



HAL
open science

Xylem tension relaxation under water does not lead to refilling in embolized grapevine petioles

José C. Herrera, Hervé Cochard, Eric Badel, Uri Hochberg

► To cite this version:

José C. Herrera, Hervé Cochard, Eric Badel, Uri Hochberg. Xylem tension relaxation under water does not lead to refilling in embolized grapevine petioles. 3rd Xylem International Meeting, Sep 2017, Bordeaux, France. , 78 p., 2017, 3rd Xylem International Meeting. hal-01649849

HAL Id: hal-01649849

<https://hal.science/hal-01649849>

Submitted on 27 Nov 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Xylem tension relaxation under water does not lead to refilling in embolized grapevine petioles



Jose C. Herrera^{1*}, Hervé Cochard^{2,3}, Eric Badel^{2,3} and Uri Hochberg⁴

¹ Division of Viticulture and Pomology, University of Natural Resources and Life Sciences, Vienna, Austria

² INRA, UMR 547 PIAF, 63100 Clermont-Ferrand, France

³ Clermont Université, Université Blaise-Pascal, UMR 547 PIAF, 63000 Clermont-Ferrand, France

⁴ Department of Organismic and Evolutionary Biology, Harvard University, 02138 Massachusetts, USA

* E-mail: jose.herrera@boku.ac.at



Universität für Bodenkultur Wien

Department für Nutzpflanzenwissenschaften

Abstract

In recent years, the validity of embolism quantification methods has been questioned, especially for long-vesseled plants. Some studies have suggested that cutting xylem while under tension, even under water, might generate artificial cavitation Wheeler et al. (2013). Accordingly, a rehydration procedure prior to hydraulic measurements has been recommended to avoid this artefact. However, concerns have been raised that xylem refilling might occur when samples are rehydrated.

Here, we explored the potential biases affecting embolism quantification for grapevine (*Vitis vinifera* L.) petioles harvested under tension or after xylem relaxation. We employed direct visualization of embolism through X-ray micro-computed tomography (microCT) to test for the occurrence of fast refilling (artificially low percent loss of conductivity (PLC) due to rehydration prior to sample harvest).

