# Rethinking plant's stomatal behavior

Nicolas Martin-StPaul, Sylvain S. Delzon, Hervé H. Cochard

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Martin-StPaul NK[1*], Delzon S[2] & Cochard H[3].

[1] INRA, UR629 Ecologie des Forêts Méditerranéennes (URFM), Avignon, France.
[2] INRA, University of Bordeaux, UMR BIOGECO, F-33450 Talence, France.
[3] INRA, Clermont University, UMR547 PIAF, F-63100 Clermont-Ferrand, France.

*Author for correspondence: nicolas.martin@paca.inra.fr

Abstract:

It's commonly accepted that the universal trade-off between water saving and $CO_2$ capture driven by stomatal conductance includes two strategies of hydraulic functioning that determine plant vulnerability to drought. Accordingly, isohydric species, that close stomata rapidly to regulate water loss, can be subjected to carbon starvation. By contrast, anisohydric species can maintain significant rates of gas exchange but are predisposed to hydraulic failure because they operate with narrower hydraulic safety margins during drought. *Despite a large research effort very few convincing evidence has been reported so far.* In this study we developed an ecophysiological model that couple stomatal and hydraulic behaviors to study the response to water deficit. Based on initial soil features, plant transpiration rate, conductance and leaf area, resistance to cavitation and osmotic potential at full turgor; the model computes soil and plant water potential, leaf turgor pressure and plant and soil conductance. Stomatal regulation is a function of leaf turgor potential. The model allows computing the dynamic of dehydration, the number of days with stomata open (*i.e.* length of the photosynthetically active period) and the plant death by hydraulic failure. The model was tested for a wide range of plant and soil type. Three major outcomes have been addressed: first, any species can behave as isohydric or anisohydric according to environmental conditions. Second, for a given safety margins, species more resistant to cavitation are surprisingly more prone to drought-induced hydraulic failure. Third, to maximize carbon capture while avoiding hydraulic failure; stomatal closure should occur within a narrow range of water potential (before ~-4MPa) whatever the resistance to cavitation of the species. The predictions of the model for an optimal behavior (in terms of avoiding cavitation and maximizing openness of stomata) are congruent with global databases of stomatal closure, osmotic potential and resistance to cavitation. Altogether these results reject the isohydric versus anisohydric behavior of plant stomata and their implication in drought-induced plant mortality. The model can serve as a basis to improve vegetation models of biogeochemical cycles or plant distribution models in a context of anticipating risk related to increasing drought under climate change.