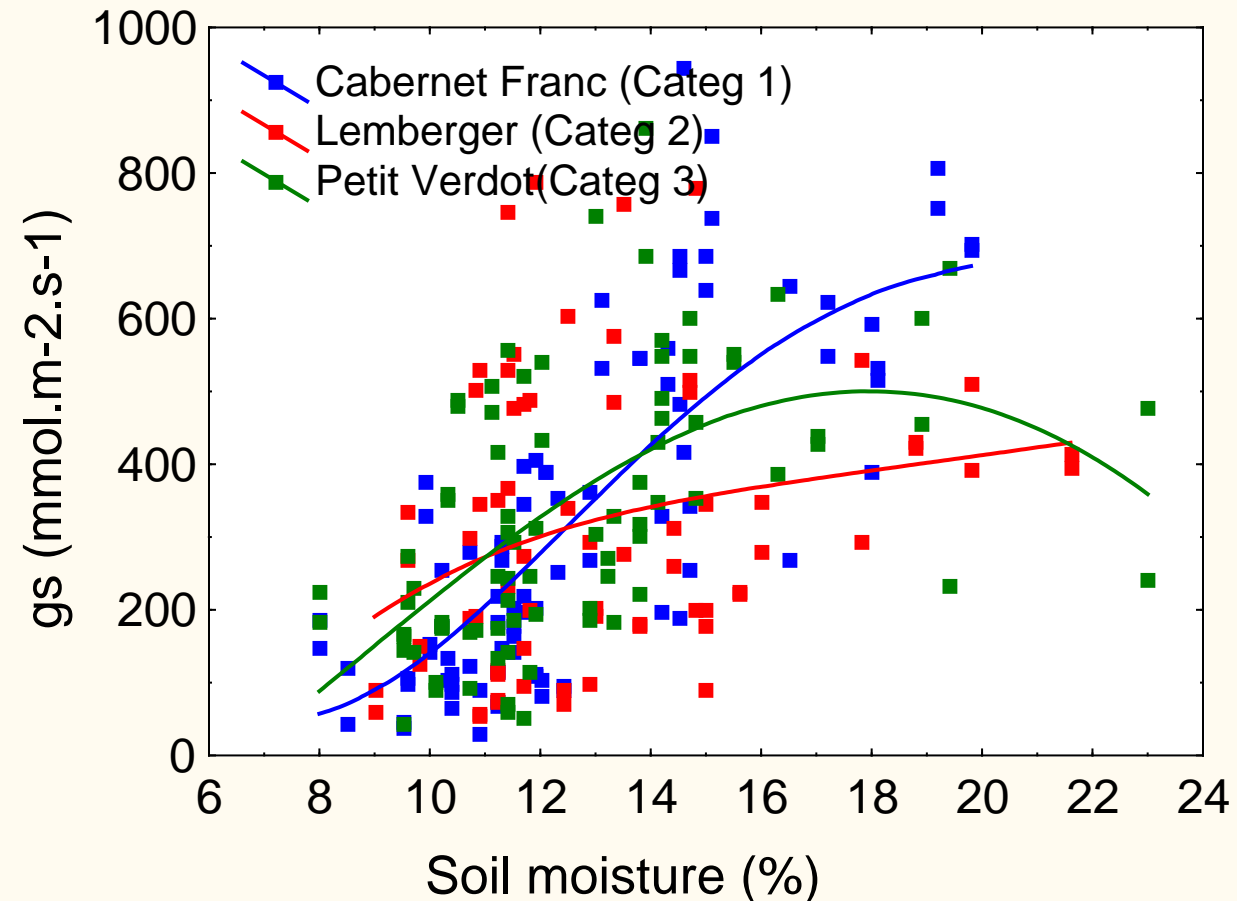
- ✓ A plateau of Ψ_{midday} values occur over a large range of declining soil moisture values
- ✓ Ψ_{midday} remains high despite soil drought
- ✓ It is difficult to attain a moderate stress
- ✓ Mild water stress can occur at soil moisture of 64% til below Permanent Wilting Point PWP (40% FC in Sandy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



