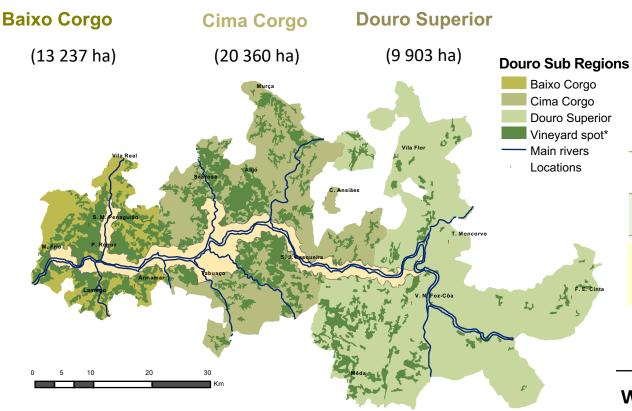


# Douro Demarcated Region

One of the biggest steep slope viticulture regions of world





Surface vineyards (Ha)	43 500
Winegrowers (nº)	20 370

Surface / winegrower: **2.14 ha** (5 parcels)

Source: IVDP, 2019

Winegrowers ADVID	166
Surface vineyards (ha)	6 337.0
1004	E 04.6

WORLD WINDLE THIONOW

IPM 5.916

Organic 421

# **■** Portuguese viticulture facts & figures

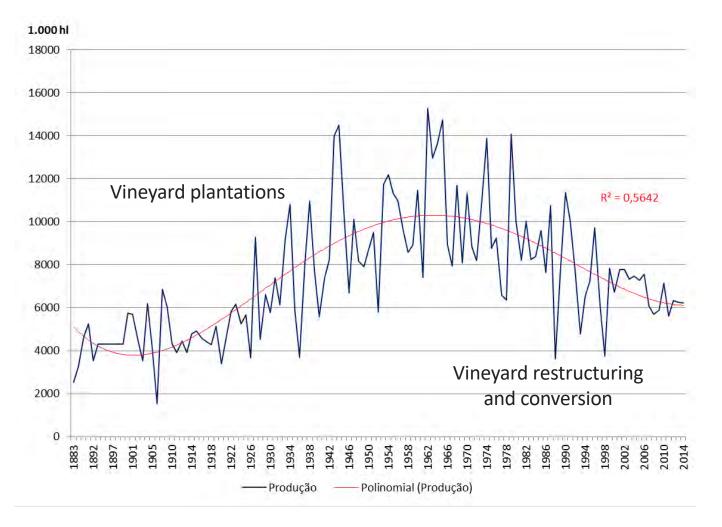
11<sup>th</sup> wine producer (5<sup>th</sup> Europe); 9<sup>th</sup> position in surface with vineyard but with very low productivity (~4 ton/ha) One of the lowest prodution / ha

Source: OIV, 2019 STATISTICAL REPORT ON WORLD VITIVINICULTURE

Country	Wine Prod. (10 <sup>6</sup> HI)	<b>Area</b> (10 <sup>3</sup> Ha <b>)</b>	L/Ha	Tones / Ha
Germany	10,3	103	10,0	13,6
Australia	12,9	146	8,8	12,0
Italy	54,8	705	7,8	10,6
South Africa	9,5	126	7,5	10,3
Argentina	14,5	218	6,7	9,1
France	48,6	793	6,1	8,4
Chile	12,9	212	6,1	8,3
USA	23,9	439	5,4	7,4
Spain	44,4	969	4,6	6,2
Portugal	6,1	192	3,2	4,3
China	9,1	875	1,0	1,4

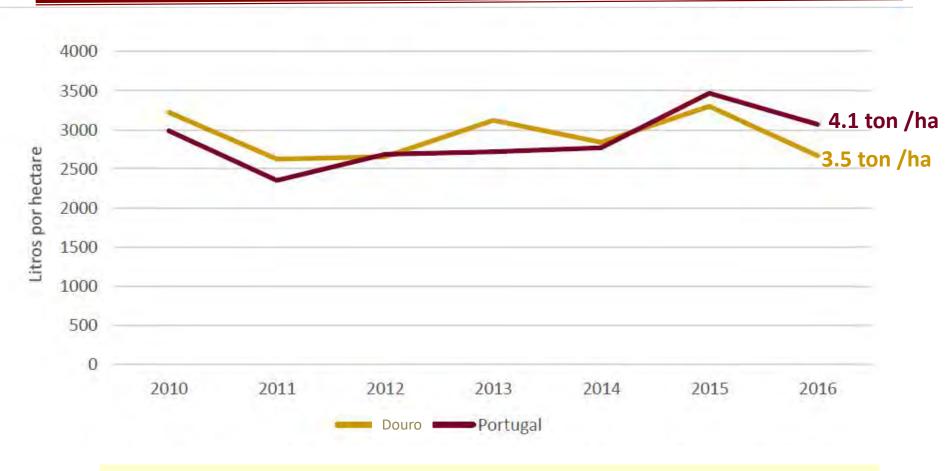
# ■ Wine production time series in Portugal

# The Douro wine sector is extremely vulnerable to climate conditions



Strong interannual variability forced by weather conditions

# **■** Evolution of wine production in Douro Demarcated Region



The productivity is extremely low, when compared with the maximum allowed in DOC) (7.5 ton/ha for red wines; 8.8 ton/ha for withe wines)

Source: IVDP (2017) RUMO ESTRATÉGICO PARA O SETOR DOS VINHOS DO PORTO E DOURO

## ADVID – Research and Experimental Development main areas

# Flagship Projects Research and Experimental Development - R&ED Impact of climate changes on the Douro **Zoning wine production potential Functional biodiversity** Assessment of grapes quality potential **Preservation of genetic diversity** Sustainable production in viticulture Maximizing efficiency of hillside vines **Training and dissemination**

■ Goals of ADVID under climate change strategic line of research

- To identify impacts of climate change in viticulture and needs of wine sector

- To promote studies to analyze evolution of climate conditions and evaluate the application of adaptation measures, in close collaboration with the wine sector and scientific partners at national and international level

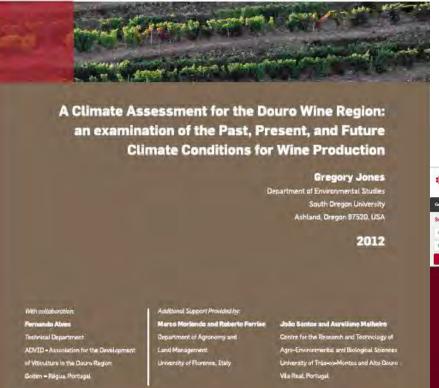
- To recommend to winegrowers the best management practices to reduce their vulnerability to climate change impacts, promoting the stability of production, high quality of wines, enhancing the resilience of wine sector

## Study conducted in Douro about Climate projections (Jones 2012)

A climate assessment for the Douro wine region: an examination for the past, present and future climate conditions for wine production

