April 10>13, 2016 – Bordeaux, France

ClimWine 2016 International Symposium

VINEYARD DROUGHT ADAPTATION IN THE DOURO DEMARCATED REGION

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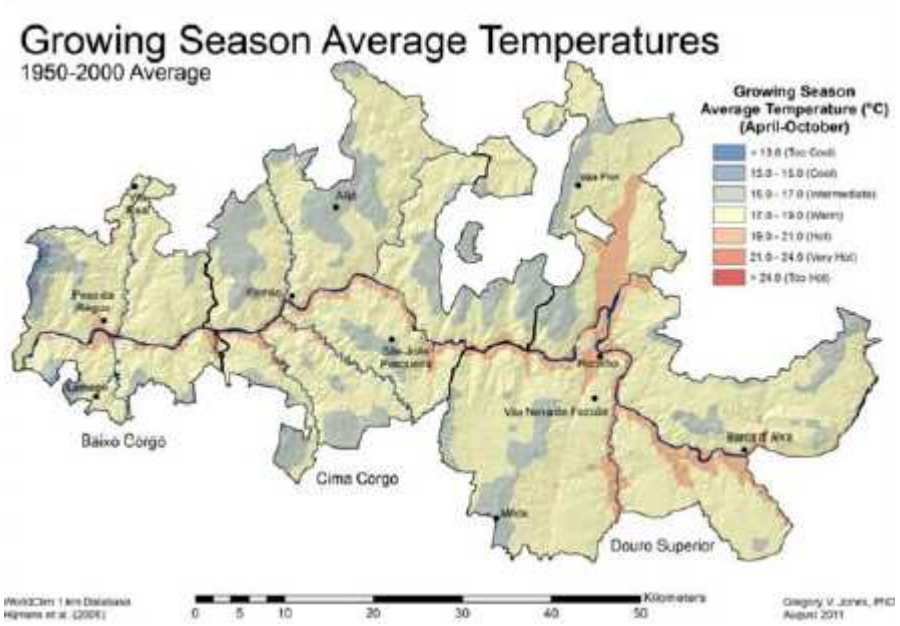
Douro Region: climate

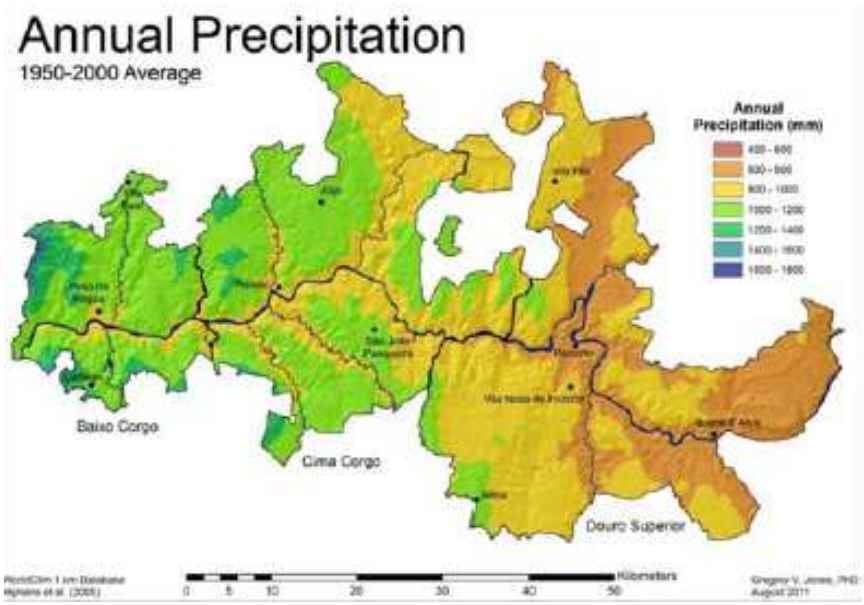
- **Growing season temperatures**

  For the period 1950–2000 (Hijmans *et al* 2005) averaged 17.8°C over the entire region, but ranged from a low of 12.1°C in the upper elevations in the Baixo Corgo to 19.7°C in the warmest areas in the Douro Superior

- **Annual and growing season precipitation**

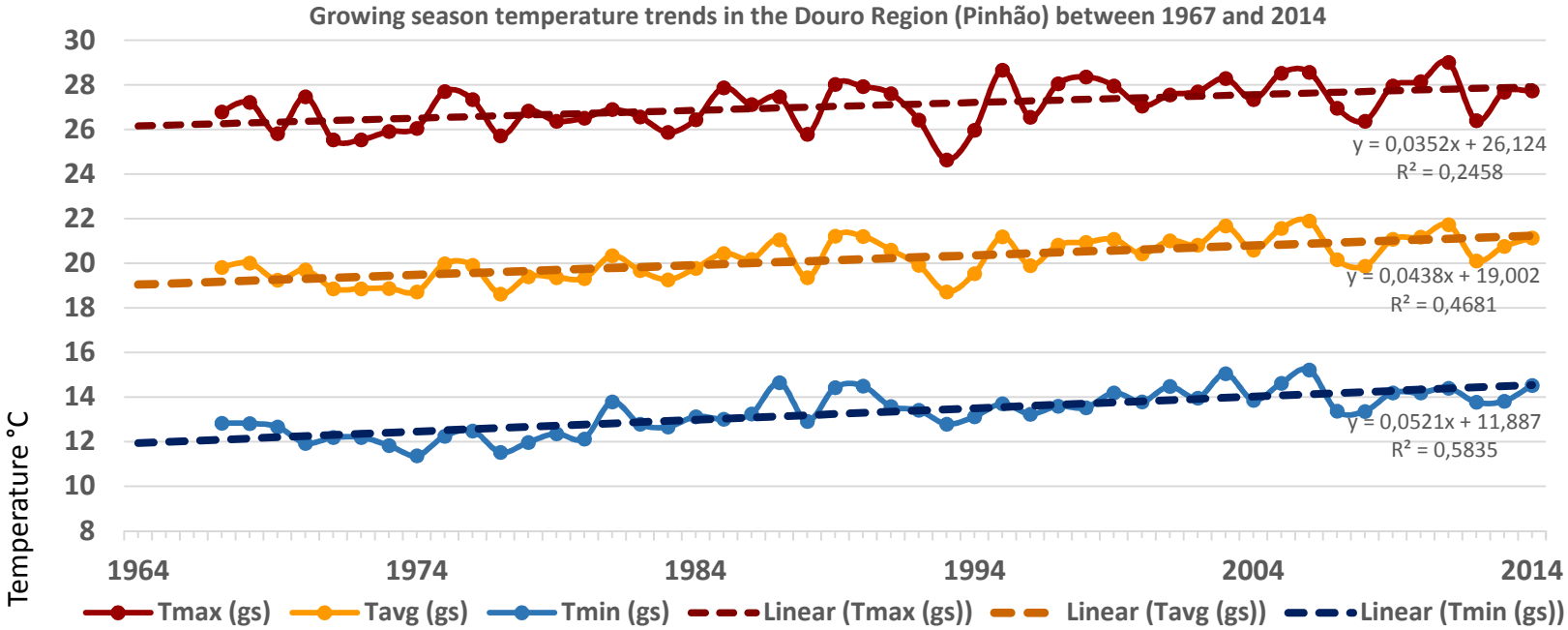
  During the active growth stages of grapevines. the average rainfall varies between 189 and 326 mm, while it is only 50 to 85 mm during the ripening stage. give rise to situations of intense summer plant-soil-water stress. particularly in the Cima Corgo and Douro Superior.





G Jones; F Alves / ADVID/ 2012 (IJGW *Vol. 4. Nos. 3/4)*

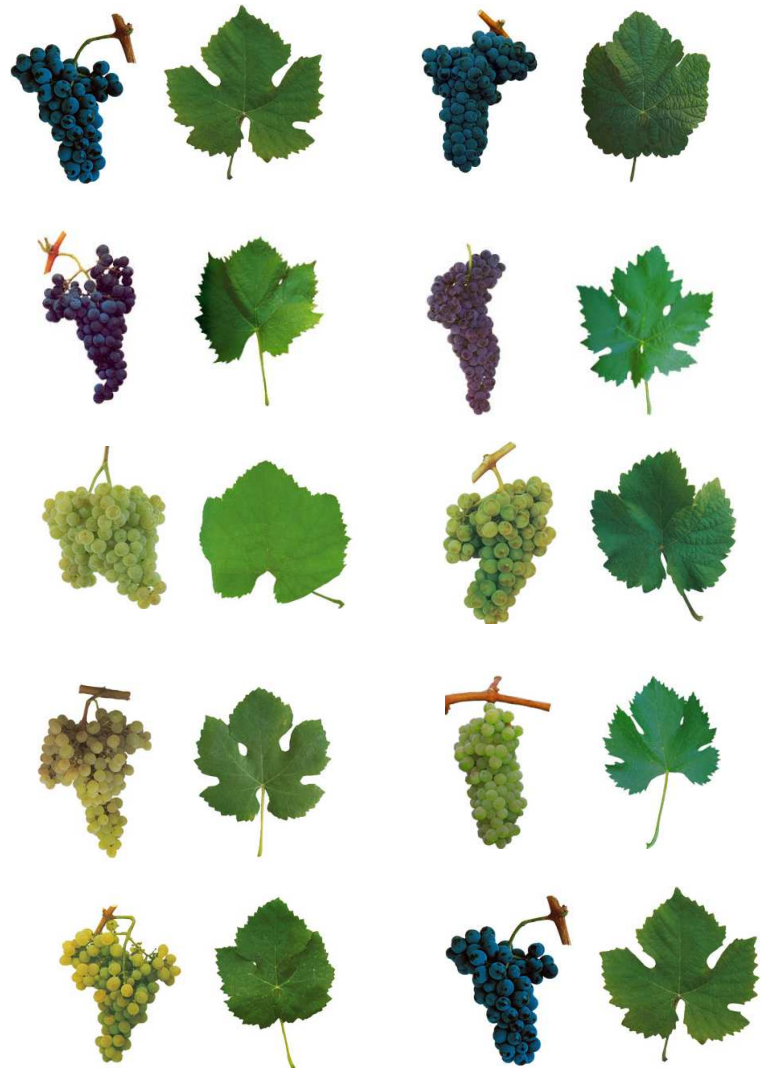
Douro : temperature trends (Pinhão)



- During this 47-year period minimum temperatures have increased 2.6°C on average, almost double the increase in maximum temperatures (1.4°C). Furthermore, the trend shows that average growing season temperatures during the second half of 1967–2014 are 1.3ºC warmer than the first half of the period.
- Future projections for the Douro Wine Region, over three different emission scenarios, indicate a range of growing season warming of 0.8-1.8°C by 2020; 1.8-4.3°C by 2050 and 2.5-6.6°C by 2080. A range of annual precipitation decreases of 7% by 2020 and 22% by 2080.

