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worldwide viticulture  
8<sup>th</sup> International Congress on  
Mountain and Steep Slopes Viticulture  
Montreux – Switzerland 6–8 May 2026

**utad**

UNIVERSIDADE  
DE TRÁS-OS-MONTES  
E ALTO DOURO



# PHYSIOLOGICAL AND MANAGEMENT-BASED ADAPTATION OF MOUNTAIN VINEYARDS TO INCREASING WATER STRESS UNDER MEDITERRANEAN CLIMATE



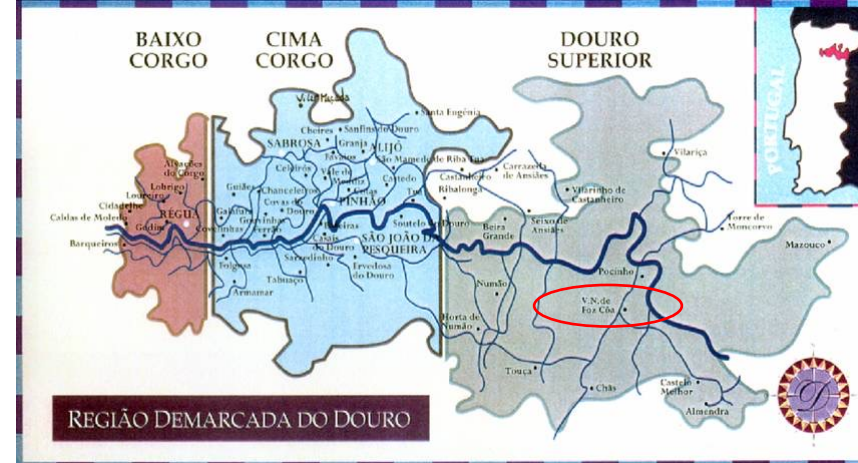
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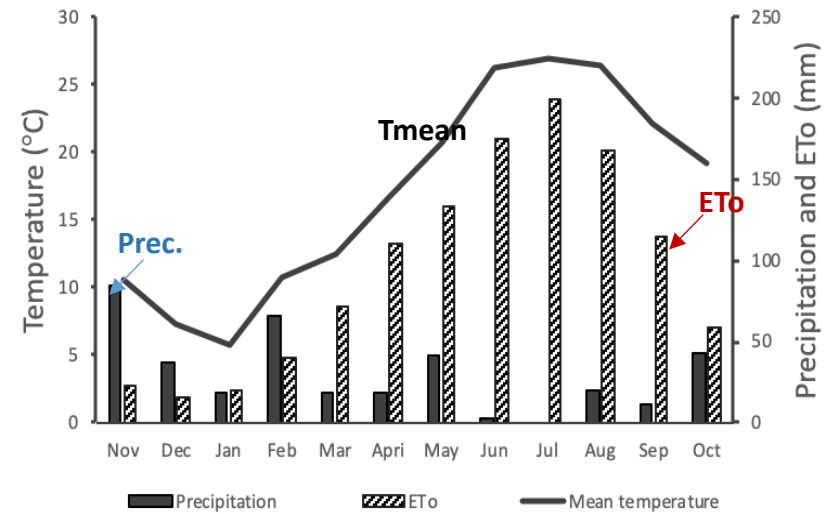


# DOURO DEMARCATED REGION

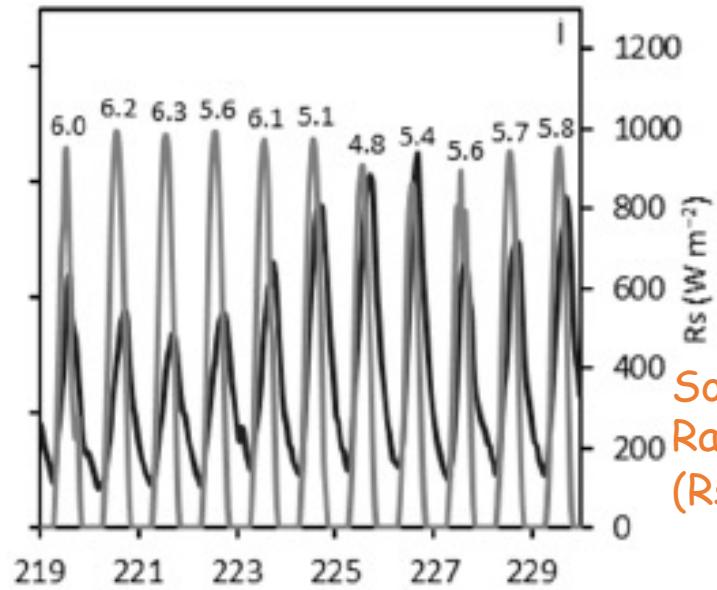
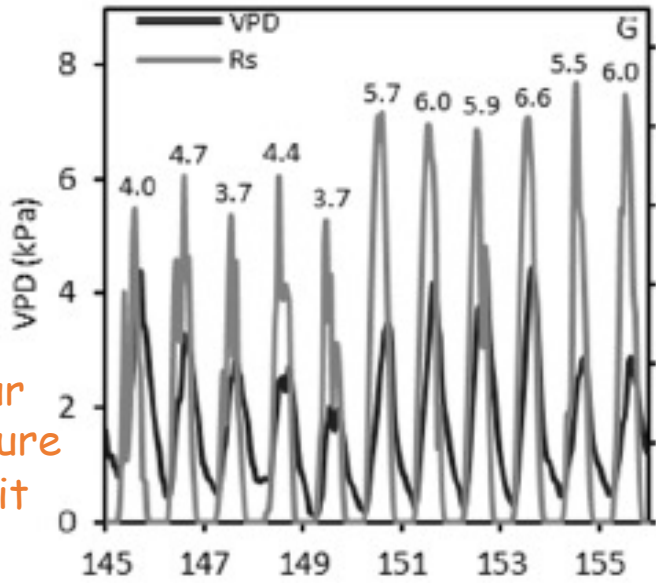


## *Climate:*

- Hot and dry local conditions during the maturation (summer)