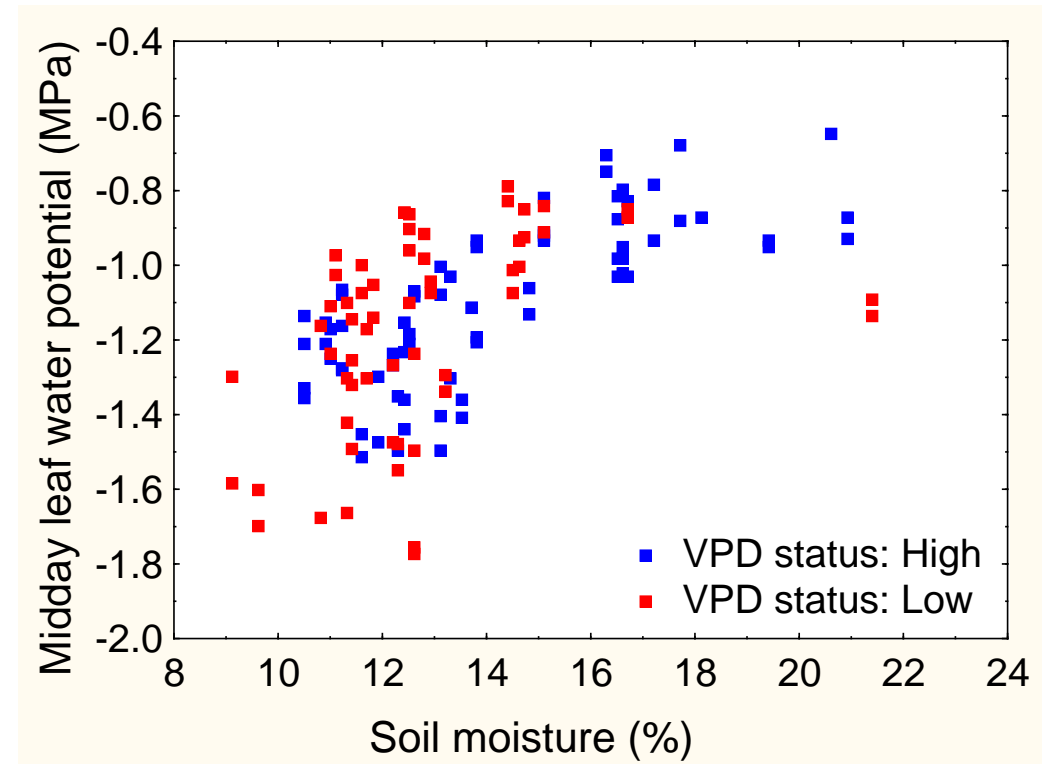
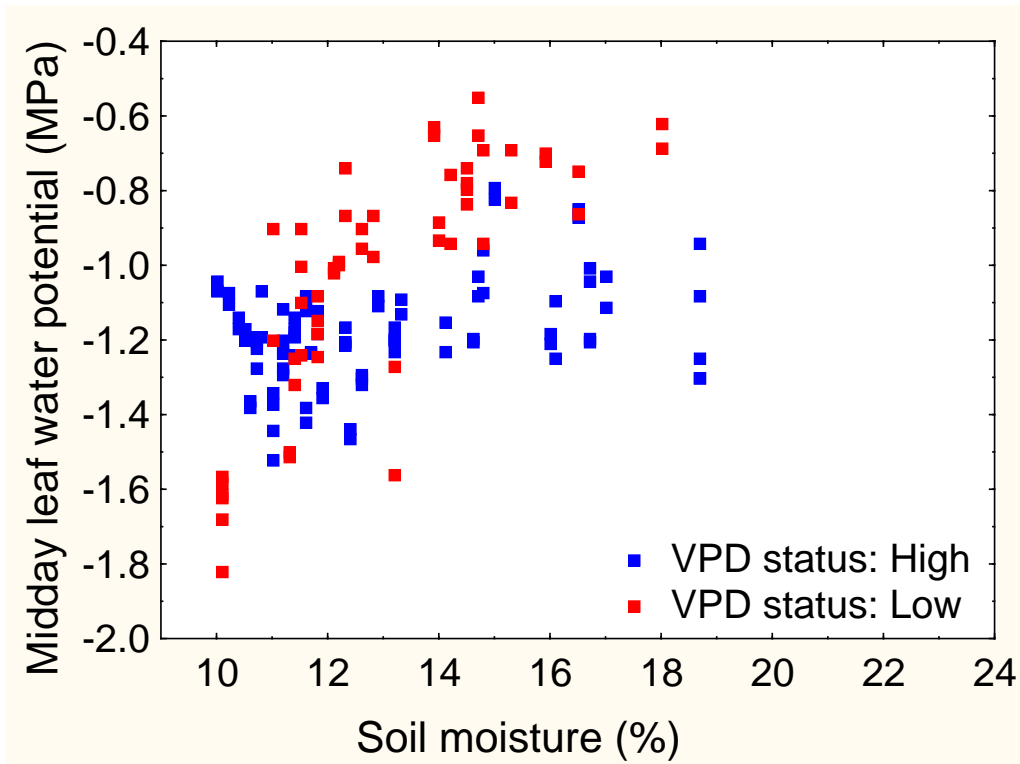
Stomatal conductance and its sensitivity to soil moisture depletion

