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Poplar vulnerability to xylem cavitation acclimates to drier soil conditions

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Xylem vulnerability to cavitation differs between tree species according to their drought resistance, more xerophilous species being more resistant to xylem cavitation. Variability in xylem vulnerability to cavitation is also found within species, especially between in situ populations. The origin of this variability has not been clearly identified. Here we analyzed the response of xylem hydraulic traits of *Populus tremula* × *Populus alba* trees to three different soil water regimes. Stem xylem vulnerability was scored as the xylem water potential causing 12, 50 and 88% loss of conductivity (P_{12}, P_{50} and P_{88}). Vulnerability to cavitation was found to acclimate to growing conditions under different levels of soil water content, with P_{50} values of −1.82, −2.03 and −2.45 MPa in well-watered, moderately water-stressed and severely water-stressed poplars, respectively. The value of P_{12}, the xylem tension at which cavitation begins, was correlated with the lowest value of midday leaf water potential (ψm) experienced by each plant, the difference between the two parameters being approximately 0.5 MPa, consistent with the absence of any difference in embolism level between the different water treatments. These results support the hypothesis that vulnerability to cavitation is a critical trait for resistance to drought. The decrease in vulnerability to cavitation under growing conditions of soil drought was correlated with decreased vessel diameter, increased vessel wall thickness and a stronger bordered pit field $(t/b)^2$. The links between these parameters are discussed.

Introduction

The summer drought and heat wave that occurred in Europe in 2003 seriously affected forest ecosystems (Levinson and Waple 2004, Meehl and Tebaldi 2004, Rebetez et al. 2006). Visible impact was reported in several regions of France, from partial crown dieback to individual deaths (Bréda et al. 2004, Rozenberg and Pâques 2004). As a consequence, there has been a rising demand for more drought-resistant plant materials, and this demand will surely increase with the greater frequency and intensity of drought episodes expected in the future. Detailed knowledge of the mechanisms of drought response may give new insights into factors controlling plant productivity and survival in drought-prone regions (Brodribb and Hill 1999, Brodribb et al. 2002, Nardini and Salleo 2005). The mechanisms of trees' drought response are very diverse. Trees may adapt or acclimate to drier conditions. The first process occurs through gradual natural selection of genotypes with greater fitness in more xeric habitats. These ecotypes

Abbreviations – ψ_m, midday leaf water potential; ψ_p, predawn leaf water potential; C, control plants; MS, moderately water-stressed plants; P_{12}, P_{50} and P_{88}, xylem water potential causing 12, 50 and 88% loss of conductivity; SS, severely water-stressed plants.