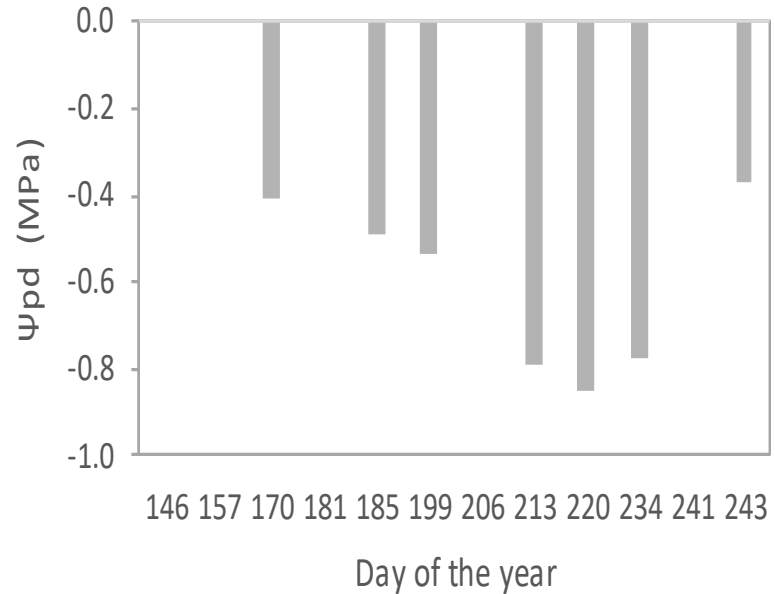
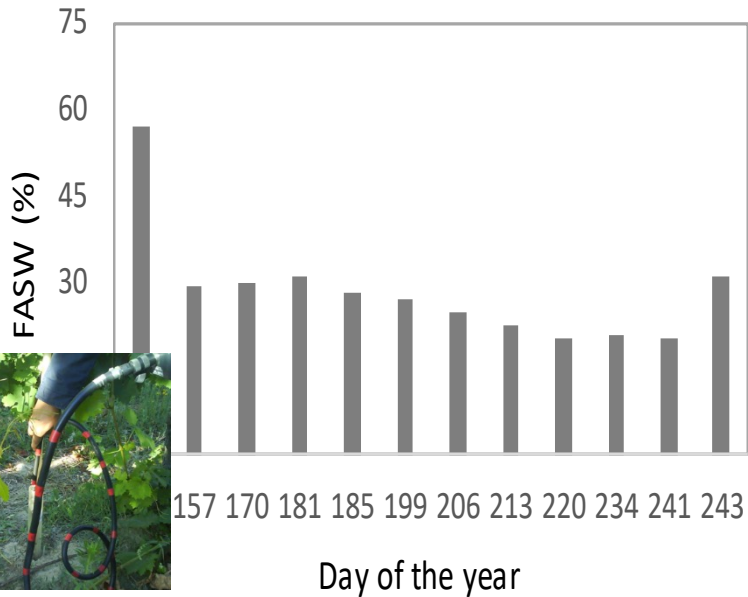


Vapour Pressure Deficit (VPD)

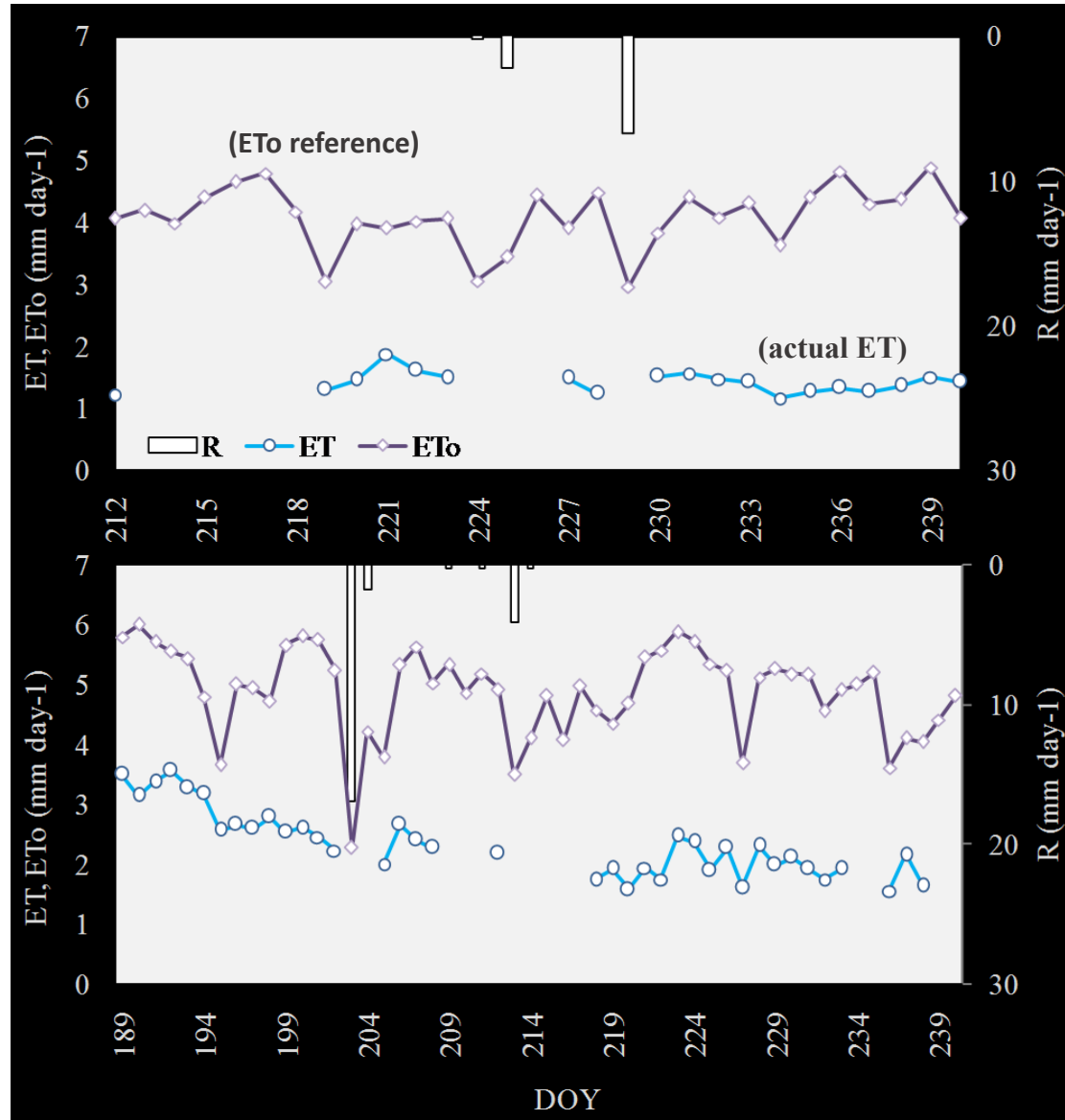
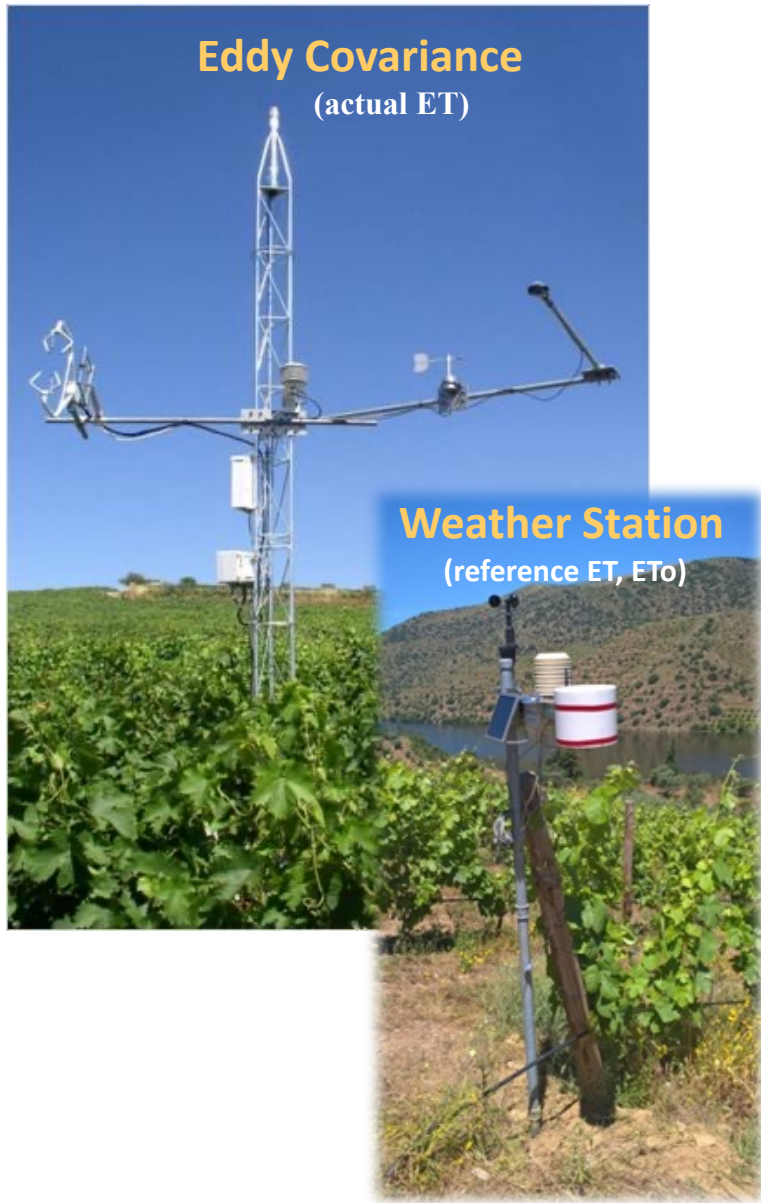