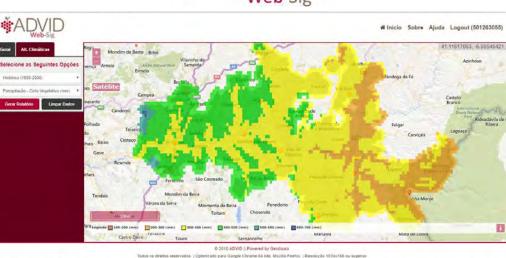






ADVID developed a webtool that allow growers to have access to this information in order to support management decisions





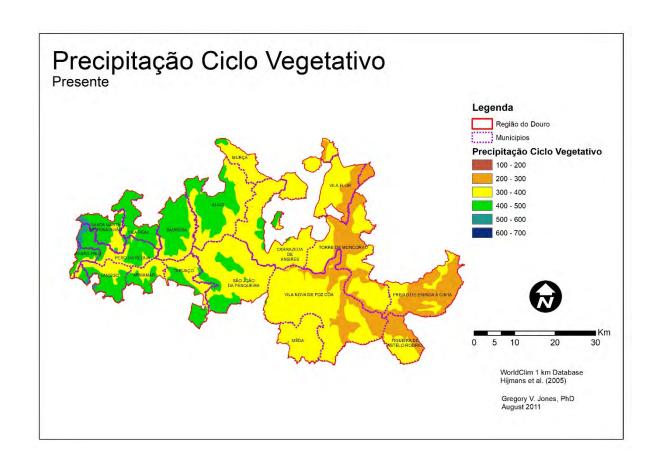
#### A climate assessment for the Douro wine region - Study Description

- 11 climate parameters analized
- 3 greenhouse gas emission scenarios (B2, A1B, A2)
- Spatial Climate: Historic Data (1950-2000)
- Three future time periods (2020, 2050, and 2080)
- Spacial Resolution: 1 km2 (100 ha).

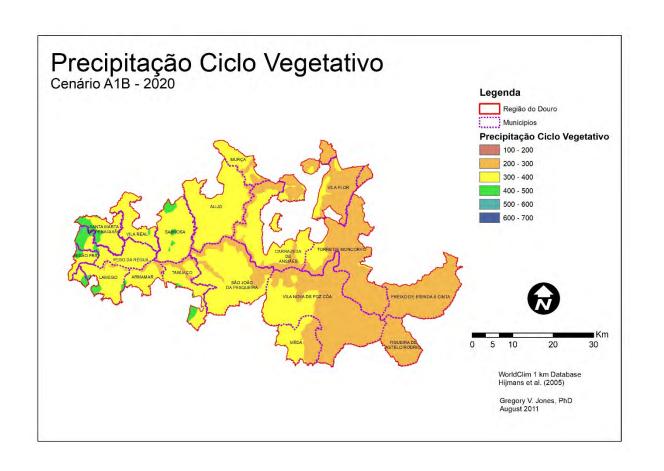
Climate Parameters
Annual Precipitation (mm)
Average Annual Temperature (ºC)
Growing Season Active Temperatures (∑TA, ºC)
Growing Season precipitation(mm) – April to October
Growing Season Average temperature (ºC) – April to October
Growing Season Maximum Temperature (ºC) – April to October
Growing Season Minimum Temperature (ºC) – April to October
Huglin Index
Winter Precipitation (mm) – November to March
Winter Maximum Temperature (ºC) − November to March
Winter Minimum Temperature (ºC) – November to March

Future climate conditions in the Douro Wine Region were examined using IPCC SRES projections.

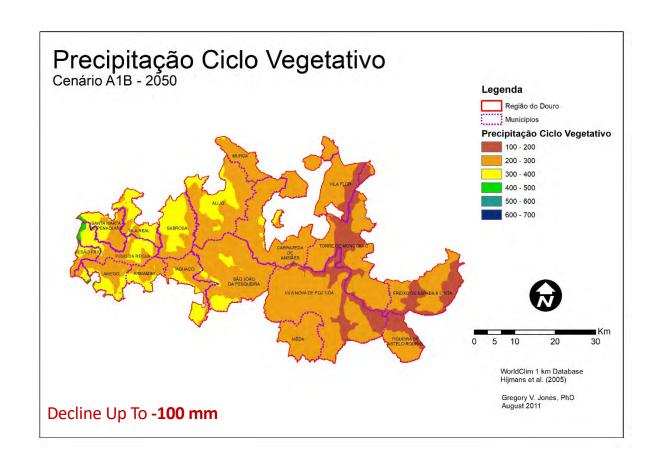
### ■ Growing Season precipitation (mm) - Historic (1950-2000)



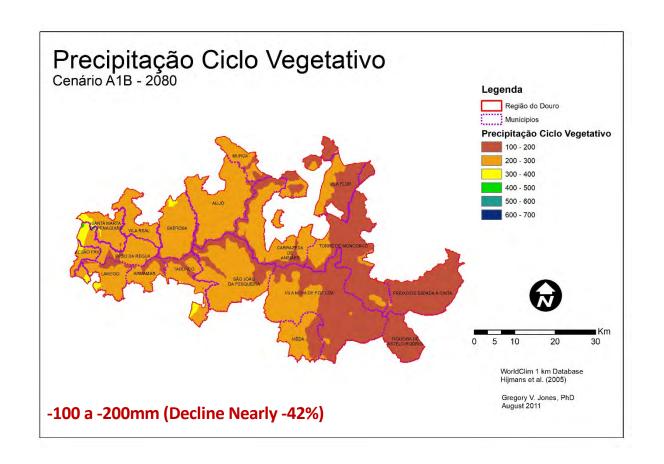
### ■ Growing Season precipitation (mm) - A1B Scenario 2020



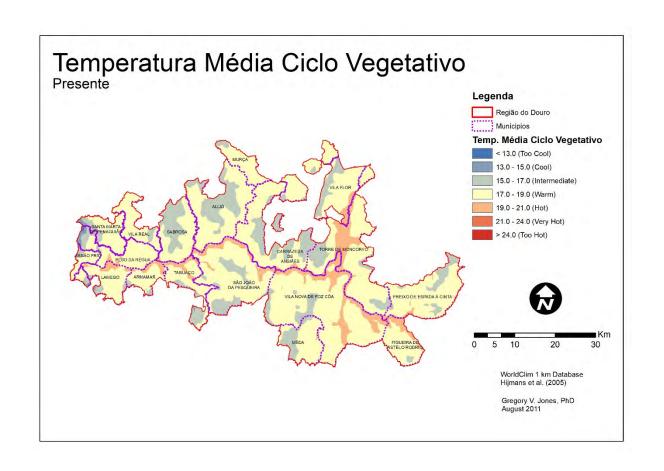
### ■ Growing Season precipitation (mm) - A1B Scenario 2050