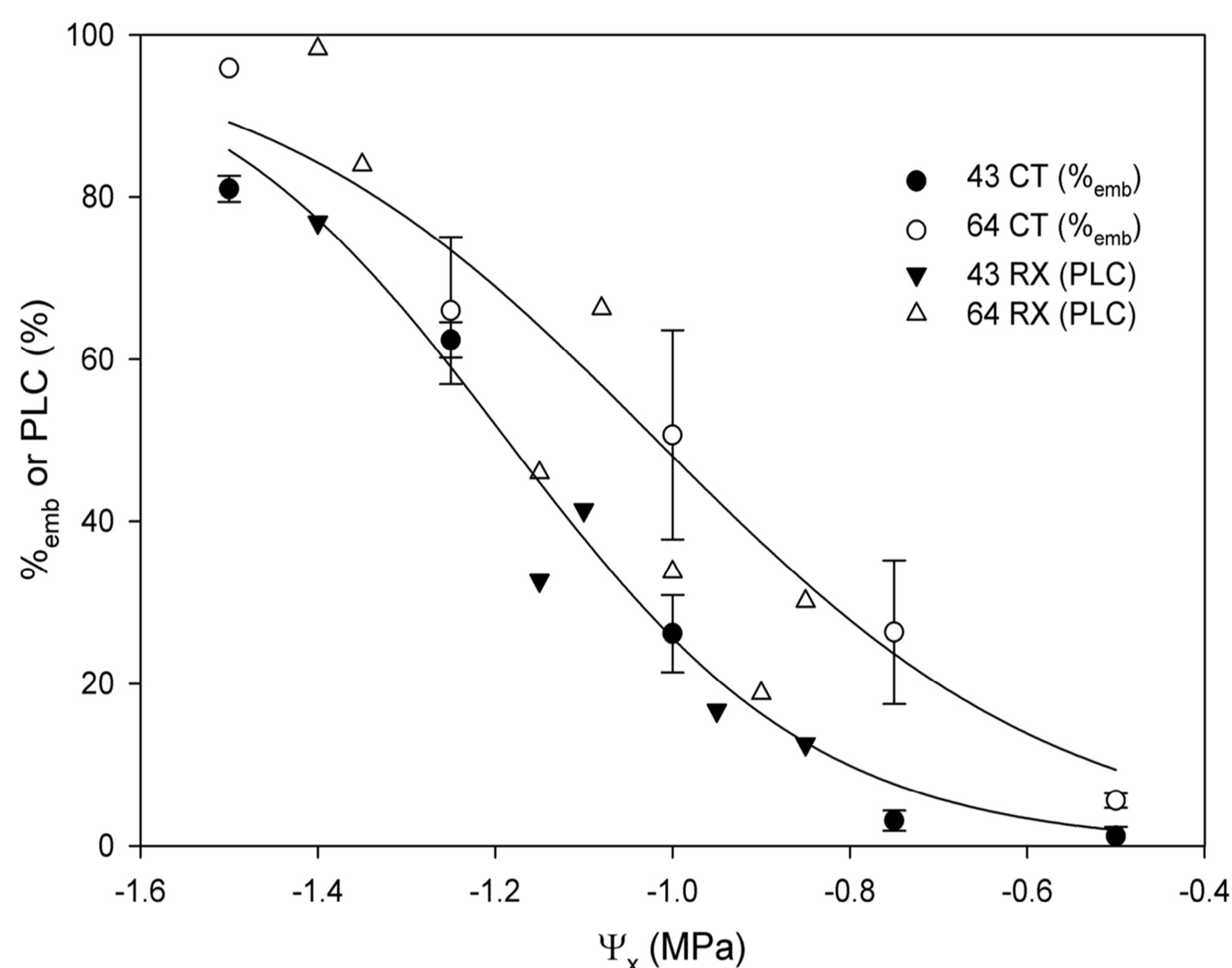
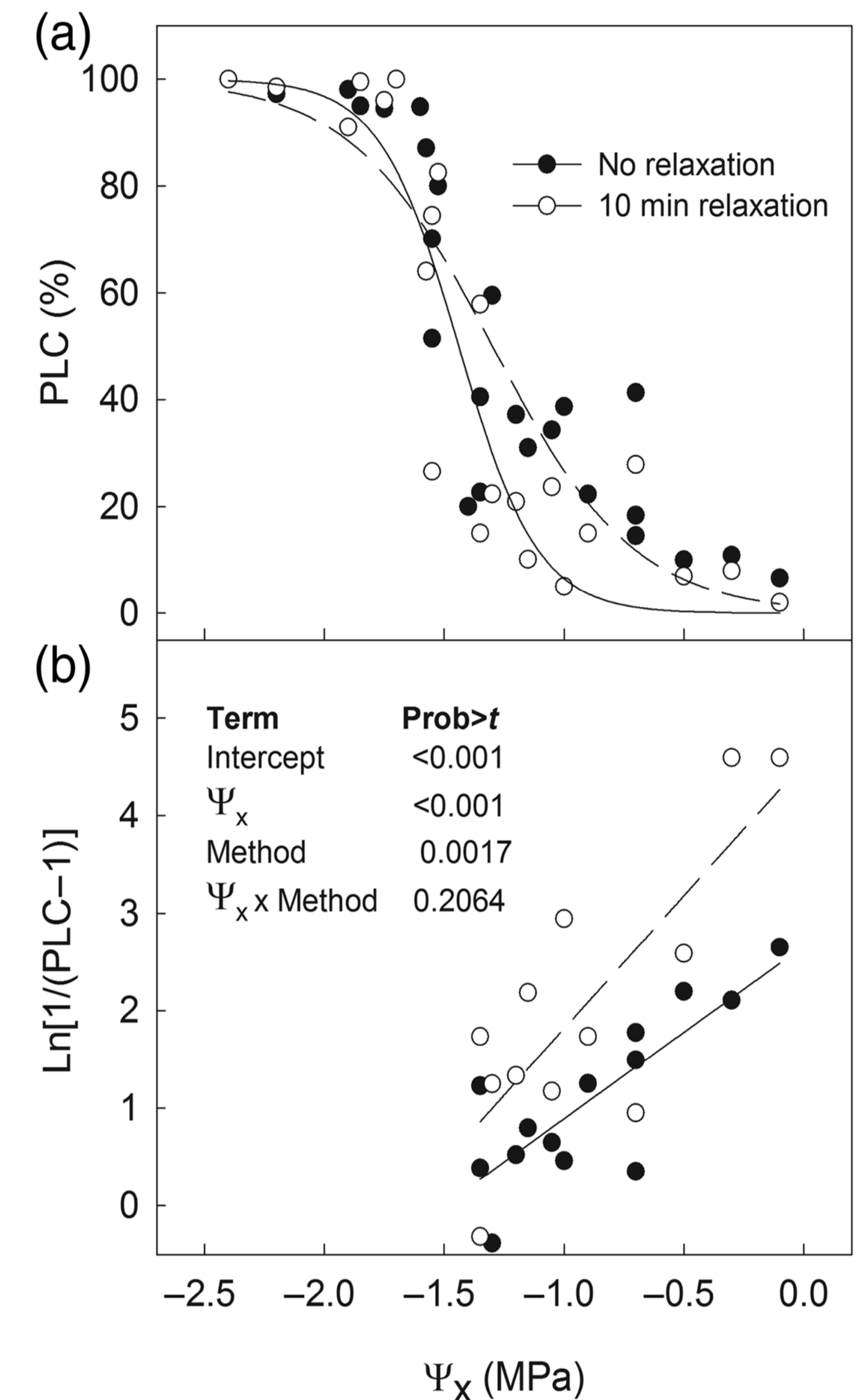