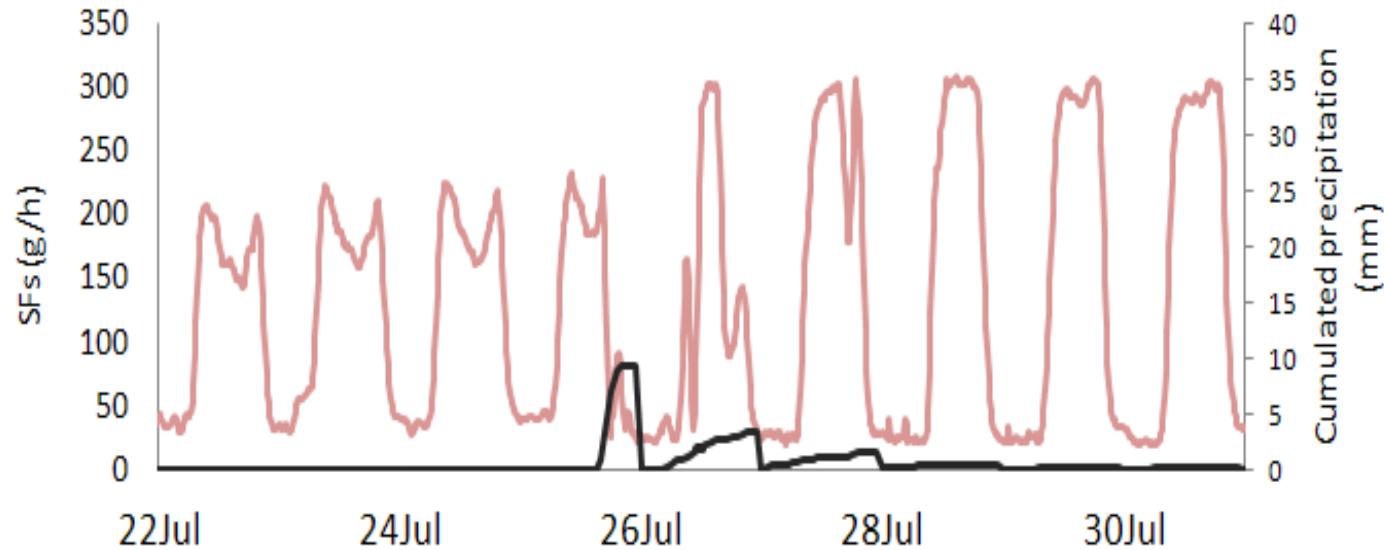
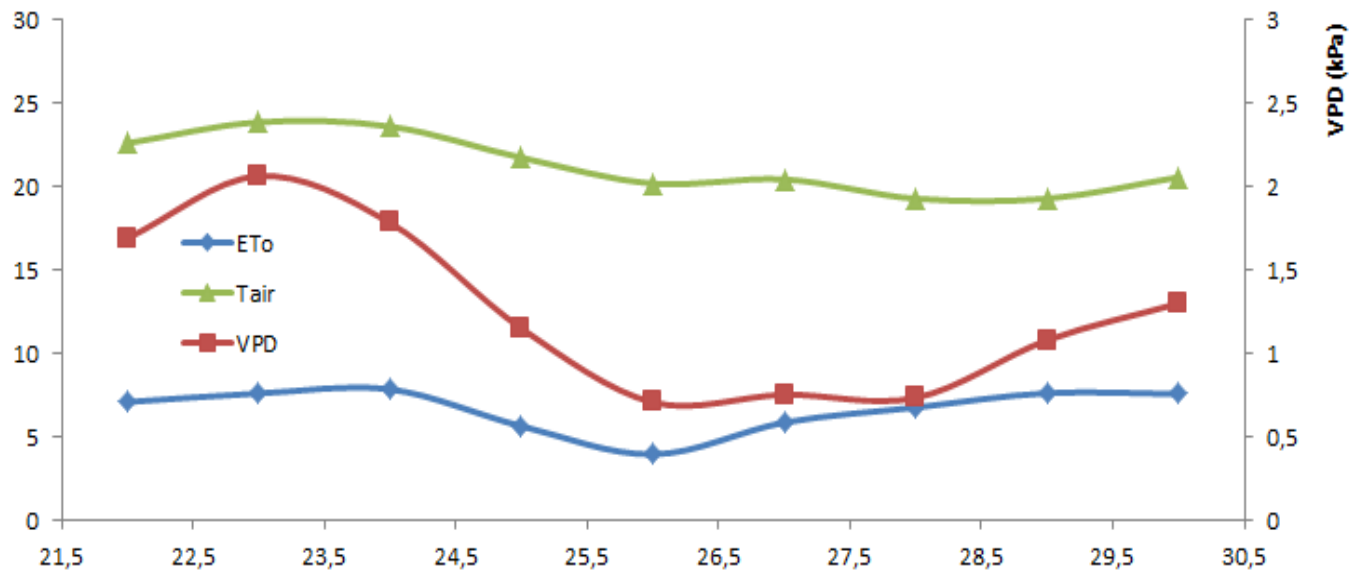
Solar Radiation (Rs)