Adapted from: G Jones; F Alves / ADVID/ 2012 (IJGW *Vol. 4. Nos. 3/4)*
G Jones et al 2012 (ADVID Ed.) - A Climate Assessment for the Douro Wine Region: an examination of the Past. Present. and Future Climate Conditions for Wine Production

Grapevine genotypes diversity: adaptation



- **Portugal**
- **343** grapevine variety's on national catalog;
- Near **250** from total are indigenous varieties;
- Country with the greatest variety diversity of any wine producing nation (per 1.000 km2);
- Unmatched legacy which must be preserved and studied for the benefit of the whole of the country’s and world wine sector;
- **Douro**
  - **115** grapevine variety´s
  - **65** red
  - **50** white

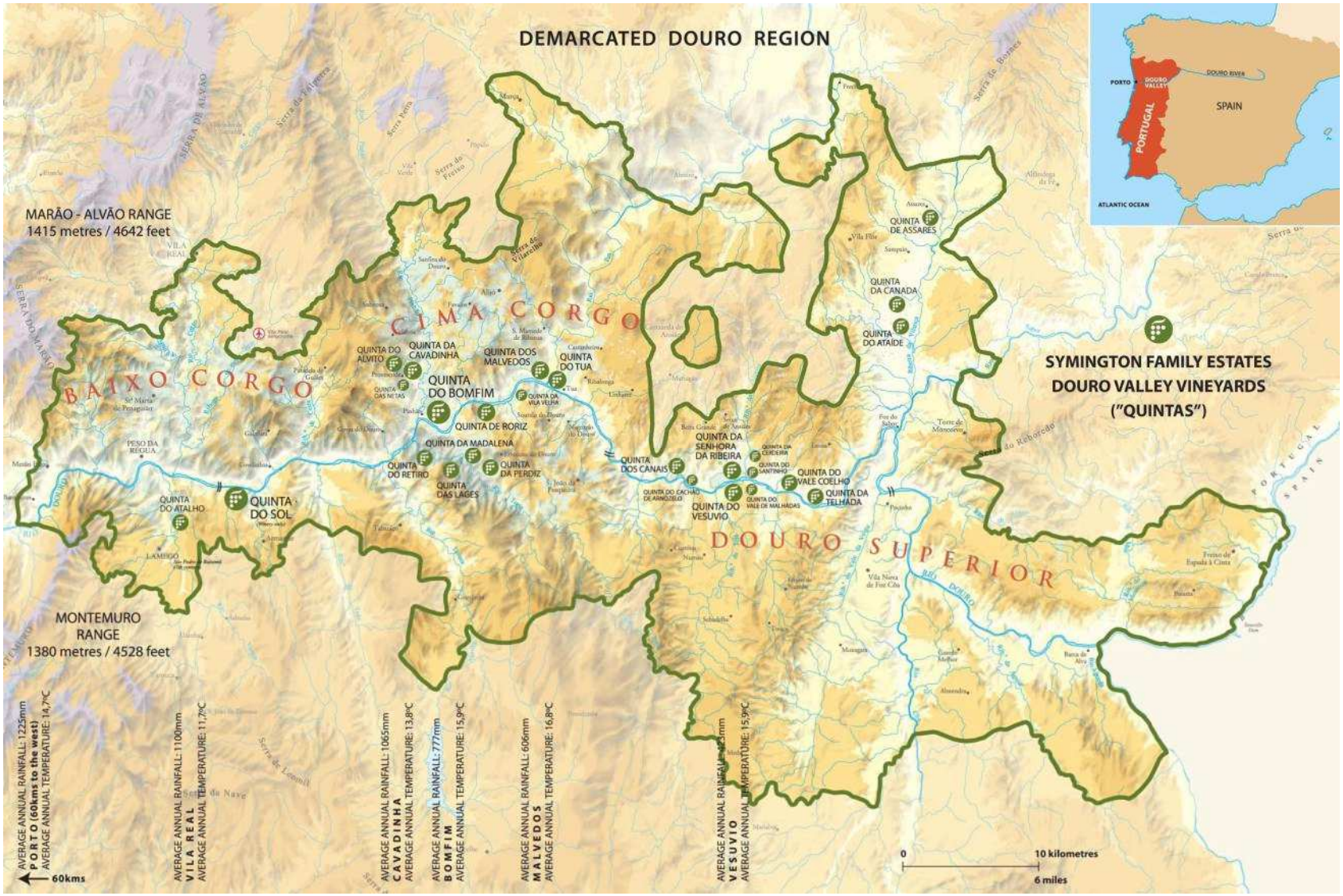
Symington Family Estates

- Symington Family Estates (SFE) is one of the principal Port producers and is the leading vineyard owner in the Douro Valley.

- With a total area of 1.006 hectares (2.486 acres) of vines spread across 27 Quintas dotted around the Douro's three sub regions (Baixo Corgo. Cima Corgo and Douro Superior) in what is the world's largest mountain vineyard.

- Producing top quality wines in a challenging Region.

Symington Family Estates



- **Properties covering a wide climatic situations in the Douro Valley.**

Previous studies

- **Effects of rootstock and environment on the behaviour of Portuguese grapevine varieties in the Douro Region**
  - F Alves, M Edlmann, J Costa. P Costa, P Leal Costa, C Symington
  - **IX Terroir Congress 2012**
  - **Data analyzed over 11 years**

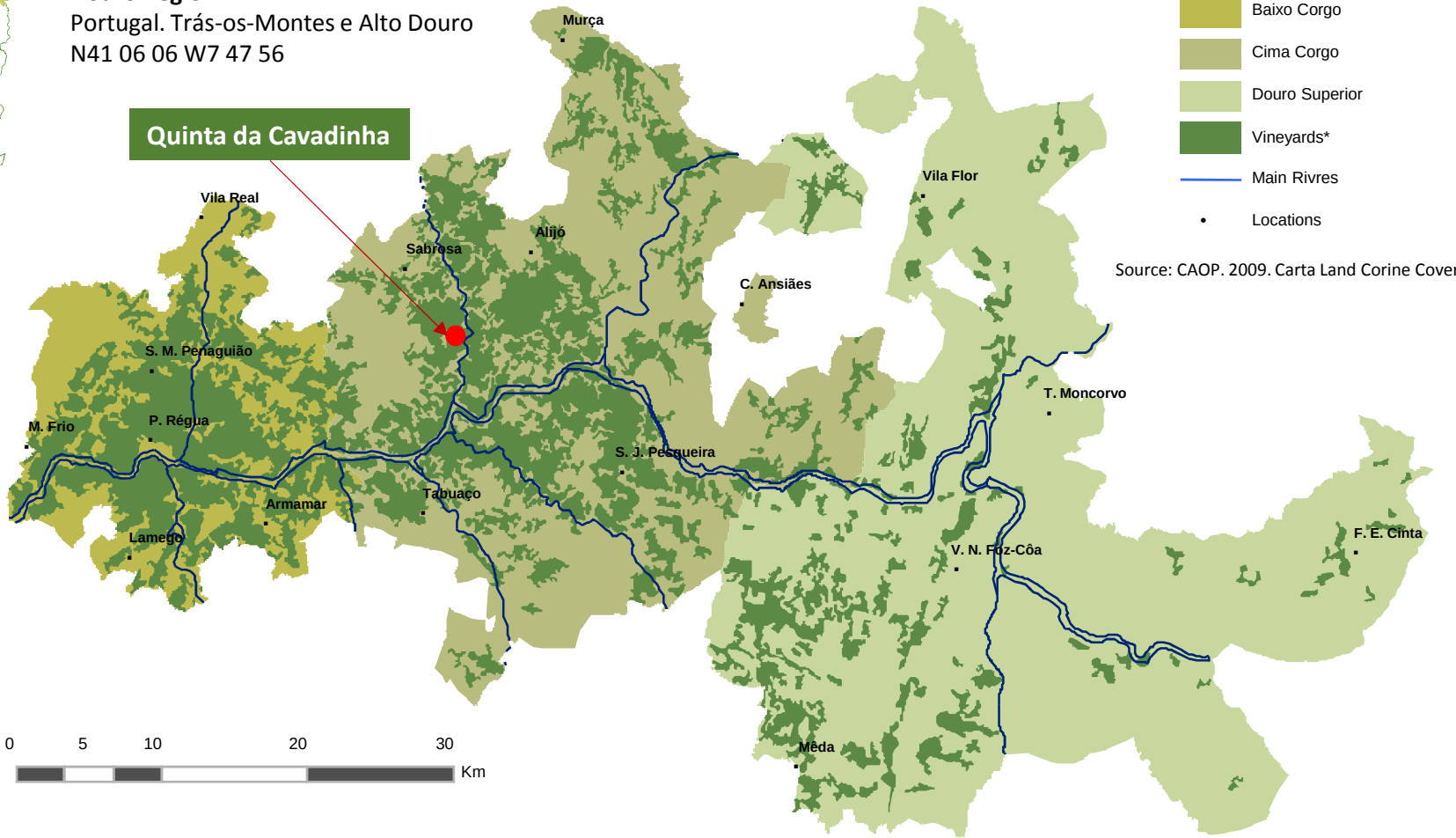
- **Heat requirements and length of phenologycal stages. Effects of rootstock on red grape varieties at Douro Region**
  - F Alves, M Edlmann. J Costa, P Costa, P Macedo, P Leal Costa, C Symington
  - **18th Symposium GiESCO 2013**
  - **Data analyzed over 12 years**

