

Phi Thickening Induction as a Response to Abiotic Stress in the Orchid Miltoniopsis

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Abstract : Phi thickenings are specialized secondary cell wall thickenings that are found in the cortex of the roots in a wide range of plant species, including orchids. The role of phi thickenings in the root is still under debate through research have linked environmental conditions, particularly abiotic stresses such as water stress, heavy metal stress and salinity to their induction in the roots. It has also been suggested that phi thickenings may act as a barrier to regulate solute uptake, act as a physical barrier against fungal hyphal penetration due to its resemblance to the Casparian strip and play a mechanical role to support cortical cells. We have investigated phi thickening function in epiphytic orchids of the genus *Miltoniopsis* through induction experiment against factors such as soil compaction and water stress. The permeability of the phi thickenings in *Miltoniopsis* was tested through uptake experiments using the fluorescent tracer dyes Calcofluor white, Lucifer yellow and Propidium iodide then viewed with wide-field or confocal microscopy. To test whether phi thickening may prevent fungal colonization in the root cell, fungal re-infection experiment was conducted by inoculating isolated symbiotic fungus to sterile in vitro *Miltoniopsis* explants. As the movement of fluorescent tracers through the apoplast was not blocked by phi thickenings, and as phi thickenings developed in the roots of sterile cultures in the absence of fungus and did not prevent fungal colonization of cortical cells, the phi thickenings in *Miltoniopsis* do not function as a barrier. Phi thickenings were found to be absent in roots grown on agar and remained absent when plants were transplanted to moist soil. However, phi thickenings were induced when plants were transplanted to well-drained media, and by the application of water stress in all soils tested. It is likely that phi thickenings stabilize the root cortex during dehydration. Nevertheless, the varied induction responses present in different plant species suggest that the phi thickenings may play several adaptive roles, instead of just one, depending on species.

Keywords : abiotic stress, *Miltoniopsis*, orchid, phi thickening

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