Precipitation (Nov. - Oct.) = 320 mm



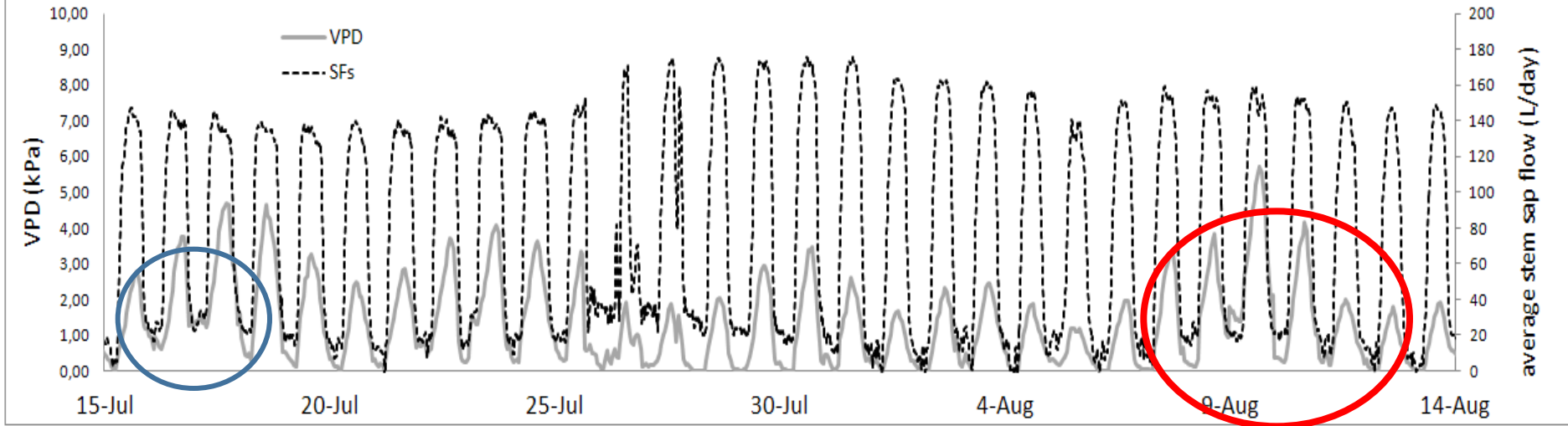
# Evapotranspiration



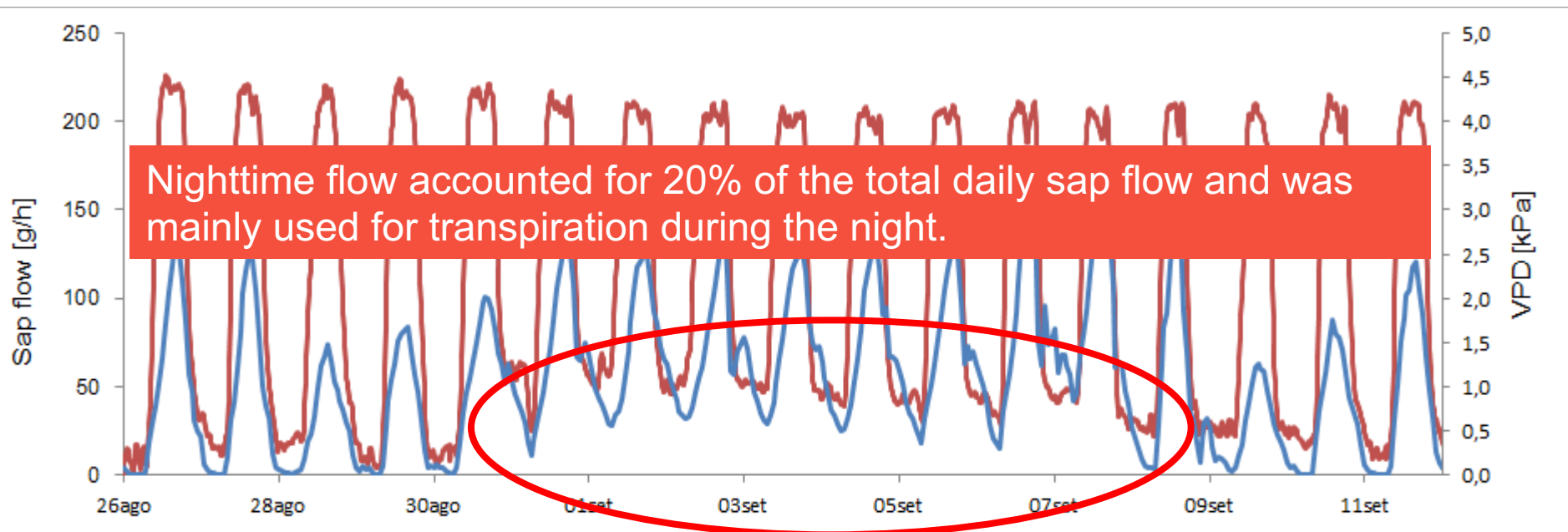


Sap flow daily course during two periods of similar *Tair* and *ETo*:

- prior to rainfall (important **midday stomatal closure** and **high nocturnal flow**)
- after rainfall (lower **midday stomatal closure** and **nocturnal flow**)

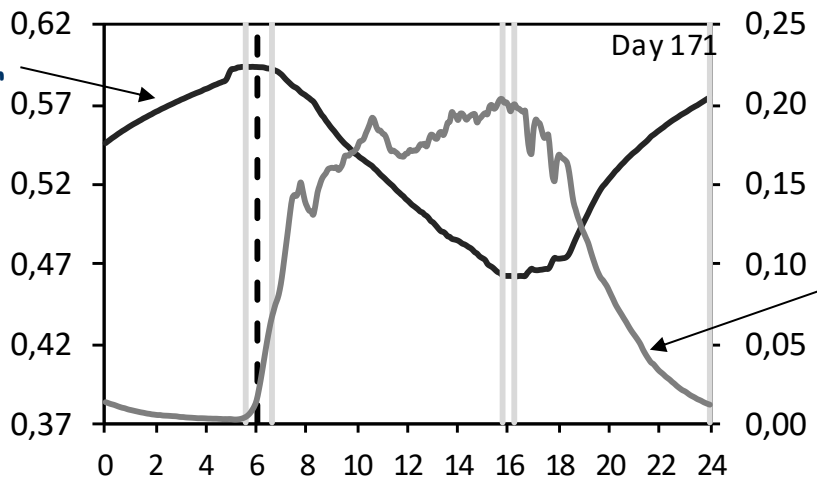


Sap flow in trunks, SFs, and vapor pressure deficit (VPD). A period with precipitation was included.