Variety	Ψ_{midday} pattern	Ψ_{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

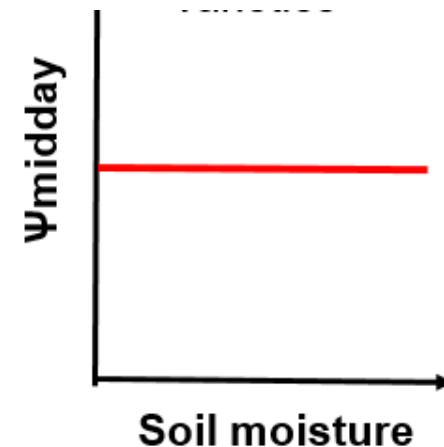
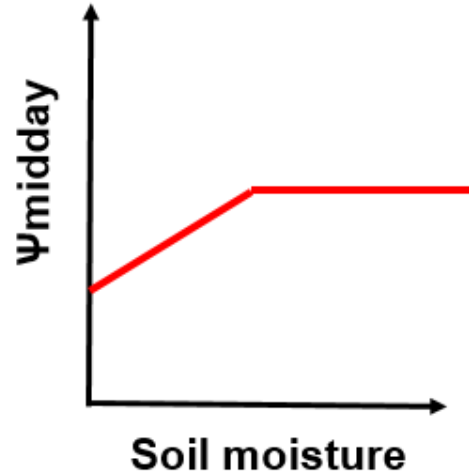
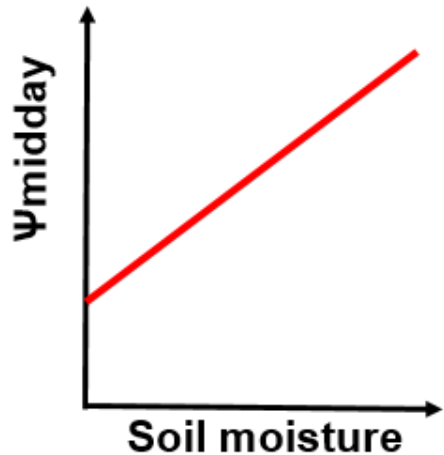


VPD can be an additional factor affecting the Ψ_{midday} in some varieties.

In Malbec (Left), Ψ_{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 Ψ_{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 Ψ_{midday} do not always have insensitive stomata neither do the varieties that maintain Ψ_{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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