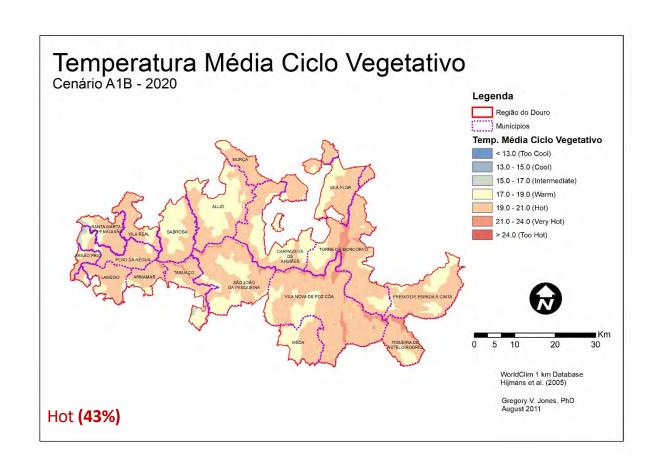
### ■ Growing Season precipitation (mm) - A1B Scenario 2080



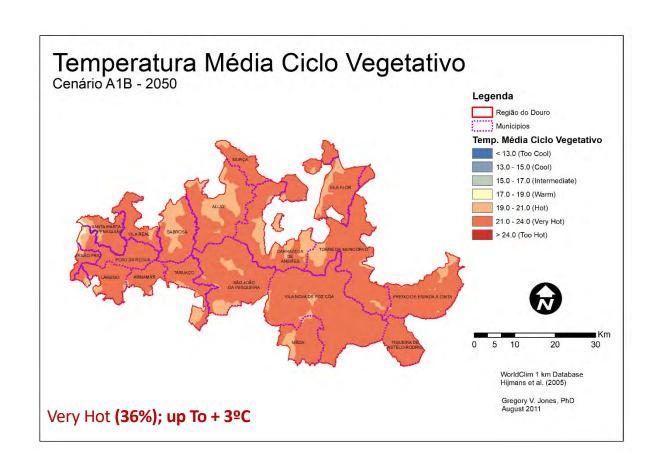
### ■ Growing Season Average temperature (°C) - Historic (1950-200)



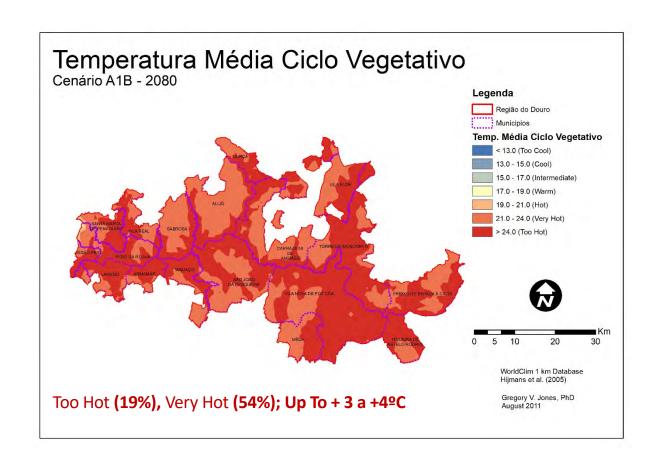
### ■ Growing Season Average temperature (°C) - A1B Scenario 2020



### ■ Growing Season Average temperature (°C) - A1B Scenario 2050

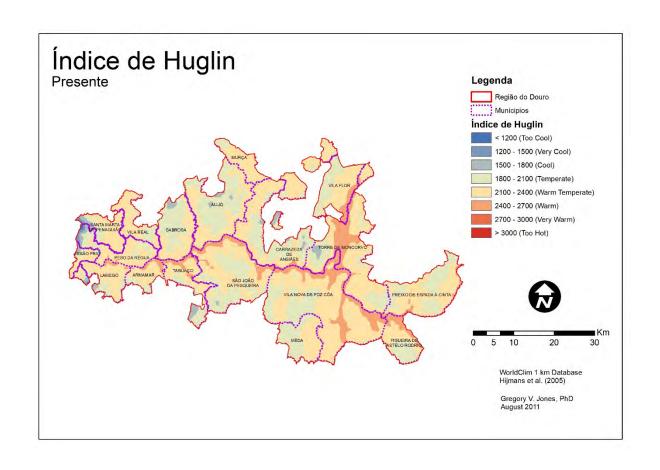


### ■ Growing Season Average temperature (°C) - A1B Scenario 2080

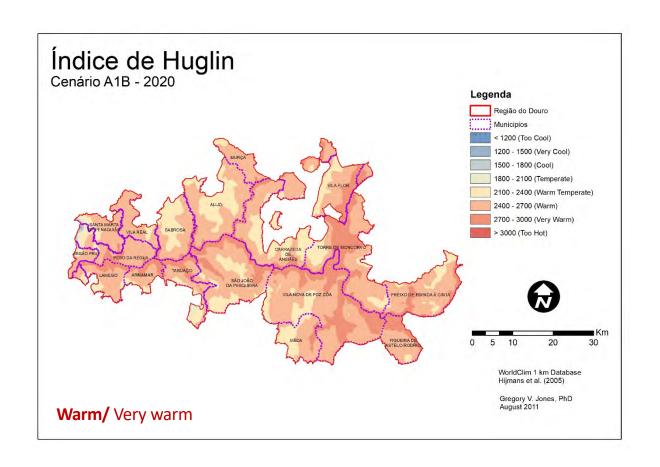


### ■ Huglin Index - Historic (1950-2000)

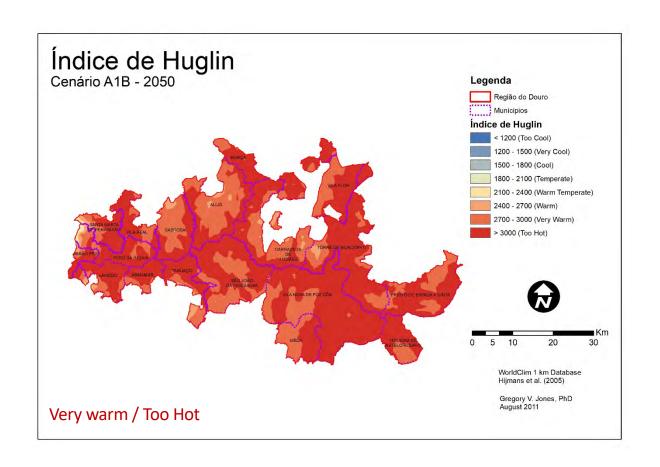
# Bioclimatic Index used in viticulture that indicates suitability of an area for vine cultivation



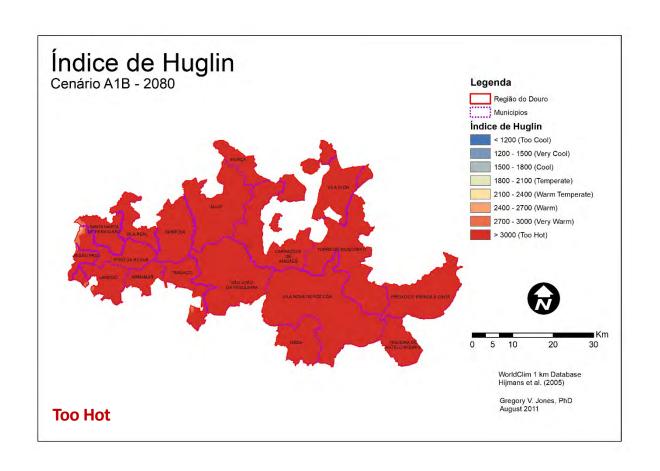
### ■ Huglin Index - A1B Scenário 2020



## ■ Huglin Index - A1B Scenário 2050



## ■ Huglin Index - A1B Scenário 2080



# ■ Impacts (risks) of climate changes in viticulture

- Anticipation of grape ripening / Reduction in time window for harvest (ex. 2017)
- Changes in grape characteristics and wine profiles
- Physiological impacts in vineyards (higher water, heat and radiative stresses)
- Reduction in vineyards longevity
- Changes in pests and diseases complex (ex. More trunk diseases, mealybugs, mites)
- Impacts on soil quality (reduction in organic matter) with higher risk of erosion
- Lower productivity with impacts on economic sustainability
- Risk of abandonment of vineyards in drier zones