Nighttime flow accounted for 20% of the total daily sap flow and was mainly used for transpiration during the night.

Trunk diameter variation

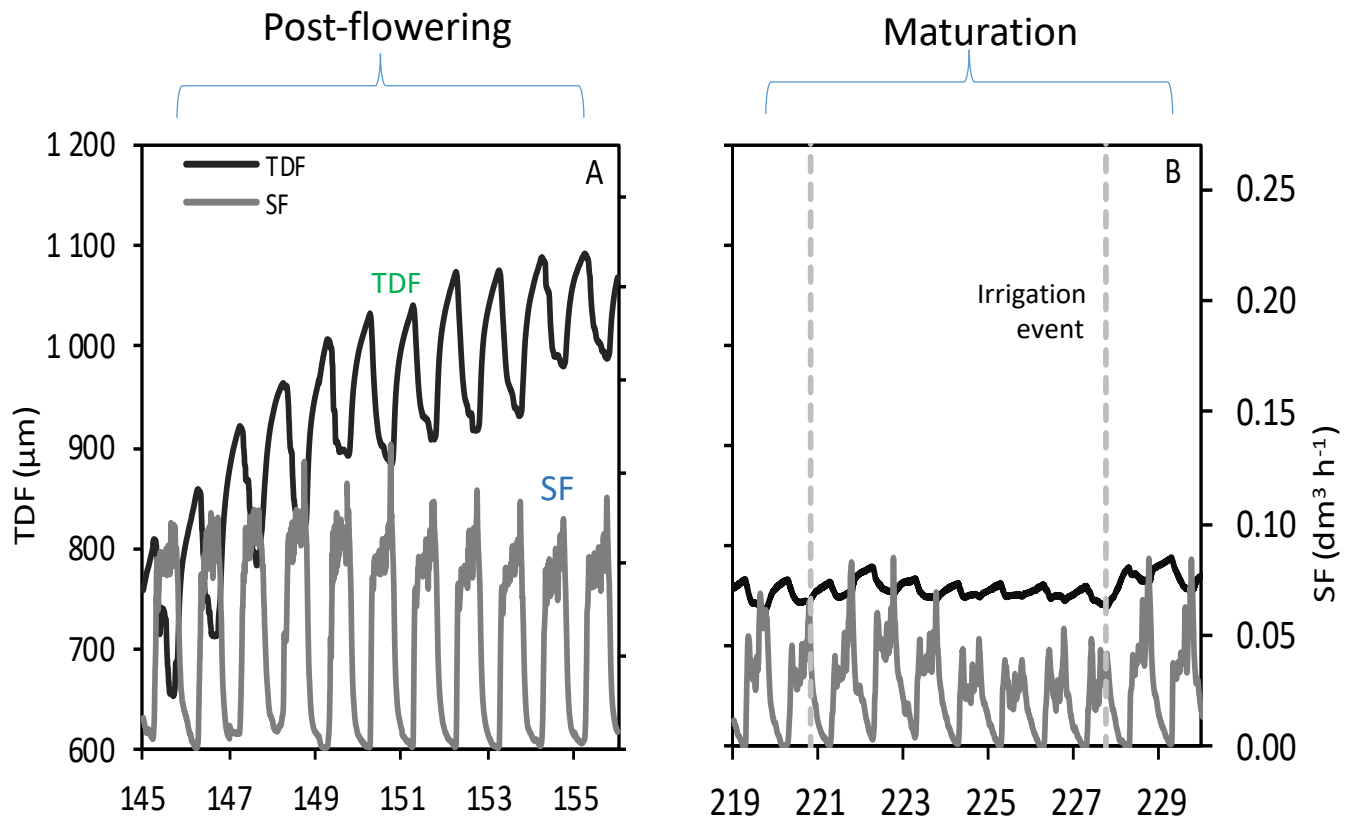


Sap flow



- LVDT

✓ Both variables have a daily cycle.



- ✓ The amplitude of these cycles decreases substantially throughout the growing season due to progressively lower water availability.
- ✓ The stomatal control, in order to reduce transpiration and rehydration, as well as the adjustment of the total leaf area, were the most important survival strategies of the vines.
- ✓ The use of automated and non-destructive techniques in grapevines, such as **sap flow** and **trunk diameter fluctuations**, revealed sensitivity to varying conditions of atmospheric demand and soil moisture.

# DOURO DEMARCATED REGION

(41.17° N, 7.25° W, 250 m)

## Introduction:

- Hot and dry local conditions during the maturation (summer)
- ❖ Adaption strategy: spur pruned Cordon vs Guyot



Trunk height:  
0.6 m

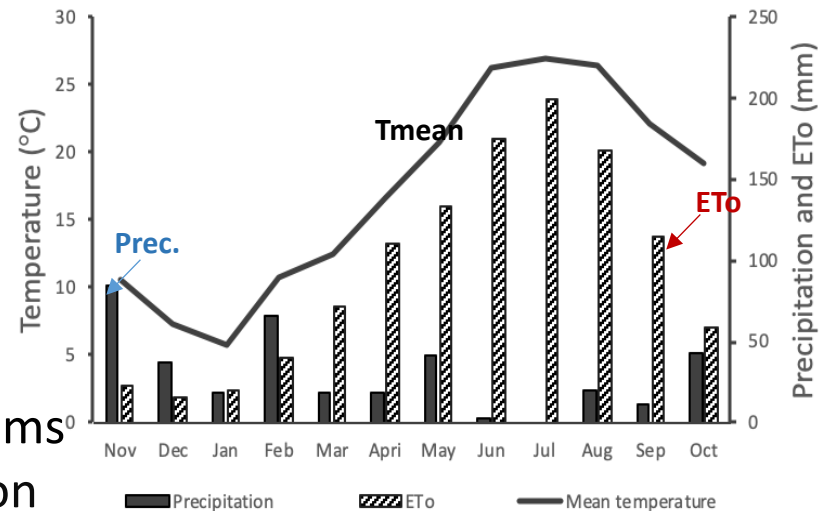


Trunk height:  
0.4 m

*Vitis vinifera* L. Touriga-Nacional  
grafted onto 110R rootstock

Trained to spur pruned **Cordon** and **Guyot** systems  
2.2 × 1.0 m (interrow x row) with E-W orientation