Fig. 2 Comparison of xylem vulnerability curves built by imaging intact vessels with X-ray microCT (CT—circles) or by using the hydraulic apparatus with relaxed segments (RX—triangles). The relationship between the Ψ_x and the PLC or %_{emb} was assessed in grapevine petioles of two grapevine genotypes: 043 (filled symbols) and 064 (open symbols). X-ray microCT data are averages of four different plants \pm SE, while data points of the hydraulic apparatus represent averages of three petioles excised from the same shoot. The lines are the sigmoidal regressions of the X-ray microCT data.

Fig. 1 (a) The relation between PLC and Ψ_x in grapevine petioles under tension (filled circles) or after relaxation in which the shoots were submerged under water for 10 min (open circles). The sigmoidal regression suggest that the relaxation shifted the Ψ_{50} from -1.35 to -1.44 MPa. **(b)** Statistical comparison of the methods (with or without relaxation) to generate xylem vulnerability curves in (a). The sigmoidal curves were linearized and compared using a regression model with Ψ_x , the method, and their interaction as model effects.



Key results

- ✓ Comparison of VC measured with 10 min relaxation or without prior relaxation, showed a significantly lower PLC for the relaxed treatment ($P < 0.05$) for Ψ_x values higher than -1.4 MPa (Fig. 1).
- ✓ VC constructed using hydraulic apparatus for relaxed samples was similar to VC established using microCT (Fig. 2).
- ✓ Our results suggest that segments could be submerged under water for several hours without any risk of refilling (Fig. 3).
- ✓ Relaxation incorporation into hydraulic measurements of grapevines would result in reliable evaluations of PLC.

