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RESEARCH PAPER

Dynamics of spatial heterogeneity of stomatal closure in *Tradescantia virginiana* altered by growth at high relative air humidity

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Abstract

The spatial heterogeneity of stomatal closure in response to rapid desiccation of excised well-watered *Tradescantia virginiana* leaves grown at moderate (55%) or high (90%) relative air humidity (RH) was studied using a chlorophyll fluorescence imaging system under non-photorespiratory conditions. Following rapid desiccation, excised leaves grown at high RH had both a greater heterogeneity and a higher average value of PSII efficiency (Φ_{PSII}) compared with leaves grown at moderate RH. Larger decreases in relative water content resulted in smaller decreases in water potential and Φ_{PSII} of high RH-grown leaves compared with moderate RH-grown leaves. Moreover, the Φ_{PSII} of excised high RH-grown leaves decreased less with decreasing water potential, implying that the stomata of high RH-grown leaves are less sensitive to decreases in leaf water potential compared with moderate RH-grown leaves. After desiccation, some non-closing stomata were distributed around the main vein in high RH-grown leaves. Direct measurements of stomatal aperture showed 77% stomatal closure in the margins after 2 h desiccation compared with 40% closure of stomata in the main-vein areas in high RH-grown leaves. Faster closure of stomata in leaf margins compared with main-vein areas of leaves grown at high RH was related to substantially lower relative water content in these areas of the leaves.

Key words: Desiccation, patchiness, PSII efficiency, relative water content, stomata, water potential.

Introduction

Stomata play a dominant role in the control of plant water relations and photosynthesis. Stomatal behaviour is the result of interactions between physiological factors and environmental conditions (Assmann, 1993; Kearns and Assmann, 1993; Hetherington and Woodward, 2003). Moreover, stomatal response characteristics depend on the growing conditions in which the stomata developed. One of the most important growing conditions affecting stomatal response is relative air humidity (RH). For example, stomatal malfunctioning has been reported in roses grown at an RH above 85% (Torre and Fjeld, 2001; Torre *et al.*, 2003). Furthermore, a failure of stomata to close in response to desiccation or abscisic acid (ABA) has been shown in leafy cuttings rooted at high RH (Fordham *et al.*, 2001) and plants propagated *in vitro* (Ziv *et al.*, 1987; Santamaria *et al.*, 1993). Recent research has shown that whether grown at moderate (55%) or high (90%) RH, the stomata in the leaves of *Tradescantia virginiana* decreased their aperture in response to desiccation, ABA application, and exposure to darkness (Rezaei Nejad and van Meeteren, 2005). However, transpiration rate and stomatal conductance and aperture in the high RH-grown plants remained higher than in the moderate RH-grown plants (Rezaei Nejad and van Meeteren, 2005), indicating a quantitative

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Abbreviations: ABA, abscisic acid; F_t, the steady-state value of fluorescence at a certain light level; F'_m, maximum fluorescence at a certain light level; $\Delta F'/F'_m$, the ratio of the difference between ($F'_m - F_t$) and F'_m is equal to Φ_{PSII} if during the saturating light pulse the Q_A pool is completely reduced; Φ_{PSII}, relative quantum yield or efficiency for electron transport by photosystem II; PSII, photosystem II; Q_A, primary quinone acceptor of photosystem II; RH, relative air humidity; RWC, relative water content.