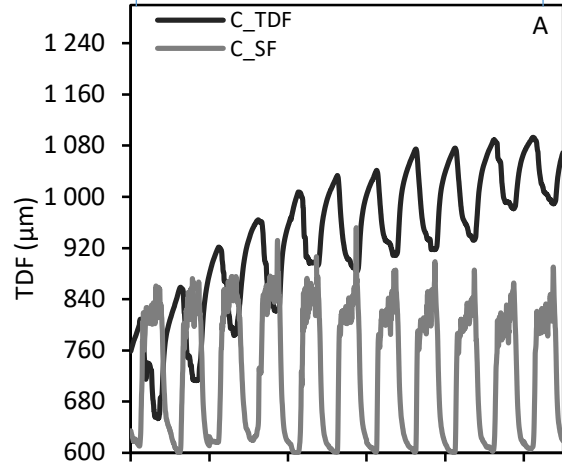
**Soil** is of schist origin with a loam-dominated texture,  
classified as an anthrosol



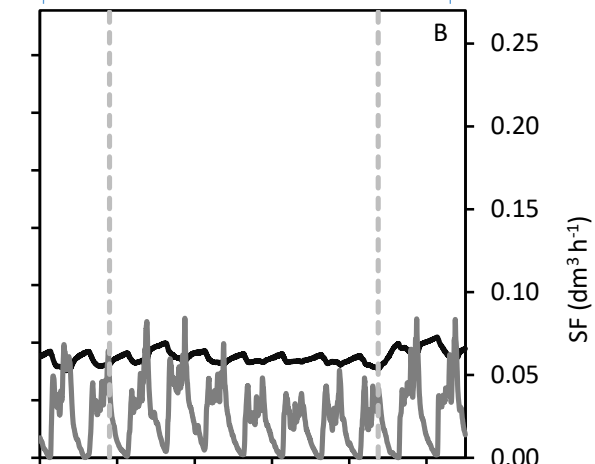


**Cordon**

Post-flowering



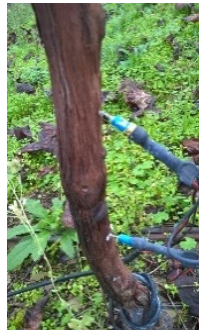
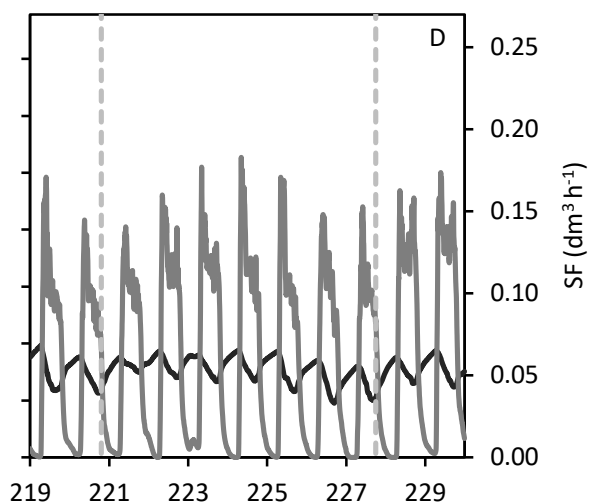
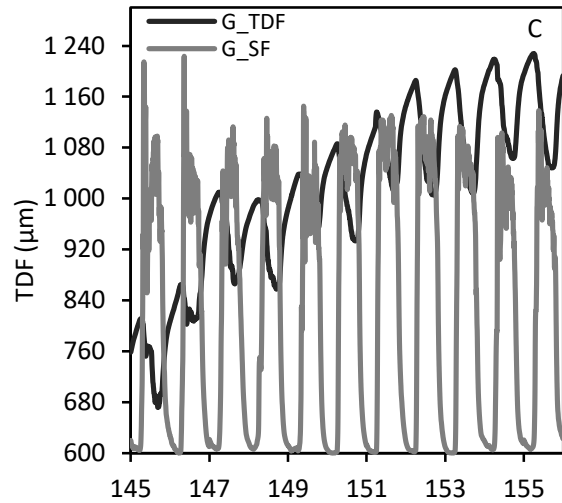
Maturation



• LVDT

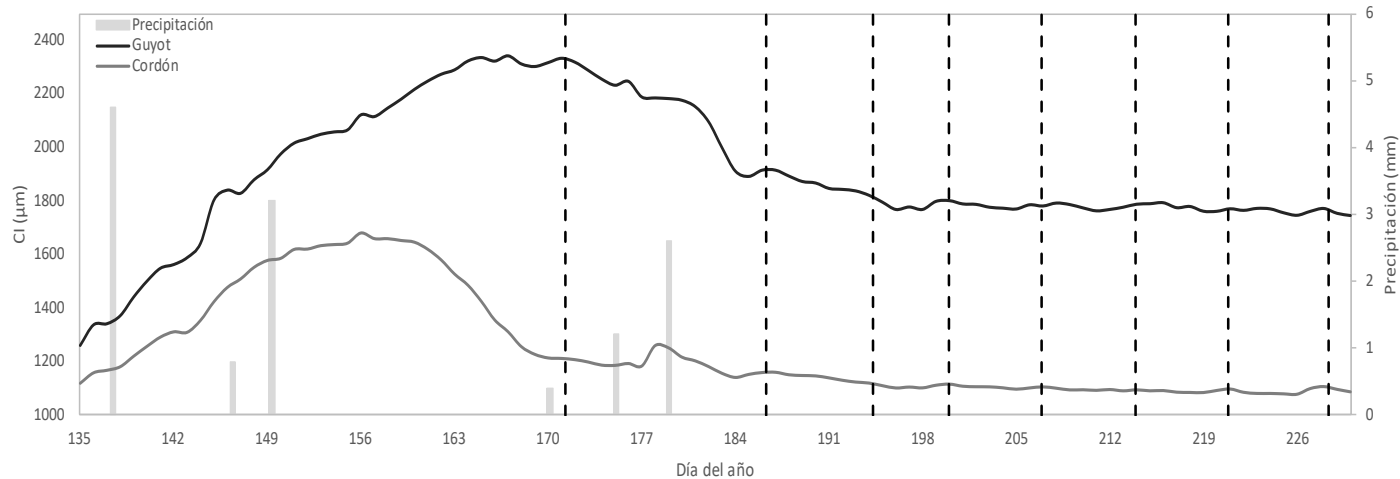


**Guyot**



• sap flow

✓ Adaptive potential of the Guyot pruned vines to the hot and dry areas (effect of the shorter length of the hydraulic pathways), in comparison to the higher trunk and the permanent horizontal cordon of the trained to spur pruned Cordon vines.



