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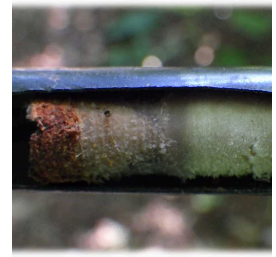
Intrinsic water use efficiency estimate: an isotopic method



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Flavie Gerle[1], Pauline Malherbe[2], Christelle Boisselet[1], David Lafleuriel[1], Julien Godfroy[2,3], Pierre Lochin[2], Baptiste Marteau[2], Hervé iegay[2], Sara Puijalon[1], Antoine Vernay[1]

[1]Univ Lyon, Université Claude Bernard Lyon 1, CNRS, ENTPE, UMR 5023 LEHNA, F-69622, Villeurbanne, France;
[2]UMR 5600 EVS, ENS de Lyon, F-69342 Lyon, France;
[3]National Research Institute of Science and Technology for Environment and Agriculture, Research Unit Mountain Ecosystems, University Grenoble Alpes, 2 rue de la Papeterie, F-38402 St-Martin-d'Hères

Antoine Vernay
LEHNA

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Abstract

Protocol summary and key steps

This protocol describes in detail how to calculate the intrinsic water use efficiency (WUE_i) from ^{13}C measurements in phloem samples collected at breast height in trees. Basically, the isotopic signature of photosynthetized carbohydrates ($^{13}C/^{12}C$) in the phloem sap inform on the assimilation condition: a higher ($^{13}C/^{12}C$) is associated with a lower transpiration rate, increasing heavy isotope (^{13}C) use by the plant (Dawson et al. 2002). A higher $^{13}C/^{12}C$ in the phloem content reflect a higher proportion of assimilated C compared to transpiration rate, in other words, a higher WUE_i. The method described here is based on the isotopic discrimination of $\delta^{13}C$ in trees and considers ecophysiological processes of stomatal and mesophyll conductance (g_s and g_m, respectively). The protocol aims to provide the operator with a step-by-step method from the collection of phloem samples in the field to the
final calculation. The protocol is already described in the scientific literature (Klein et al. 2016; Seibt et al. 2008; Vernay et al. 2020) but this document addresses more practical and technical details that a practitioner might expect. WUE (water use efficiency) corresponds to plant productivity or the productivity of an organ of the plant regarding the amount of water used to produce this fresh matter (Théroux Rancourt 2014). At an individual scale, WUE considers a ratio of the biomass produced compared to the amount of water used to produce this biomass. At the leaf level, WUE_i (intrinsic WUE) determines the ratio of CO_2 assimilation per amount of water transpired and can take into account the micro-environment of the leaf, by considering g_s/g_m to be more precise (Vialet-Chabrand 2013).

Attachments

WUEi_Protocol_2023.p..

622KB

Image Attribution

Antoine VERNAY

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