Objectives of the present work

- Although some studies are available, regarding the most adapted cultivars of grapevines to adverse conditions.
- Only few of them are performed to understand the actual mechanism of adaptation behind the tolerance to drought.
- This preliminary study intends:
  - Elucidate some of the basic mechanisms of adaptation of different cultivars
  - Grafted onto several rootstocks, to withstand drought.

Field experiments location

Douro Region
Portugal. Trás-os-Montes e Alto Douro
N41 06 06 W7 47 56



RDD - Sub Regions

- Baixo Corgo
- Cima Corgo
- Douro Superior
- Vineyards*
- Main Rivres
- Locations

Source: CAOP. 2009. Carta Land Corine Cover. 2006

Total area	**251.000 ha**
Vineyard area	**45.500 ha**
Wine production	**1.4 millions hectoliters**

Grapevines and rootstocks

Tinta Barroca (TB)

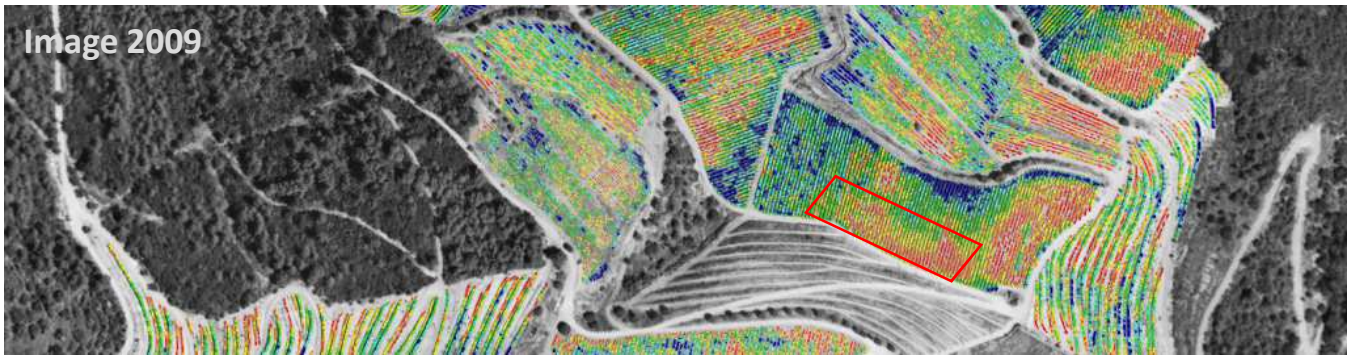
Tinta Roriz (TR)
Syn. Tempranillo

Grafted on:

196-17 CL / 110 R / 1103 P / Rupestris du Lot

Material and methods

- Vine located at Quinta da Cavadinha (Symington Family Estates). Sabrosa - Douro Region
- Planted in 1997 - schist soil - elevation 210 m - slope (24%) facing northeast.
- Bilateral Royat with vertical shoot positioning (8-10 buds / vine)



- Study period - 2013
- Grapevines: Tinta Barroca (TB). and Tinta Roriz (TR) (*Syn*. Tempranillo)
- Rootstocks: Rupestris du Lot (R. Lot). R110. R99. 1103P and 196-17.
- During grape maturation berry samples taken for oenological properties
- At harvest yield parameters were recorded and vine vigour through pruning weights.
- Sampling for anatomical analyses in 23 September

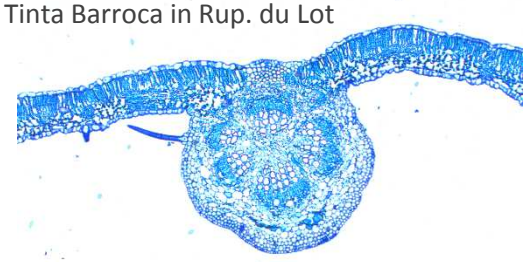
Material and methods ▪ sampling

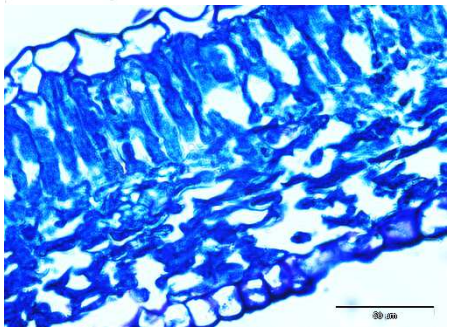
- 2 leaves at same node position was sampled in 6 vines
- 6 berries sampled per vine

Material and methods ▪ analyses performed

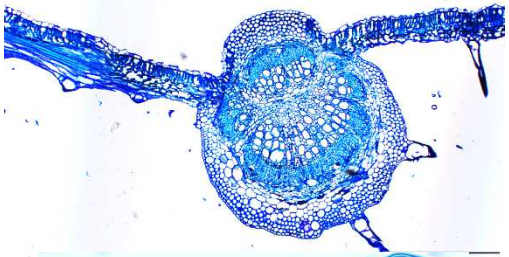
- Leaf anatomical
  - Xylem vessels and tissue measurements
- Leaf biochemistry
  - Waxes
  - Photosynthetic pigments
  - Soluble sugars
  - Starch and non-structural carbohydrates content
  - Total phenolics
  - Proteins
  - Thiobarbituric acid reactive substances –TBARS
- Berries
  - Anatomical
  - Biochemical
  - Fruit quality