## Seasonal variation of cumulative increment (CI) of Touriga-Nacional trained in Cordon and Guyot systems

- ✓ Adaptive potential of the Guyot pruned vines to the hot and dry areas (effect of the shorter length of the hydraulic pathways), in comparison to the higher trunk and the permanent horizontal cordon of the trained to spur pruned Cordon vines.

**Location: DOURO DEMARCATED REGION**  
(41.17° N, 7.25° W, 250 m)

**CLIMATE CONDITIONS:**

- Hot and dry local conditions during the maturation (summer)

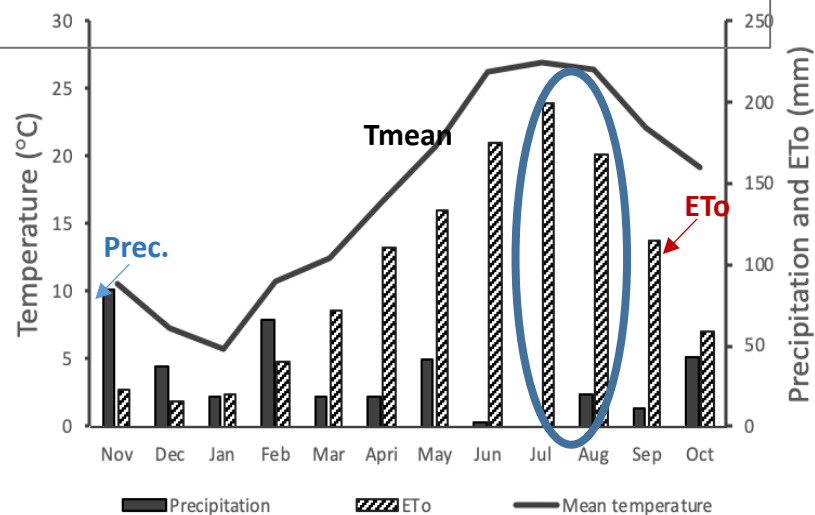
❖ Deficit irrigation as an adaption strategy

- Treatments: Rainfed (control) and 20%ETc, 40%ETc, 60%ETc
- Drip-irrigation: start threshold:  $\Psi_{\text{stem}} < -1.0$  MPa

***Vitis vinifera* L. Touriga-Franca**  
grafted onto 110 R rootstock

Trained to spur pruned cordon  
2.2 × 1.0 m (interrow x row)

**Soil:** loam-dominated texture, classified as an anthrosol



**Table 1.** Leaf area, stem water potential, yield, mean cluster weight, pruning weight, Brix degree, pH and °Brix / total acidity (g/L) ratio of the must at harvest for rainfed and three irrigated treatments (vineyard 2, Sept. 2020). The means followed by distinct letters are significantly different at  $p < 0.05$ .

	Rainfed	20% ET <sub>c</sub>	40% ET <sub>c</sub>	60% ET <sub>c</sub>
Leaf area (m <sup>2</sup> /vine)	0.8 d	1.6 c	2.0 b	2.6 a
Stem water potential (MPa)	-1.6 c	-1.4 b	-1.2 a	-1.1 a
Yield (kg/vine)	0.73 b	0.99 b	1.34 a	1.52 a
Cluster weight (g)	126.0 c	177.0 b	207.0 b	247.0 a
Pruning weight (kg/vine)	0.36 b	0.42 ab	0.48 ab	0.50 a
Brix degree	20.4 c	23.03 b	23.3 b	26.6 a
pH	4.0 b	4.1 ab	4.1 ab	4.2 a
°Brix/total acidity	4.7 c	5.8 b	6.1 ab	6.5 a

➤ Drip-irrigation

56 mm

110 mm

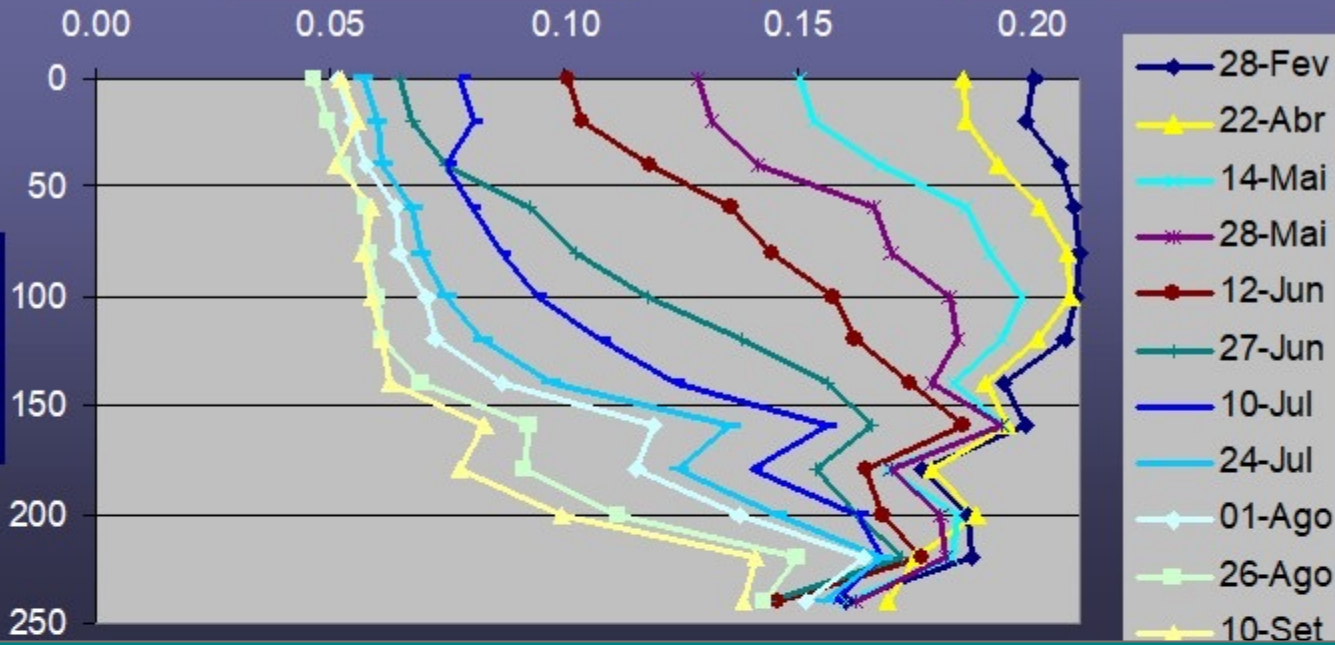
164 mm

**Main conclusion:**

- ✓ Deficit irrigation (40 - 60% ET<sub>c</sub>) had a positive impact on water status, leaf area and yield components compared to traditional rainfed vines, and with no negative effects at must quality.