Source: Carlos Lopes (ISA)



# ■ Measures to be implemented on news vineyards

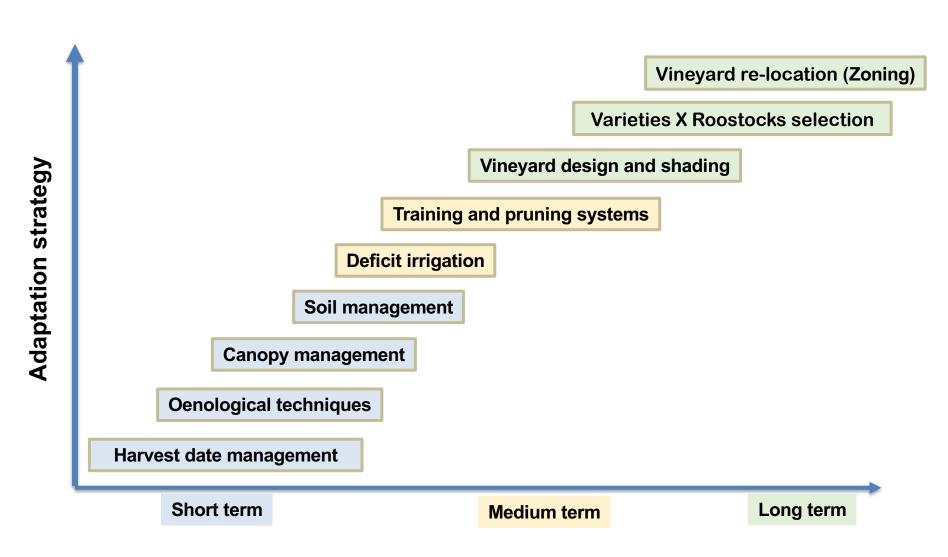
Avoiding unfavourable exposition (south) to prevent sun burn events



# ■ Water, heat and radiative stresses in August / September 2017



## Adaptation measures to climate change and period of implementation



**Period of implementation** 

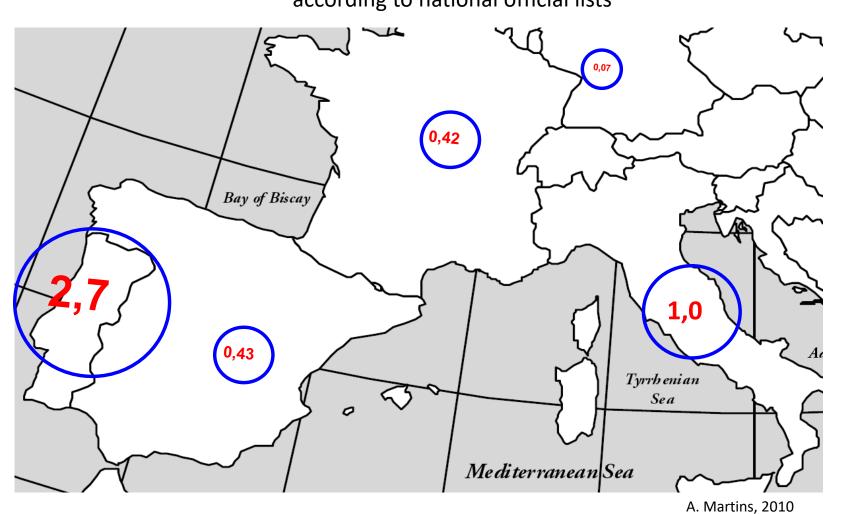
Adapted from ADVICLIM (2016)

		Adaptation	measures t	to climate	change under	study in	<b>Douro F</b>	Region
--	--	------------	------------	------------	--------------	----------	----------------	--------

- a) Preservation and study of **genetic diversity** of Portuguese varieties
- b) Application of kaolin as a leaf protector against thermal and light stress
- c) Management of **Deficit Irrigation** (RD)
- d) Other studies ongoing (application of biochar to soil; shadow nets; precision viticulture techniques)

# Genetic diversity in Portugal

# Number of authoctonous varieties cultivated / km2 in Europe according to national official lists



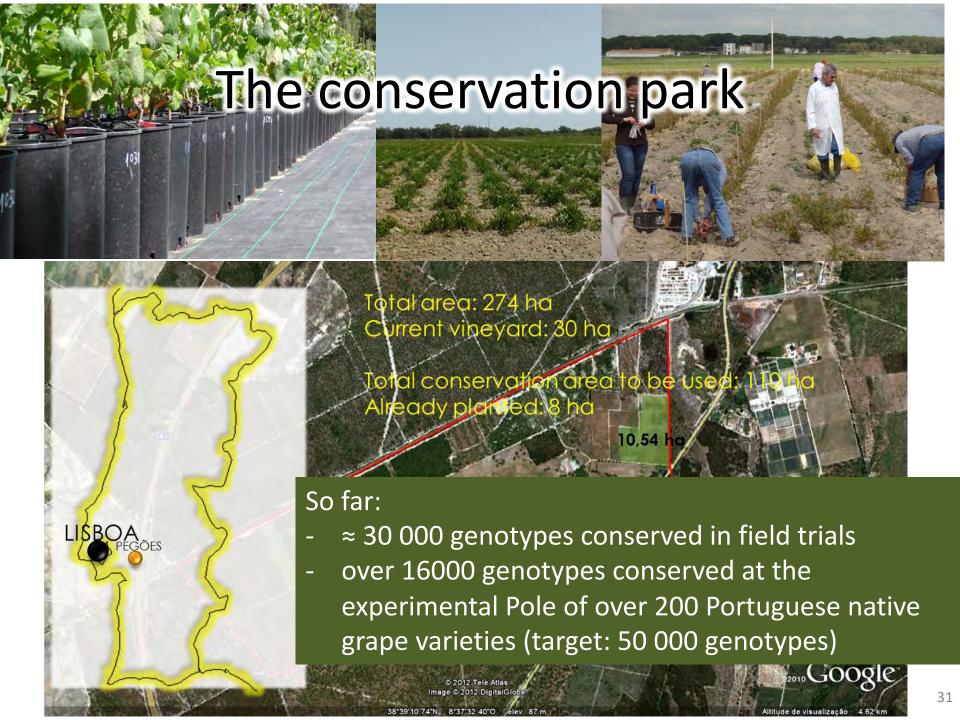
# Douro region – a genetic diversity reservoir