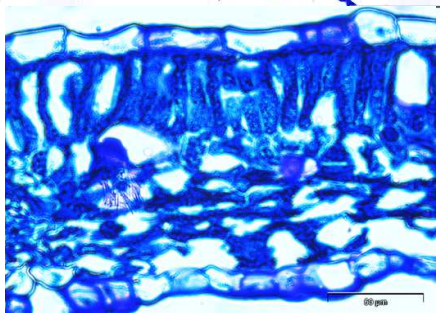
Tinta Barroca in Rup. du Lot



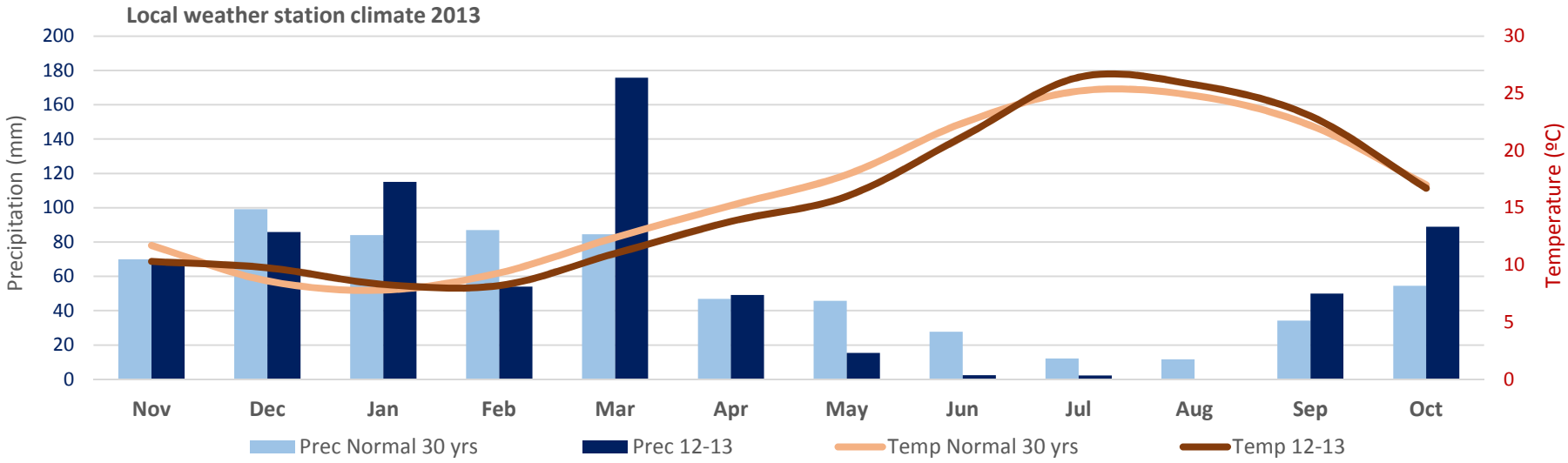


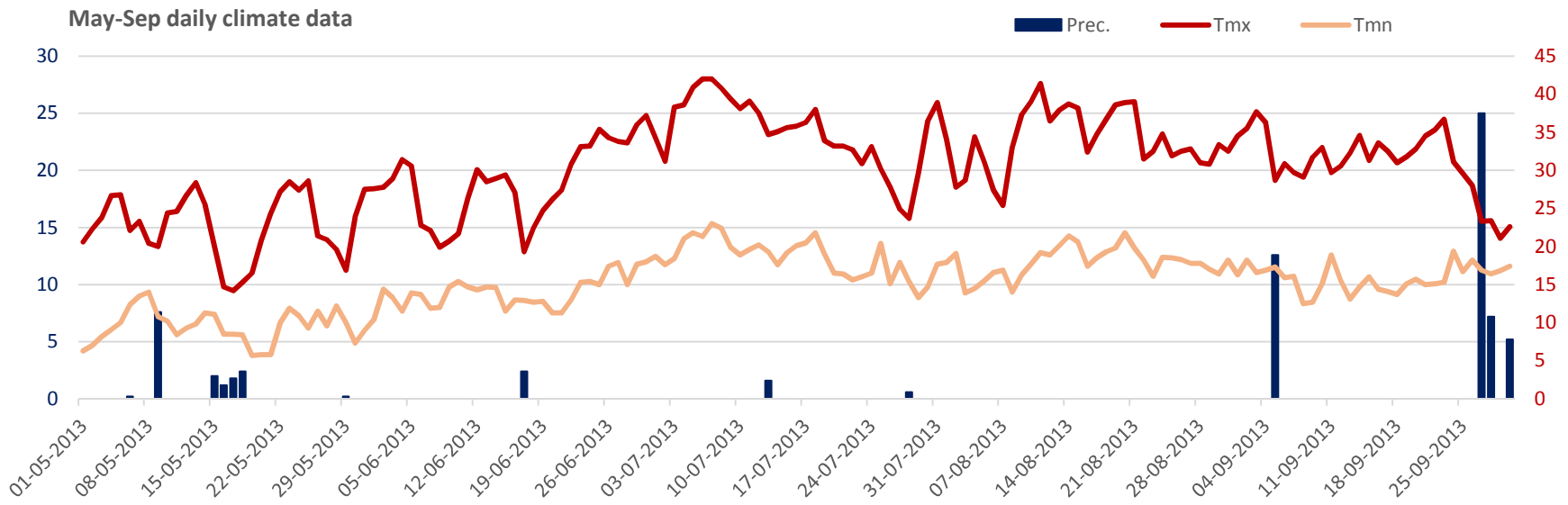
Tinta Roriz in 196-17 Cl





Climate 2013



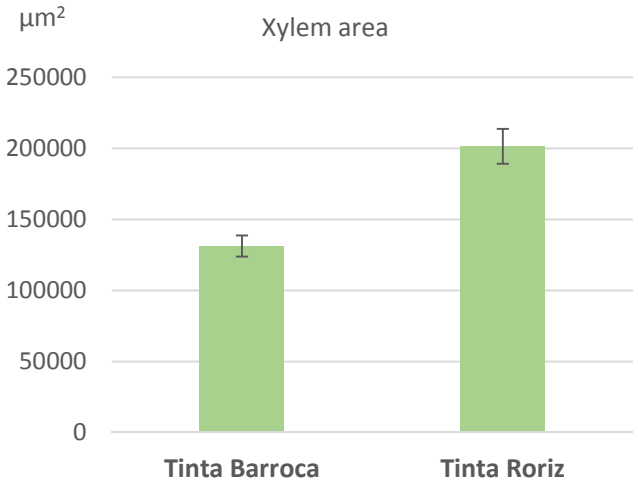


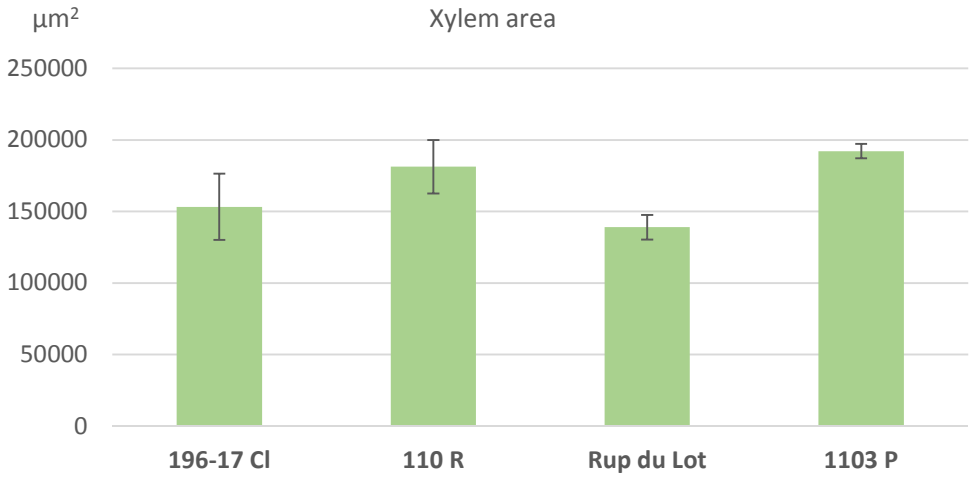
Results: fruit quality

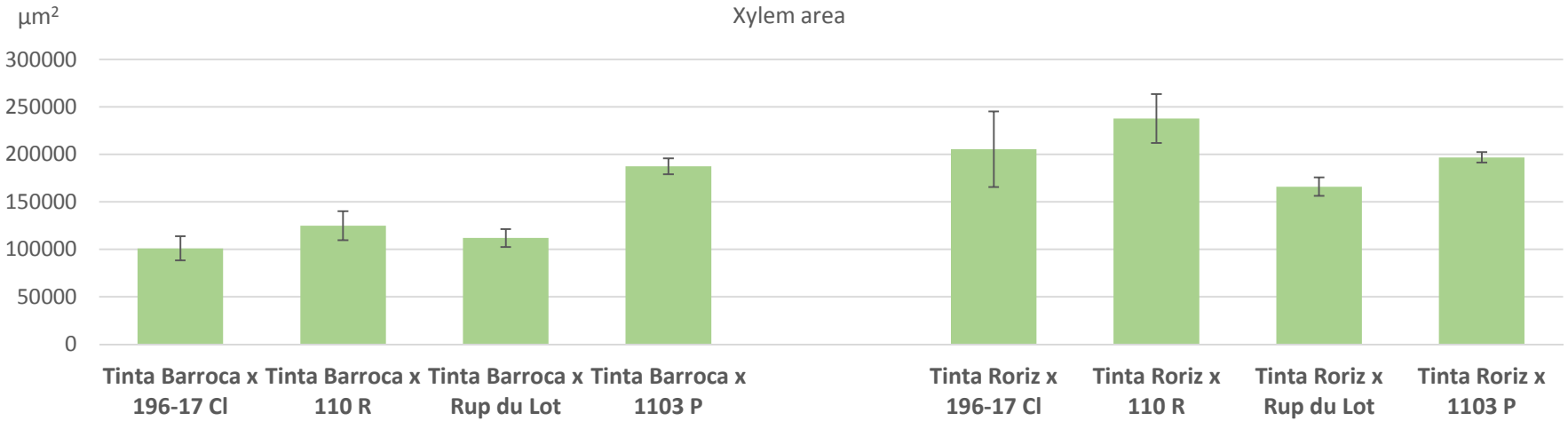
	°Brix	Total acidity g/l	pH	Tartaric Acid g/l	Malic Acid g/l
T Barroca	**27.8** a	4.17 a	3.58 a	**9.56** a	**0.86** a
T Roriz	24.7 b	3.91 a	3.54 a	9.01 b	0.50 b
1103 P	26.1 ab	**4.36** a	3.56 a	9.26 a	**1.14** a
196-17	**27.7** a	3.77 b	3.55 a	9.30 a	0.06 c
R110	26.0 ab	4.14 ab	**3.59** a	**9.43** a	0.77 ab
Rup Lot	25.2 b	3.90 ab	3.54 a	9.16 a	0.75 b
TB 1103 P	**28.0** a	**4.62** a	3.56 a	9.40 ab	**1.50** a
TB 196-17	27.5 ab	4.04 ab	3.51 a	9.48 ab	0.07 c
TB R110	28.3 a	4.18 ab	**3.66** a	**9.92** a	1.10 ab
TB Rup Lot	27.5 ab	3.85 ab	3.57 a	9.43 ab	0.77 bc
TR 1103 P	24.2 bc	4.09 ab	3.56 a	9.12 ab	0.78 bc
TR 196-17	27.9 a	3.50 b	3.58 a	9.12 ab	0.05 c
TR R110	23.7 c	4.11 ab	3.51 a	8.93 b	0.43 cd
TR Rup Lot	22.9 c	3.95 ab	3.51 a	8.88 b	0.73 bc