**Soil Moisture** ( $m^3 m^{-3}$ )

**Rainfed**



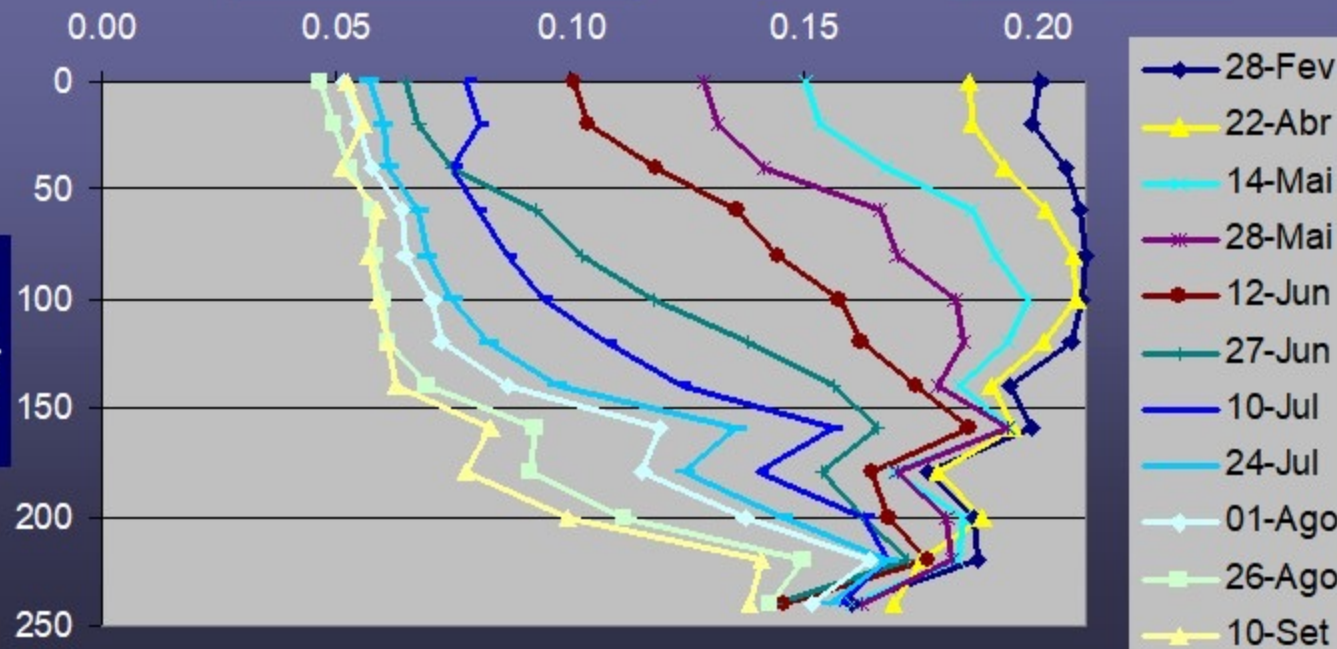
Depth	Soil Water Extraction (%)
(m)	

**Rainfed**

<b>0-0,5</b>	<b>53</b>
<b>0,5-1,1</b>	<b>69</b>

### Soil Moisture ( $m^3 m^{-3}$ )

### Rainfed



Depth (m)	Soil Water Extraction (%)
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### Rainfed

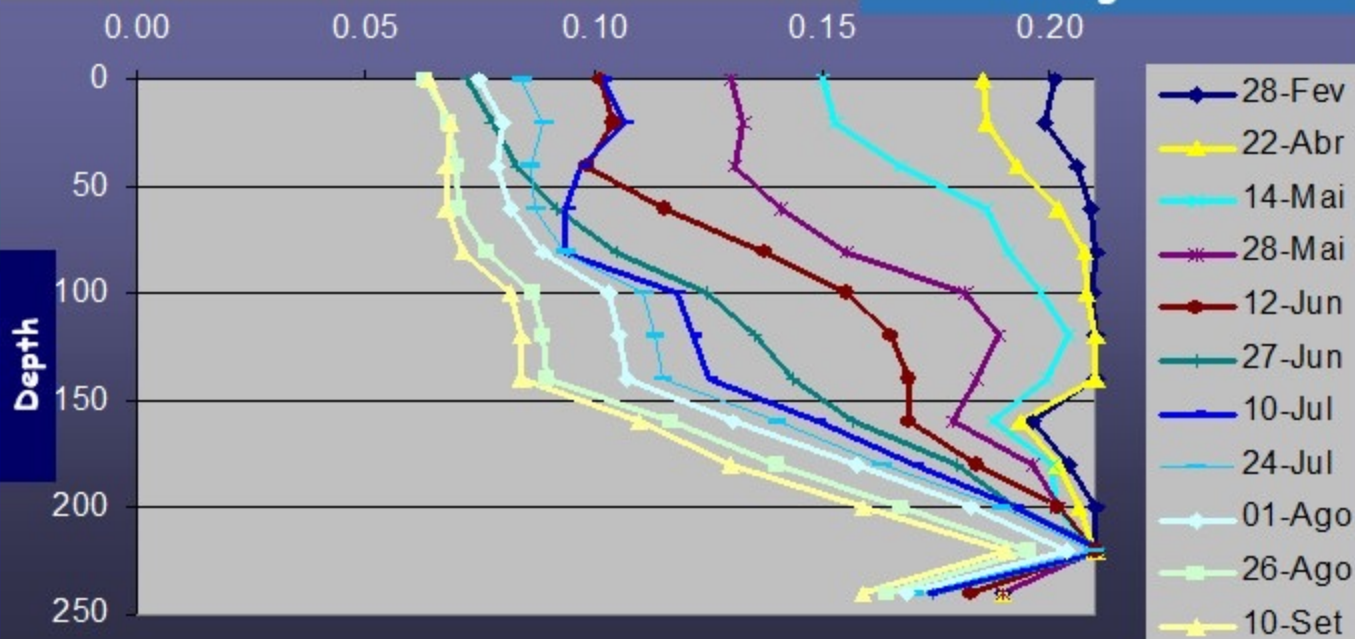
0-0,5	53
0,5-1,1	69

### Irrigated

Depth (m)	Soil Water Extraction (%)
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### Irrigated

0-0,5	83
0,5-1,1	90



**THANK YOU**

## Acknowledgments

*Company / vineyard:*

*- Quinta do Vallado – Sociedade Agrícola Lda (Quinta do Orgal)*