

Thylakoid calcium sensing receptor CaS as a regulator of stomatal closure

Markus Nurmi*, Hannes Kollist**, Saijaliisa Kangasjärvi*, Eva-Mari Aro*

* Department of Biochemistry and Food Chemistry, Molecular Plant Biology, University of Turku, mjnurm@utu.fi

** Plant Signal Research Group, Institute of Technology, University of Tartu

Calcium sensing receptor (CaS) is a 40 kDa phosphoprotein in the photosynthetic thylakoid membrane. CaS is phosphorylated by STN8 kinase in a C-terminal stroma-exposed motif, which predicts interactions with 14-3-3-proteins and with proteins containing fork-head associated domains. Such interactions are frequently associated with crucial functions in cellular signaling. Indeed, our previous work demonstrated that a retarded growth phenotype of knock-out *cas* mutants is not due to deficiencies in the structure or function of the photosynthetic membrane protein complexes. Rather, the functional role of CaS is related to plant responses to environmental cues. Comparative analysis of transcript profiles between *cas* and wild type plants showed differential expression of genes that are related to ROS signaling. Furthermore, several genes encoding for components of ethylene signaling were repressed, suggesting that CaS may be connected with hormonal signaling through ethylene. Interestingly, two genes encoding PIP-type aquaporins that are known to be regulated by ROS and inhibited by Ca²⁺ in roots, were upregulated in *cas* leaves. Subsequent measurement of stomatal conductance revealed that CaS is needed for regulation of desiccation through stomatal closure. Plants lacking the CaS protein maintained the stomata more open during the diurnal light period than the wild type plants. Responses to changes in the levels of light or humidity, however, were similar in *cas* and wild type plants. In contrast, the *cas* mutant lacked the rapid ozone-induced stomatal closure, which is typically observed when wild type plants are exposed to ozone fumigation. *cas* mutants also lacked high CO₂ induced stomatal closure. In conclusion, CaS is a chloroplastic component that mediates rapid responses in the regulation of stomatal guard cells upon environmental challenges.