- **Analyses performed with a FTIR Oenofoss**

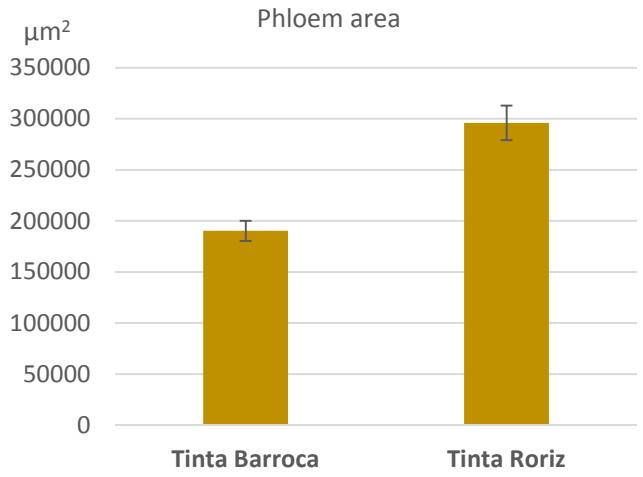
Results: xylem

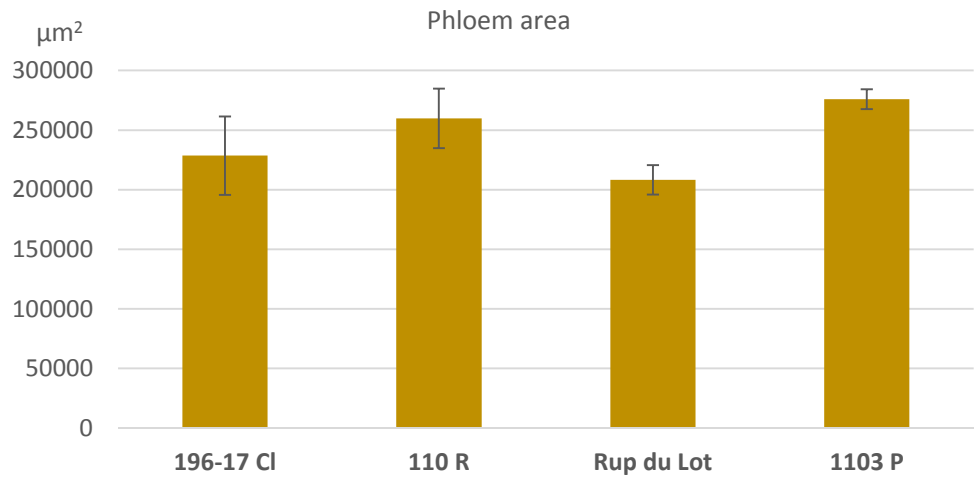


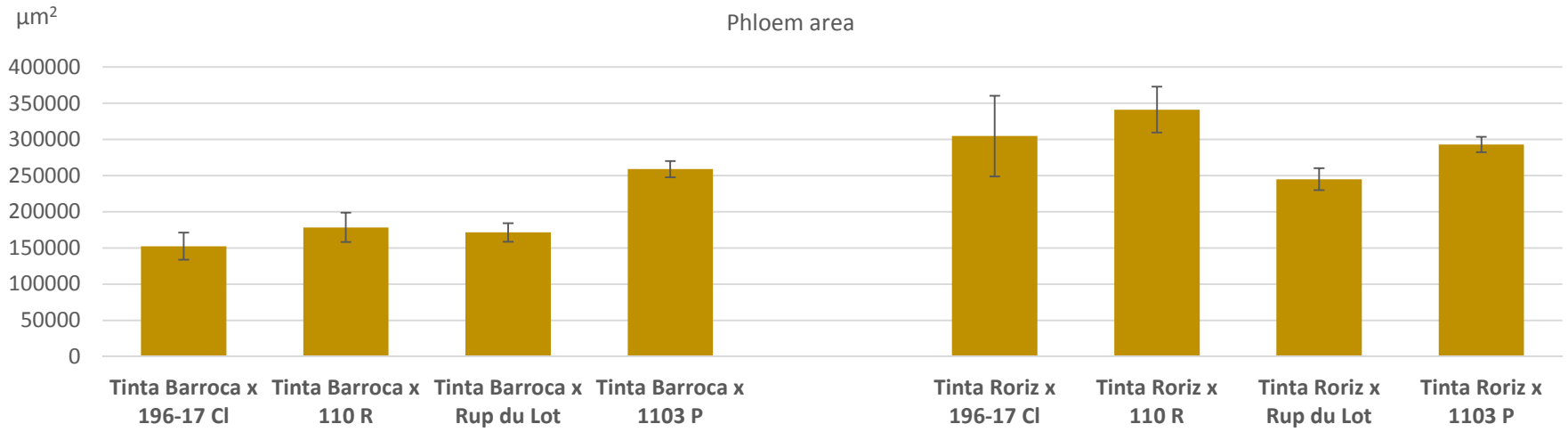




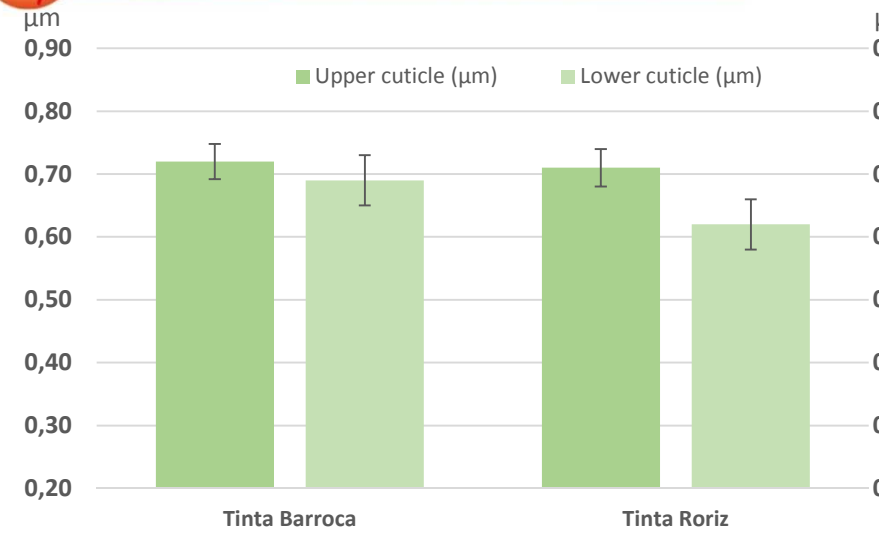
Results: phloem

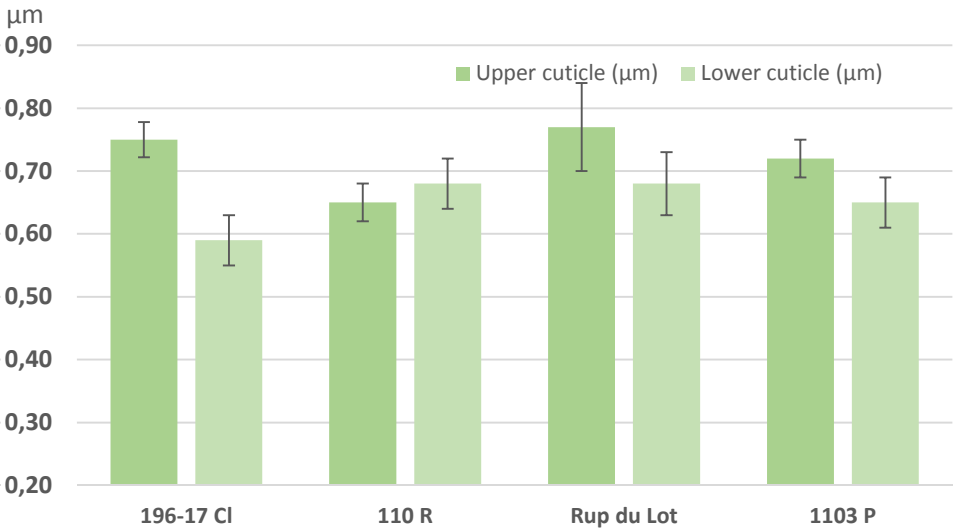


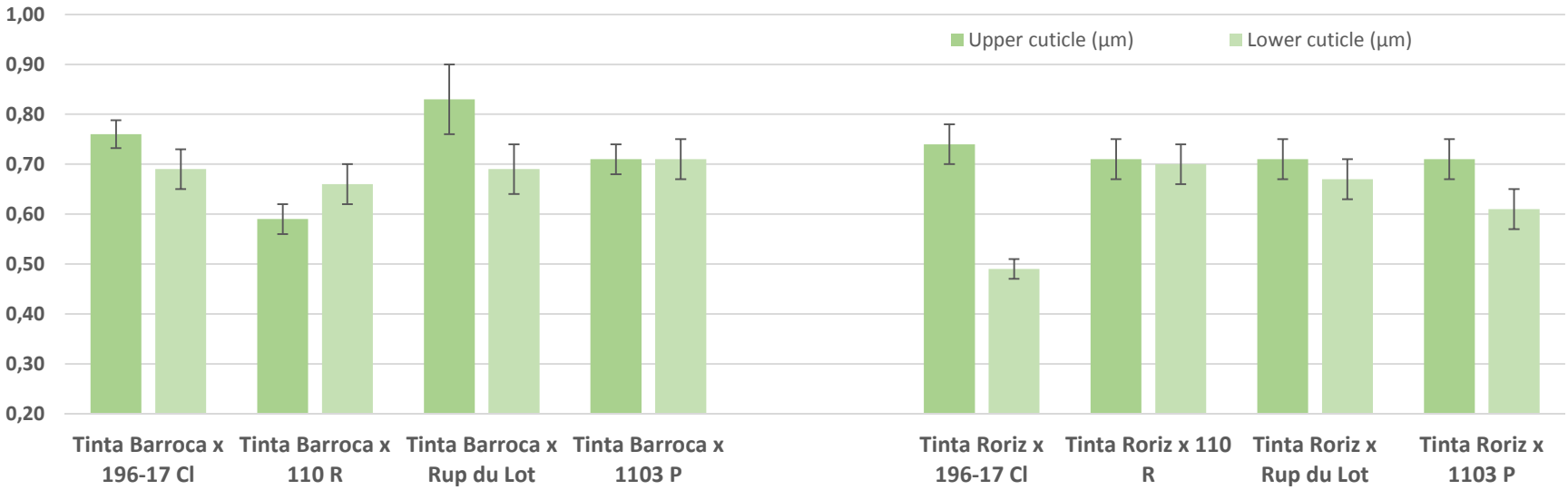




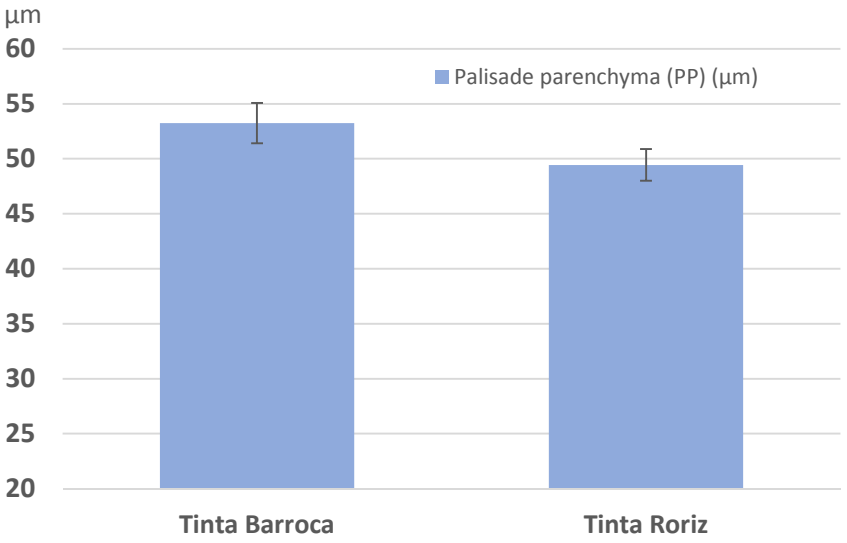
Results: cuticle (leaves)