- Public-private association founded 2009 with the following goals:
  - Conservation of INTRAVARIETAL genetic variability in pots and field trials
  - Promote studies on growing and winemaking attributes of 200 autochthonous varieties

# **Stop genetic loss of Portuguese varieties**



## ■ Intervarietal diversity as a climate change adaptation measure



- Possibility to perform polyclonal selection, with different goals
- Select varieties with higher stress resistance

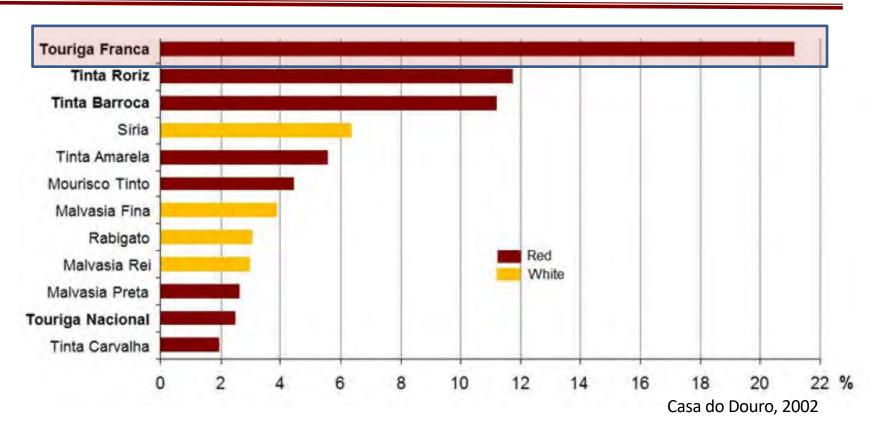
Ex: Tempranillo (Tinta Roriz in Douro) variety

- 30 selected genotypes with priority to anthocyanins are now in a second cycle of comparison in 6 trials (4 in the Douro, 1 in Dão, 1 in Alentejo);
- Selection of more heat tolerant genotypes is ongoing in a trial in Alentejo





# Most used varieties in Douro region

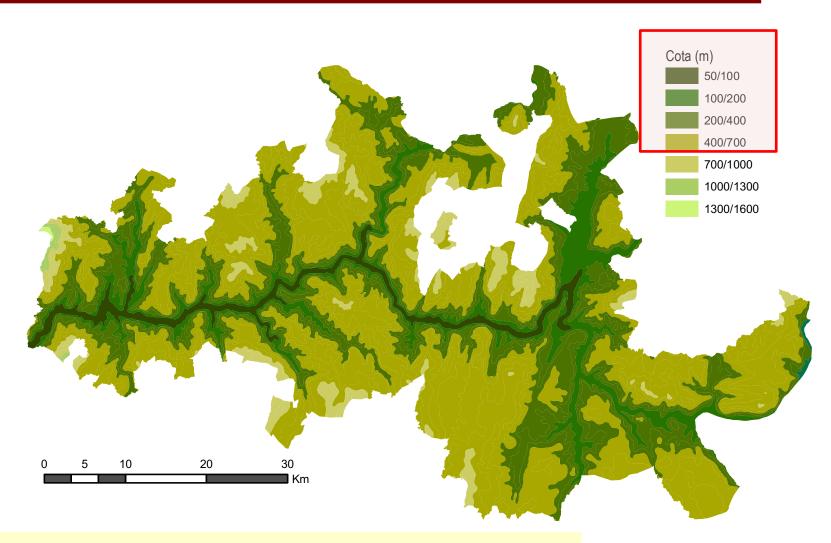


Touriga Franca, one of the most used variety, exibit a higher resistence to climate impacts

Studies are going at Insituto superior de Agronomia (Lisbon) about its leaf anatomy



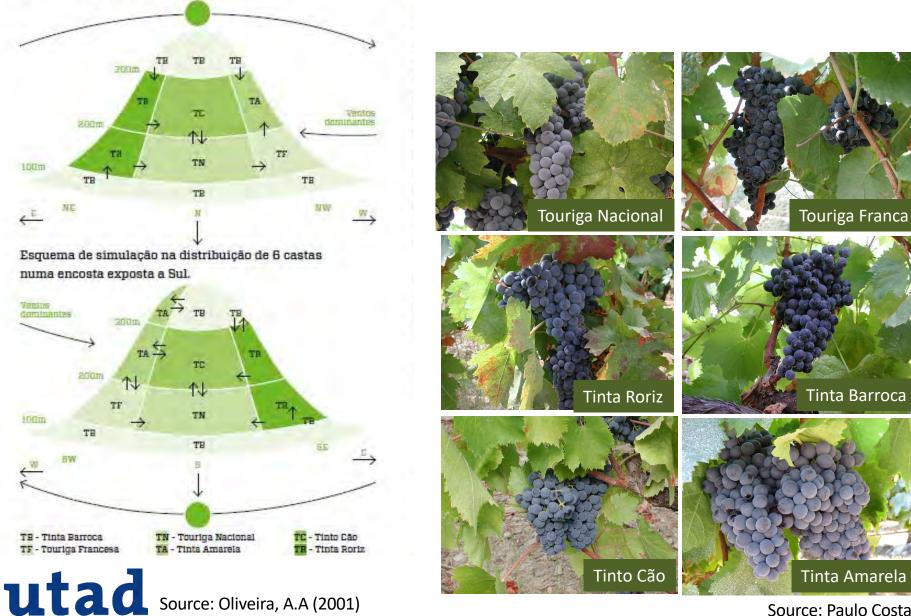
# ■ Classes of altitude in Douro region



Topographic and geographical conditions allow to relocate grape varieties (zoning)

Fonte CAOP e Instituto do Ambiente.

### Zoning strategy was studied for main red varieties used in Douro



Source: Paulo Costa

# Understanding which are the best combinations of rootstocks X Varieties to face climate change...



Heat requirements and length of phenological stages. Effects of rootstock on red grape varieties at Douro Region

Emmando ALVES\*, Millos Edilmano\*, Jorge COSTA\*, Paulo COSTA\*, Faulo Nacado\*, Pestro Loui da Costa\*, Charles Samingtoni

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#### 1. INTRODUCTION

- Snowledge of the phenological images development is crucial for the planning of the vineyand operations, and optimal timing of the ripening assumes its very important annual quality.
   Perspectuals in the major climate element for expective, undersidizentinglical integer.
- . In the Dourn, vines grow in climate conditions with important inter-servual and apaties variability
- Bootstock is among the most important decisions to adapt varieties to a specific serror.
  This wors it is an attempt to define chronological and thermic dustions for worse local red grape, varieties and warnine the potential contribution of different rootstocks on the phenological diagrametric powerful Douro English.