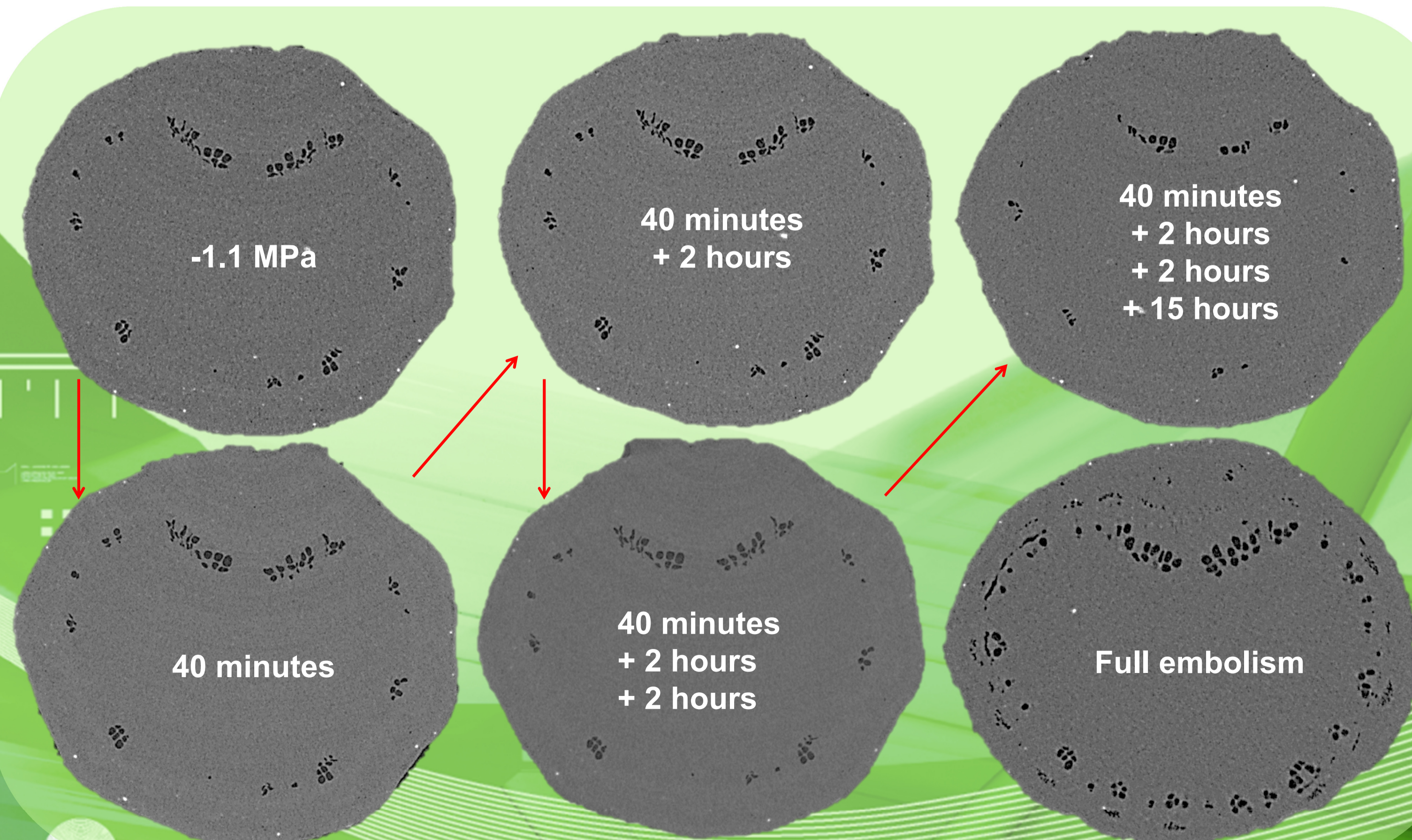


Fig. 3. MicroCT observation of grapevine petiole embolism refilling. No significant refilling was observed after 4 hours and 40 minutes under water. Many vessels were refilled after 20 hours under water. Full embolism was achieved by cutting the segment before microCT imaging.

Methods

We have performed three experiments (more details in Hochberg et al. 2016):

- i. Test whether short-time xylem relaxation results in a reliable measurement of embolism
 - ii. Compare xylem vulnerability curves (VC) of petioles from shoots under tension or relaxed
 - iii. Investigate (using microCT) the time required for refilling vessels when placed under slight (4 cm) positive pressure
- Plant material consisted on 1-year-old *V. vinifera* (Syrah \times Grenache progeny) grafted on R110 rootstock, grown in 10 L pots in a controlled environment during the 2015 winter in INRA Clermont-Ferrand (France).
 - For hydraulic measurements we used long shoot segments (1.5 m) that were bench dehydrated to a range of pressures between -0.5 and -2 MPa before they were excised under water and connected to the Xylem apparatus (Bronkhorst, France) (i.e., cut under tension treatment). The cut surface of the remaining shoot was held under water for 10 min and then 3 additional petioles were cut under water and connected to the Xylem apparatus (relaxed treatment).
 - For embolism evaluation using the X-ray microtomograph (Nanotom 180 XS, GE, Wunstorf, Germany) we used a plant segment containing a leaf with 3 internode beneath the remaining petiole insertion. We validated that such size excludes open vessels from the petiole.

References

- Hochberg U, Herrera JC, Cochard H, Badel E (2016) Short-time xylem relaxation results in reliable quantification of embolism in grapevine petioles and sheds new light on their hydraulic strategy. *Tree Physiology* 36:748–755.
- Wheeler JK, Huggett BA, Tofte AN, Rockwell FE, Holbrook NM (2013) Cutting xylem under tension or supersaturated with gas can generate PLC and the appearance of rapid recovery from embolism. *Plant Cell Environ* 36:1938–49.

A short movie demonstrating the protocol is freely available at: <https://www.youtube.com/watch?v=YzpDN7laepo>