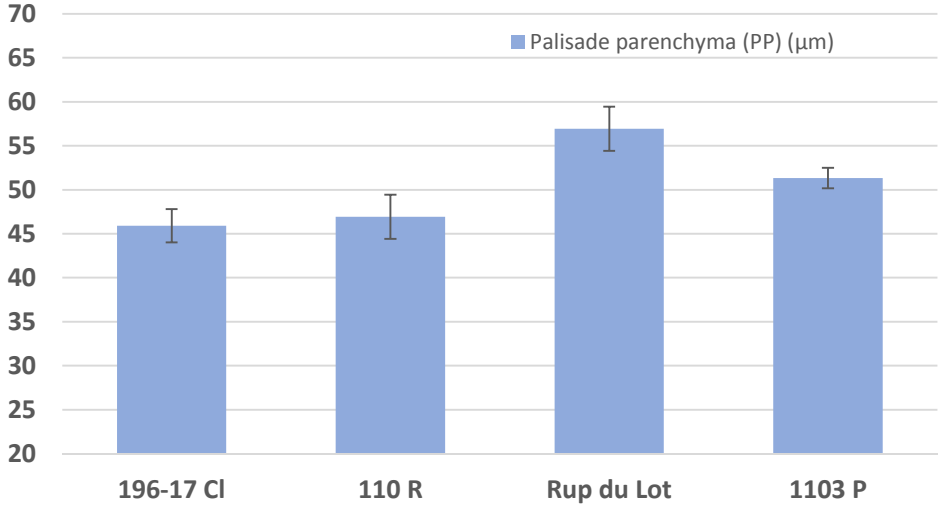


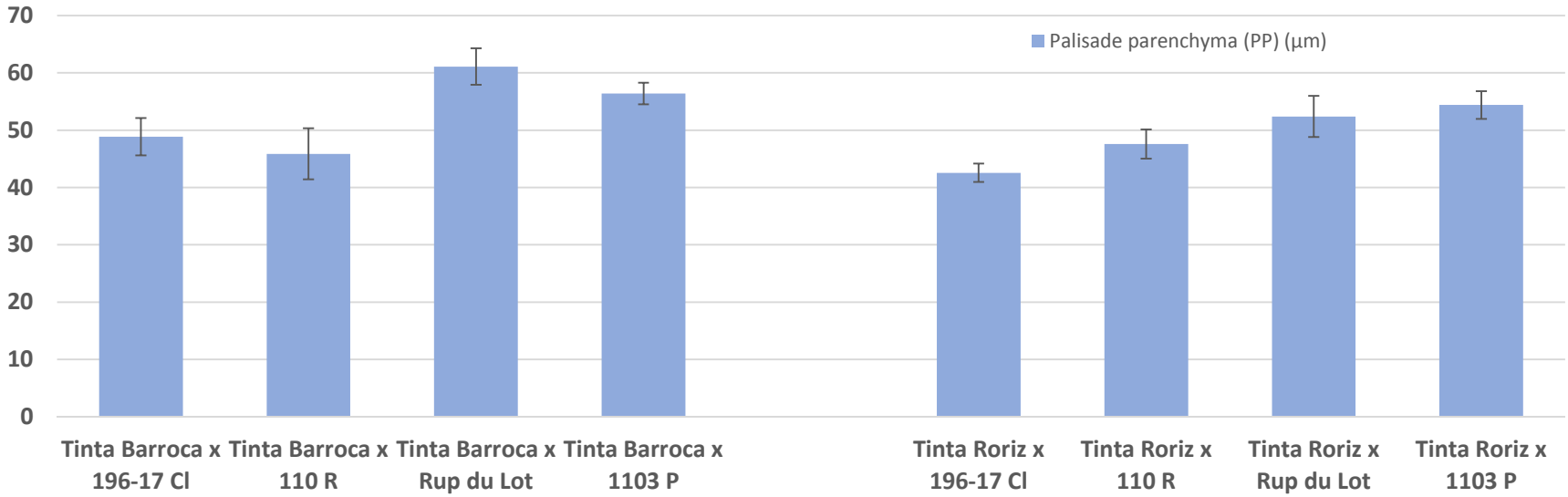




Results: palisade parenchyma



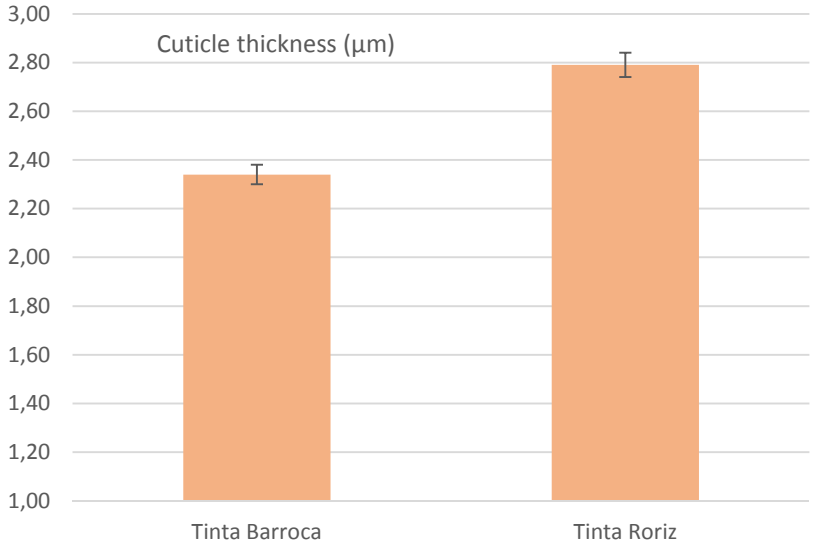


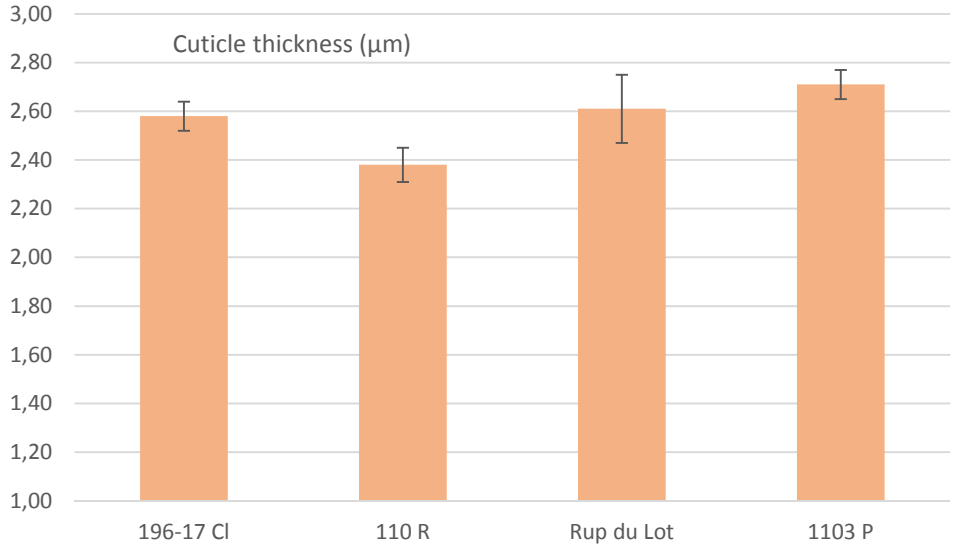


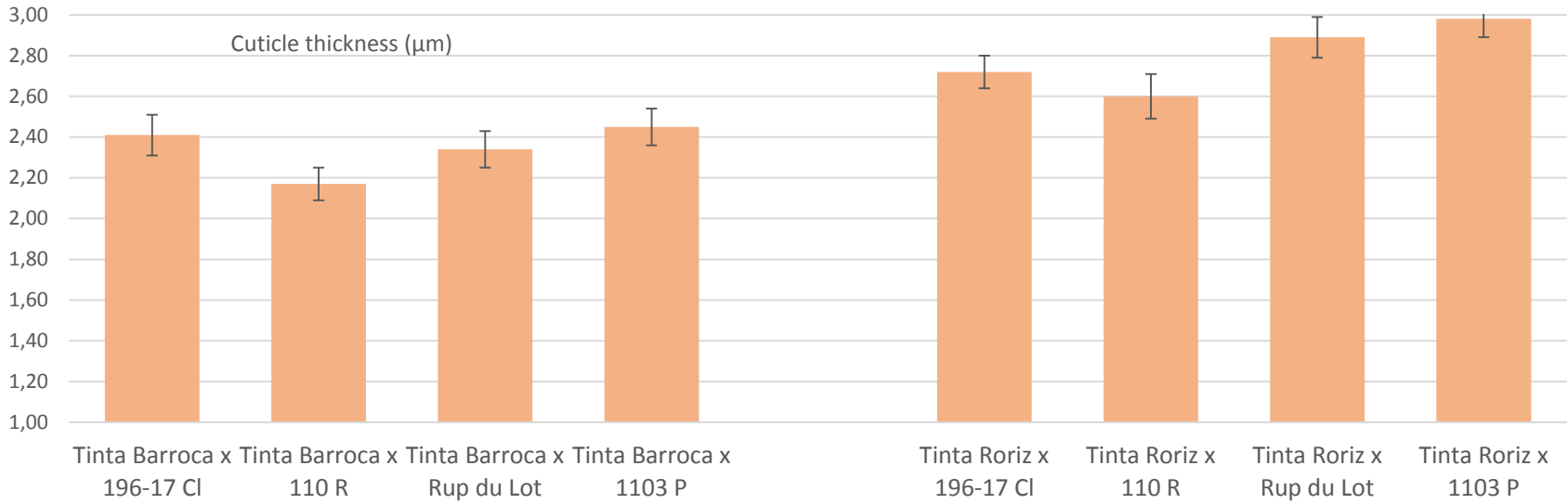
Results: xylem and phloem

- The evidence suggests that the Tinta Roriz uses rapid refill mechanisms of water due to the larger size of the vessels. but more subject to cavitation.
- Regarding cuticle, Tinta Roriz presented the lowest total lamina thickness (data not shown).