#### 2. MATERIALS AND METHODS

- . The field experiment was located at Quinta de Casadinha (Symington Family Estates).
- Attitude of 205m and it was planted in 1997 with moderate slope (20%) facing northeast.
- Verletter Tourige Nacional (TN), Time Samoca (TN), Tourige France (TF) and Time Sorts (TR) was: examined in the bicos grafted on the rootstocks R110, 196-17 and Repetr's du Lot (R. Lot).
- Buring 10 wars (2002-2011) dates of the main pre-nological stages (but bows), flowering and versions) were recorded, on everage at 50% of their occurrence.
- Climate data. Its from a weather station located at 1,3 km from the pancel and within 100m in attitude. GCD was calculated between each phenological stage.
- \* During ripering, hamplings was taken on average at the 4° week of August, 2° and 4° weeks of

Table 5 - Commission statement (C) of east, above of development of payments nations from Section, Torque Sections, Durings Forms of Time Section and office of the commission (SA 17, ED), Supported that nations (C), Section and Auditorial of Acidetic (C), Sci.

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Ritat	Thomps (become)	U	16.7%	366	8.7%	863	1676	- 2042	1534	
	Tiens Sont	10	6.76	300	7.0%	362	EZR	2246	-63	

#### \$. RESULTS AND DISCUSSION

- In average the number of days to reach phonological stages are 32 (7.5% cv) (1# jan-bud treat);
  61 (11% cv) (bud breat-flowering); and 54 (6% cv) (flowering-weathers).
- Coefficients of variation of the period Flowering-Version are the lowest for all varieties studied.
  Today Nacional but ligger inter-sensal variability of chronological sturstons and also exhibits a longer place (but breath persion).

\* RLID indice a charter cycle making when compared with Repetitis disjust (RLips).

\$20000 100000 Acres and the atmosphy of the country part it felt and arrivates in the diagram for infrages.







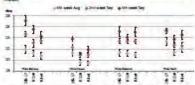


Figure 1. (Then of the contract to the design of specing recommission of adults extra (Mink) for the include action of the service of the include at the contract prompty (19 meet of largest, 2<sup>rd</sup> meet of the include at the contract of the contra

- BLIO induce a reducing in the cycle of the Touriga Nacional variety till the sension.
  195-17 exhibiting capacity to speed and shorter the ripening.
- Growing Degrees Days (ODD) and new models as proposed by Parker et al., 2001 are simple to estimate phonology, but further work is need to develop so model to estimation of maturation.

#### EFFECTS OF THE ROOTSTOCKS AND ENVIRONMENT ON BEHAVIOUR OF THE 6V TINTA RORIZ IN DOURO WINE REGION

Fernando Aives<sup>1</sup>, Paulo Costa<sup>1</sup> and Nuno Magalhães<sup>2</sup>

MOVED a Dourt Wine Region Clarks

\*MOVED - Association for the elegenant of Villackies in the Doute, Cuints do Sente Mails, April 107, USEN-105 Double, Portugal \*Schedules Professor; University of This on-Mortes and A to Doute, 6007-601, Villa Sent,

#### Introduction

The selection of the rootstocks needs to promote the better performance trood with a complex set of interactions, as soil type, physical and chemical properties, pests and deceases, water availability, graps variety and environmental factors, in order to give the stability and the better compromise between production and quality of the grathed grapsvines outlivers.

The aim of this work is to examine the attacts of different toolstooks and environmental conditions on yield and quality of the or Tinta. Floriz, the 2<sup>th</sup> most planted graps variety in Douro Wine Region and the 10<sup>th</sup> all over the world (Temphanillo).

#### Material and methods

The trial was set up at Curita do Borr-Retro (Visiança do Douto), at an elevation of 300 in, north-foliagin, invo-dow, latraces in a sell-derived from schiet, planted in 1988, (2.3 m x 1.3 m). The or Trial Fortz was gratited on Rupeserls du Loi, R110, R10a, S04, 11030, 198-17, 44-53 and 420A rootstocke and Haland in double Royal with vertical shoot position. The climate for the years in study is chartaclerised in Egune 2. The appenimental design foliaxes a model in randomised blocks, with these reputitions and 12 vines per rootstock type. At harvest yield components and grape quality were determined from 1987 to 2500.



Fig.1: the interferous belief of a promotion represents a fire-terminal account.



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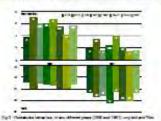
#### Results and discussion

Tab 1: Hone of reduced an publical description to the wells have made of global lawy register and by (10) and Tab of the a Time Description of Security (Security Security Sec

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Table 2: Through the part may had seed chapter completion when complete and Table Visions are arranged of all containing More and Allice Containing and Allice Containing Alli

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-	2.00	4	200		100	100	206		1180	20.0	
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-	DM.	13.	1980	17		NO.	400	-	-town	1900	



- R1(0 and 1103F generally induce the nighest yields in the variety (Table 1), and seems to be better adapted to the drought years (Fig.3).
- R. Lot, 44-53 and 196-17 recistories had a tendency to induce the lowest yields per vine.
- FIGS, is significant irregularity in the observed yield capacity, where it is ceen that drought years affect its performance (Fig 3).
- 1103P inducing the highest number of shoots per plant and the lowest number being reported for 196-17.
- The lower yields of 44-53 and 196-17 are associated with higher Bits, while Rupestris du Lot, traditionally used in the past, for yield levels within the series range as those rootstocks, is associated with lower Strix.

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Authors would the extreminists to Planor Pinfo Vintoe CA and Eng. Cartes Polytos, for all the august glorn to field work with time. To the collection from ACVID, and the students introduct in the date collect. States for the collections in the researchments.



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# Application of sunscreen protection (Kaolin) to vineyards



### This technique result in:

- Reflection of part of radiation
- Reduction in internal temp. of leafs and grapes
- Reduction in transpiration rate
- Higher efficience of photossynthesis
- High stomate condutance
- Reduction of leaf and grape sun burn phenomena

















### PHYSIOLOGICAL AND YIELD RESPONSES OF GRAPEVINES TO KAOLIN UNDER SUMMER STRESS

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#### Introduction

Winegrape production in Mediterranean regions, especially in the Douro Demarcated Region (DDR, Northeast Portugal), is subject to warm and dry summer climate conditions, that may irreversibly impair some physiological processes, leading to poor grape yields and quality. Previous work by our team in the region clearly showed that grapevines growing under severe summer stress experienced significant decline in yield due to stomatal and mesophyll limitations to photosynthesis. Frequently, some of these leaves, particularly those lower on the canes and more directly exposed to sunlight, displayed ineversible photoinhibition and chlorosis followed by process, unprotecting the cluster zone and leading to a decrease in grapevine water use efficiency. Consequently, in low vigour vines, yield, berry weight and sugar concentration are significantly reduced. Furthermore, other berry characteristics, such as colour, flavour and aroma components are suppressed by excessive solar exposure of grapes and low water availability. Related with adaptation and mitigation practices, we wish to reinforce the knowledge of the effect of particle film applications, i.e. spraying canopies with a aqueous suspension of kaolin. Hence, the aim of the present study is to investigate the main effects of a foliar application with a kaolin particle film in the physiological behaviour of the "Touriga Nacional" variety.

#### Material and methods

Experimental trial: The experiment was undertaken in 2012 and 2013 in the commercial vineyard "Quinta do Vallado", located at Peso da Régua in the DDR, northern Portugal.

