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RESEARCH PAPER

Dynamics of adaptation of stomatal behaviour to moderate or high relative air humidity in *Tradescantia virginiana*

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Abstract

Chlorophyll fluorescence imaging was used to measure stomatal closure in response to desiccation of *Tradescantia virginiana* leaves grown under high (90%) and moderate (55%) relative humidities (RHs), or transferred between these humidities. Stomata in leaves grown at high RH were less responsive to desiccation than those of leaves grown at moderate RH. Stomata of plants transferred from moderate RH conditions to high RH showed the same diminished closure in response to desiccation as did stomata that developed at high RH. This response was found both when the leaves were fully expanded and when still actively expanding during the moderate RH pre-treatment. Four days of exposure to high RH was the minimal exposure time to induce the diminished closure response. When leaves were grown in high RH prior to a 10 d moderate RH treatment, the reduced stomatal closure response to desiccation was only reversed in leaves (regions) which were actively expanding during moderate RH treatment. This indicates that with respect to stomatal responses to desiccation, high RH leaf regions have a limited capacity to adapt to moderate RH conditions. The decrease in responsiveness to desiccation of the stomata, induced by long-term exposure to high RH, was not due to osmotic adjustment in the leaves. Within 1 d after transferring moderate RH-grown plants to a high RH, the abscisic acid (ABA) concentration of their leaves decreased to the low level of ABA found in high RH-grown leaves. The closure response in leaves exposed to high RH for 5 d, however, could not be fully restored by the application of ABA. Transferring plants from high to moderate RH resulted in increased ABA levels within 2 d without a recovery of the stomatal closing response. It is discussed that the diminished stomatal closure in plants exposed to high RH could be due to changes in the signalling pathway for ABA-related closure of stomata or to an increased sequestration of ABA by mesophyll tissue or the symplast in the epidermis, induced by a longer period (several days) of a low ABA level.

Key words: Abscisic acid, desiccation, PSII efficiency, relative water content, stomatal closure, vapour pressure deficit, water potential.

Introduction

Stomata regulate leaf diffusive conductance, and thereby influence two of the most important processes in terrestrial plants: photosynthesis and transpiration. They have to balance the uptake of CO_2 with the loss of water from the plant under various environmental conditions. To obtain the optimal response to multifactorial environmental changes, guard cells of stomata sense many environmental factors such as light (quantity and quality), temperature, humidity, intercellular CO_2 concentration, and drought-induced abscisic acid (ABA) (reviewed by Raschke, 1975; Zeiger, 1983; Schroeder *et al*., 2001) and have the ability to integrate environmental and endogenous signals. Besides the short-term effects of many environmental factors, the history of growth conditions can affect the fine-tuning of the stomatal response, though these

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Abbreviations: ABA, abscisic acid; Φ_{PSII}, relative quantum yield or efficiency for electron transport by photosystem II; PSII, photosystem II; RH, relative air humidity; RWC, relative water content; VPD, vapour pressure deficit.