- In Tinta Roriz. the upper thick cuticle lead to a decrease in transpiration and water loss.
- In Tinta Barroca, a thicker cuticle combined with a thicker epidermis and smaller xylem vessels indicate a tolerance mechanism to drought based control of transpiration, acting also with the osmotic adjustment, due to higher soluble sugars (data not show).

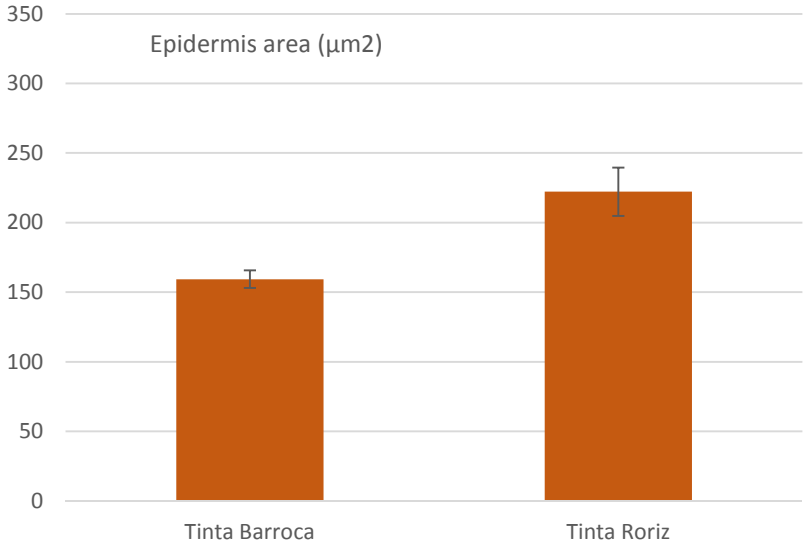
Results: cuticle (berries)

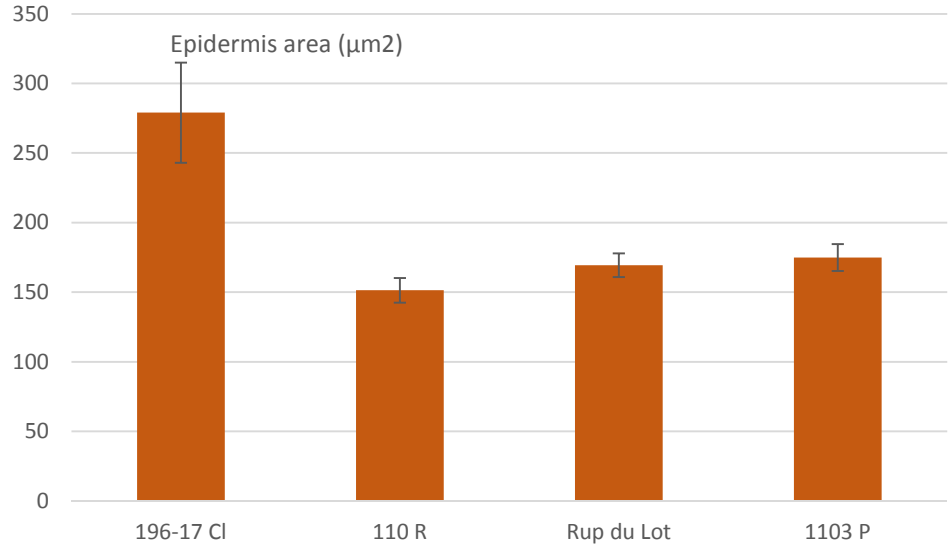


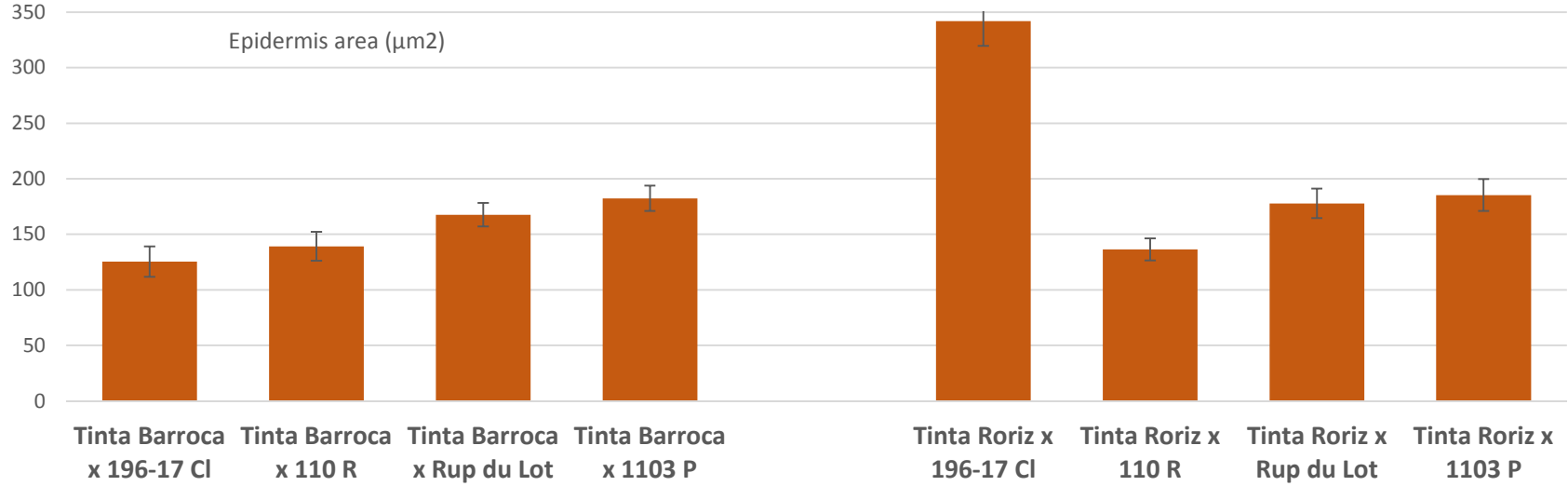




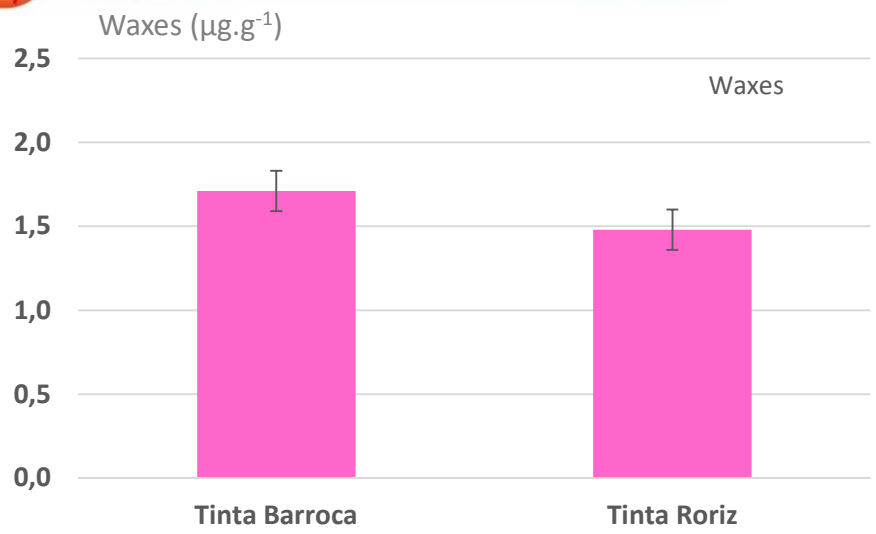
Results: epidermis (berries)