Plant material: Vilis vinifera L. "Touriga Nacionar", grafted onto 110 R. Three vineyard lines, located on a steep hill, with N-S orientated rows and with 20 plants seach one, were pulverized soon after veraison, with 5% (wiv), solain (Surround WP): Engelhard Corp. Isalin, NJ). Three additional vineyard lines, with 20 plants each one, were maintained as control. I. a without knotine ancient.

Physiological and agronomical measurements: Leaf gas exchange rates were measured with an infrared gas analyser (LCA3, ADC, England). Chlorophyll as fluorescence features were measured in situ with a pulse-amplitude-modulated fluorimeter (FMS 2, Hansatech Instruments, Norfolk, England). Total chlorophylls and total cardienoids were determined according to Lichenthater (1987). Chlorophyll concentration per area was also estimated non-destructively using a SPAD-502 meter (Minotta, Japan). Leaf temperature was measured with an infrared thermoneter (Infratrace KM800S, England) with a 15° field view. Leaf reflectance was measured from 20 to 1100 nm, using a leaf clip with a bifurcated fiber-optic cable attached to both HR2000 Spectrometer (Coean Optics, Inc., Dunedin, USA) and to an Ocean Optics LS-1 tungsten halogen light source. A tharvest, yield per vine was determined in 60 vines be treatment. Values were compared by a one-way MNOVA test. All means were compared at the 0.05 (\*). 0.10 (\*\*) and 0.001 (\*\*) with a 0.010 (\*\*) and 0.001 (\*\*) with a 0.001 (\*\*) and 0

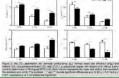




#### Results



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### Discussion and conclusions

The application of 5% kaolin resulted in the formation of a whitish dry residue on the exposed leaves which increased the reflector capacity (Fig. 1). One of the direct effects of this application was a significant reduction of leaf temperature (Table 1). Consequently, during the summer period, the degradation of photosynthetic pigments was not as evident as in control ones (Table 2). Measurements of gas exchange indicate significantly higher A in kaolin leaves (Fig. 2). Particularly at ripeness stage, the increase in A was more evident than the slight increase in Q during warmer periods of the day, leading to higher A/g, and lover C/C/c. The increase of the photosynthetic rate in kaolin treated leaves was associated to an improvement of the PSII photochemical efficiency. At harvest, mainly in 2012, the kaolin effect had a clearly positive impact on the productivity performance of the vines (Table 4).

In conclusion, the results of this study, carried out with grapevines of the same variety and under similar field-grown conditions, emphasized the beneficial role of kaolin as a short-term measure for growing grapevines under high irradiance levels and heat/water stress conditions, such as in Douro region. Particularly during the ripening stage, the photosynthetic capacity depression was associated with important photochemical and biochemical changes that can negatively compromise the grape production, particularly emphasized in low yield years.

#### References

See Proceedings of XII International Terroir Congress for more details.

#### Acknowledgments

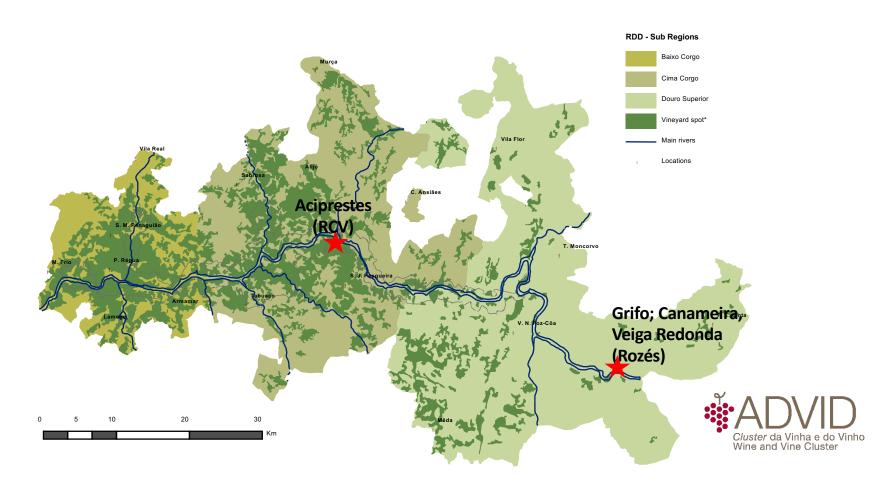
This work is supported by the FCT project PTDC/AGR-AL/110877





## ■ Promote the efficient use of water – Deficit irrigation trials

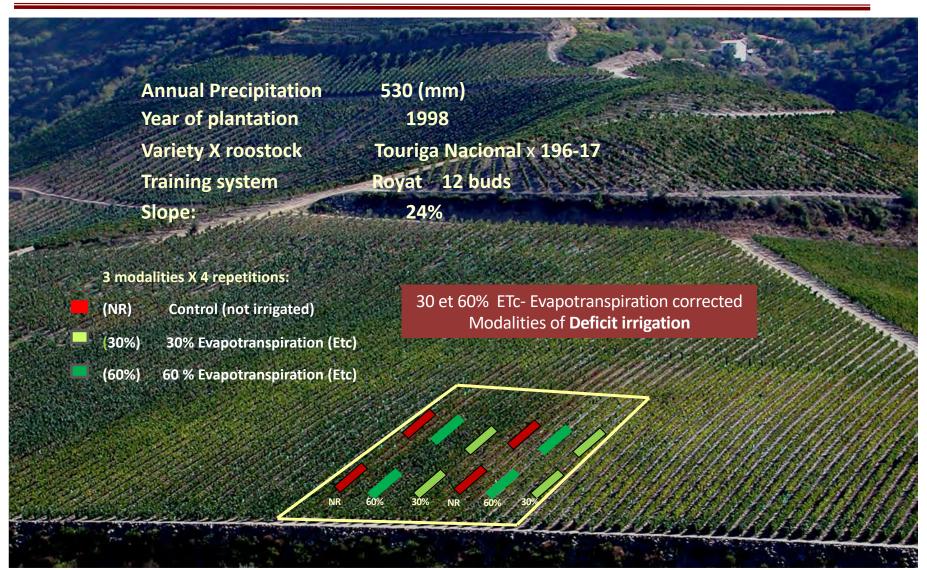
### Irrigation is strongly regulated in the Douro Wine Region