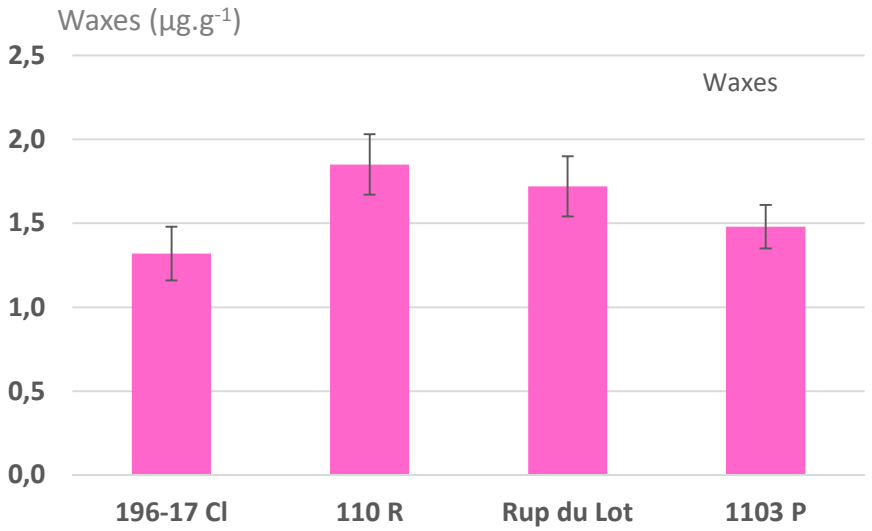


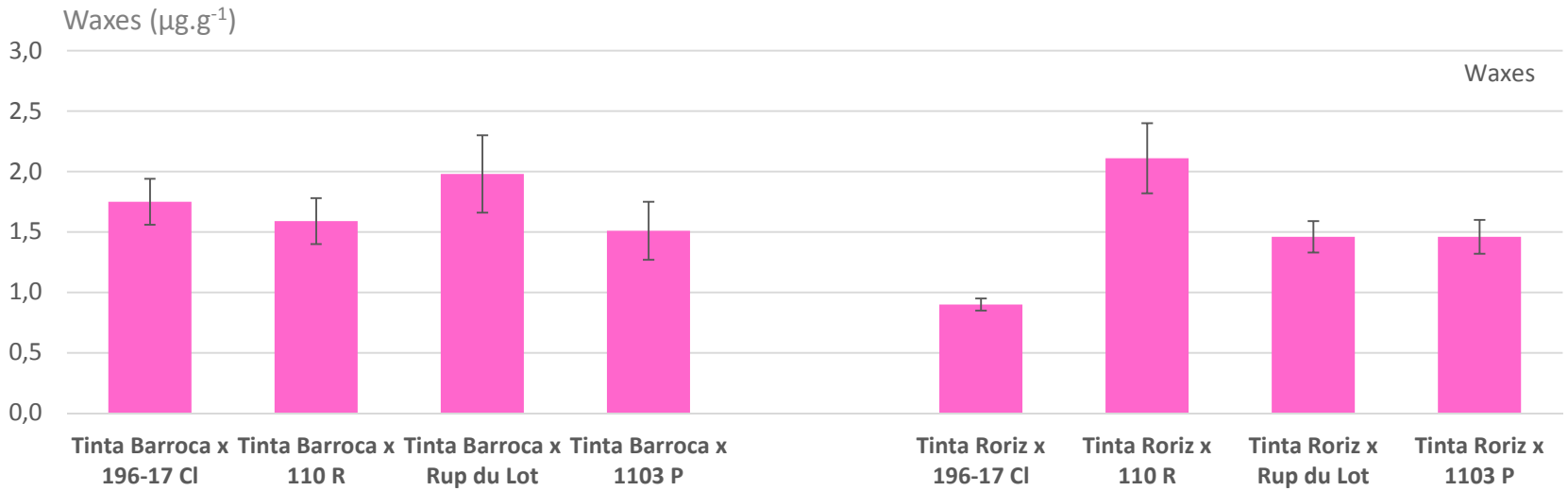




Results: waxes cuticle (berries)







Conclusions

- Overall results. although preliminary appear to show different mechanisms of adaptation to drought. when comparing cultivars.

- Regarding Tinta Barroca cultivar, the adaptation to drought appears to occur by leaf morph-anatomical modifications (higher lamina, upper and lower epidermis and cuticle thickness, as well higher waxes content), as well as by osmotic regulation (higher content of non-structural carbohydrates).

- For Tinta Roriz cultivar, biochemical changes (higher content of photosynthetic pigments and lower TBARS, as well lower content of non-structural carbohydrates) suggest a biochemical adaptation.

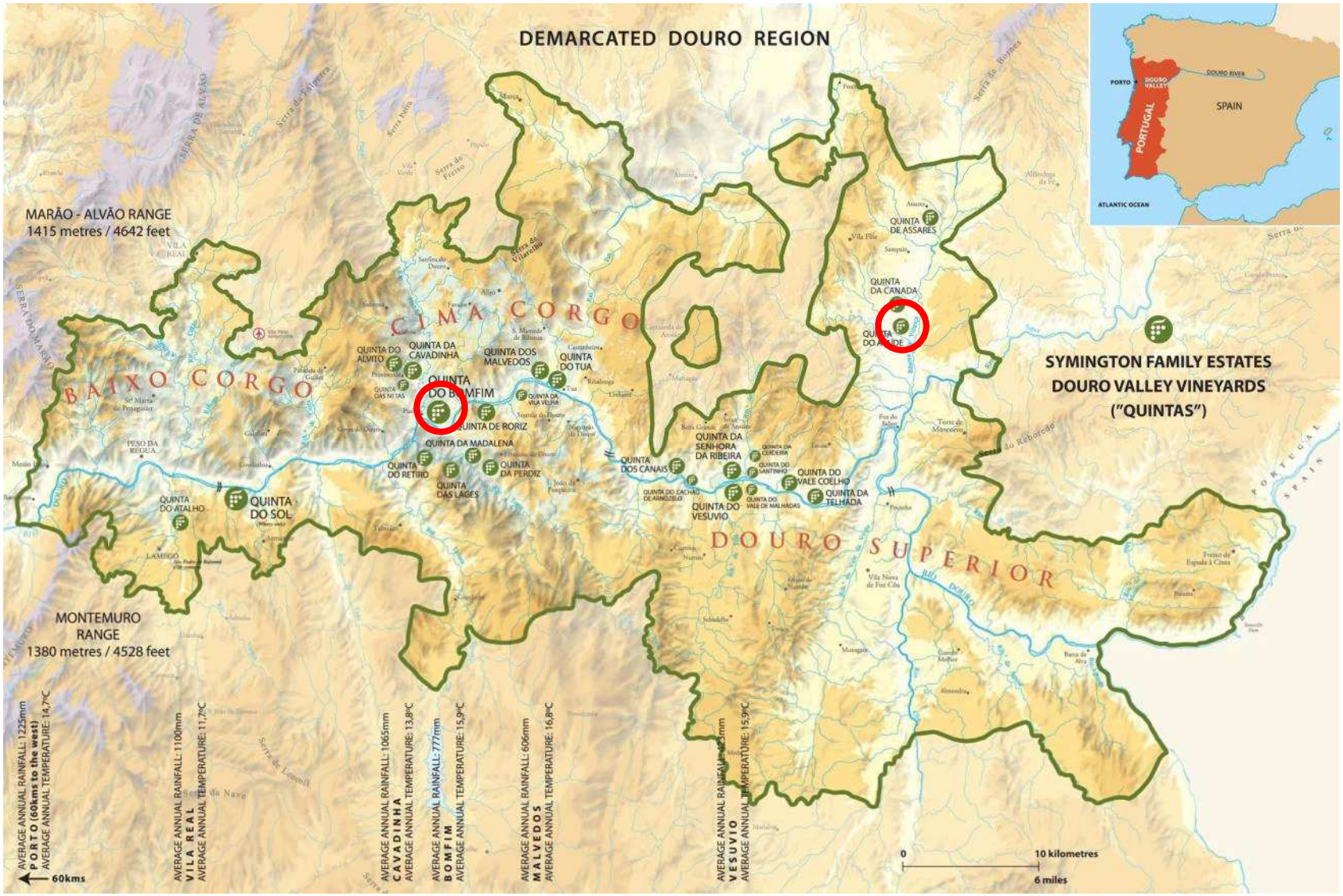
- Furthermore, the grape berries maintained the characteristics associated to each cultivar in line with previous studies on the same field experiment.

Work in progress 2014 and 2015

- Adding more grapevine varieties and eco-physiology assessment

Symington Family Estates - Grape Variety Library

- **Symington established on 2013 two grape collections over two different environments.**



Preparing for the future

- Grape collection (Quinta do Ataíde)
- 53 varieties (29 red 24 white)
- 200 vines available / variety

Preparing for the future

Preparing for the future

Thank you for the attention