Two varieties under study: Touriga Nacional and Touriga Franca

# ■ Trial installed in a comercial vineyard under study since 2002

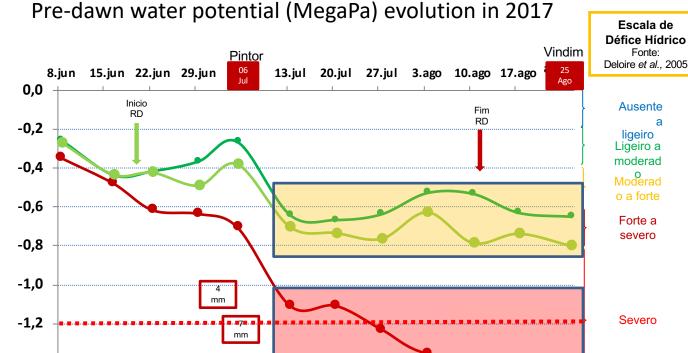




### Sholander chamber pression - An important tool for assessing hydric status

**→**NR

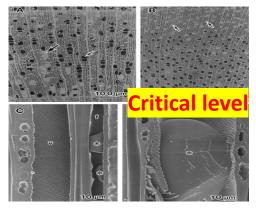




---R60%

---R30%

N=24



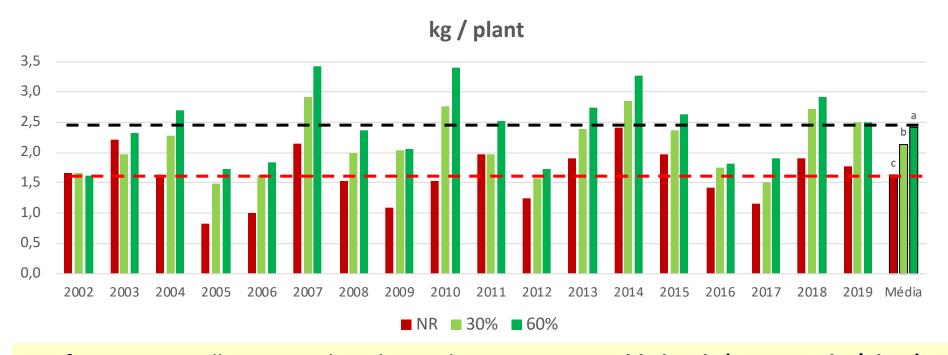
-1,4

-1,6

### ■ Pre-dawn water potential (MegaPa) evolution in control plot (nor irrigated) (2002-2019)



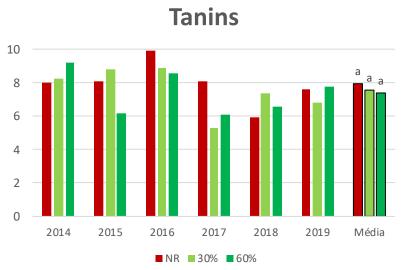
# Analysis of production / plant (2002-2019)



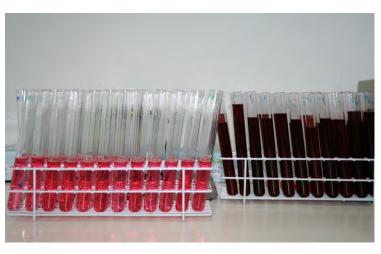
Deficit irrigation allow to regulate the production at reasonable levels (1,5 to 2,5 kg/plant)

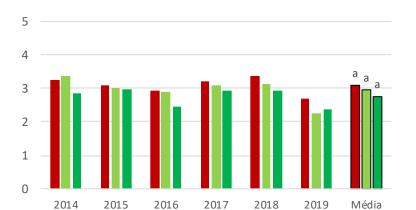


# Analyses of grape quality (2014 - 2019)









■NR ■30% ■60%

**Antocianins** 

The two modalities of Deficit Irrigation did not result in negative impacts in Antocianins and Tannins

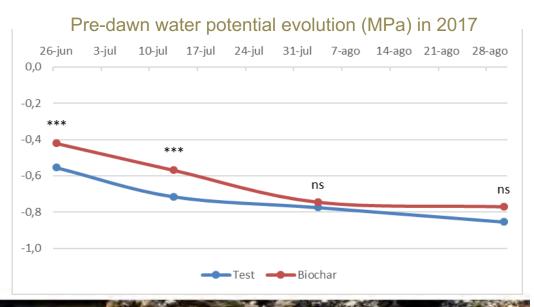
■ In available places, install water reservoirs



# Ongoind studies- Application of "BIOCHAR" to vineyard soil

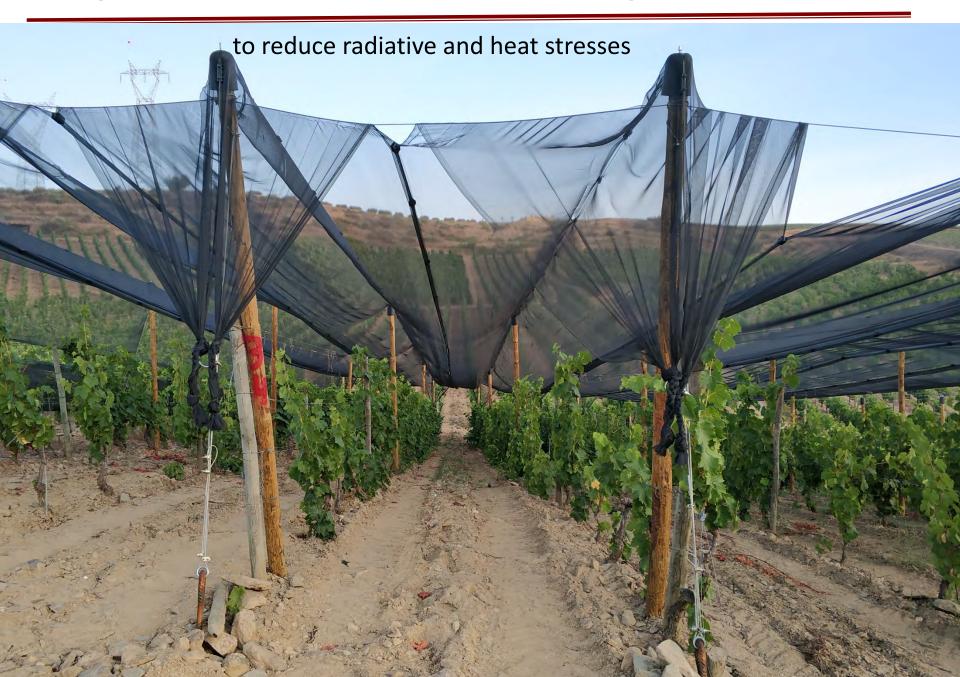
**BIOCHAR**- charcoal produced from plant matter that cab be applied to soil to improve its characteristics







# Ongoind studies- Application of "shading nets"



# **■** Work ongoing related with precision viticulture

- Project WINESPECTRA Management of deficit irrigation in vineyards based on vegetation indexes
- Partnership: Sciences faculty of University of Porto, ADVID, Real Companhia Velha and Symington Family Estates
  Evaluate the potential of vegetation indexes based on reflectance data, to estimate water status of vineyards
- Project VINIOT Network-based precision viticulture service IoT sensors for digital transformation of SMEs in the SUDOE space
- Partners: AIMEN, AGACAL, ADVID, IFV, INRA, AGAMELARIOJA, FEUGA, IRSTEA

Creation of a new technology monitoring service for vineyards in real time, to assess relevant parameters in viticulture such as water status, grape maturity or pest and phytosanitary status

## General conclusions

- There are several adaptation measures to climate change
- The adaptation measures should not be applied in a general way, but validated in different terroirs, years and different production objectives (ideally by each wine company)
- Serious and long-term studies are needed to allow us to correctly diagnose the problem and consequently define the most appropriate solutions
- Those studies should result in guidelines that allow the recommendation of most effective adaptation measures to reduce viticulture's vulnerability to climate change

