

# Functional Plant Biology

## Contents

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Biochemical and transcriptomic analysis of maize diversity to elucidate drivers of leaf carbon isotope composition

**Allison R. Kolbe, Anthony J. Studer and Asaph B. Cousins**

489–500

Leaf carbon isotope composition ( $\delta^{13}\text{C}$ ) has been used to screen for water-use efficiency in  $\text{C}_3$  plants, but gaps in the understanding of factors influencing  $\delta^{13}\text{C}$  have limited its application in  $\text{C}_4$  species. This study exploited maize genetic diversity to explore biochemical and post-photosynthetic factors that may influence  $\delta^{13}\text{C}$ . Our findings indicate that the observed variation in leaf carbon isotope composition across diverse maize lines is likely driven by differences in stomatal and mesophyll conductance and not photosynthetic or respiratory metabolism.

Impact of hemlock woolly adelgid (*Adelges tsugae*) infestation on xylem structure and function and leaf physiology in eastern hemlock (*Tsuga canadensis*)

**Brett A. Huggett, Jessica A. Savage, Guang-You Hao, Evan L. Preisser and N. Michele Holbrook**

501–508

Hemlock woolly adelgid (HWA) is an invasive insect that feeds upon the foliage of eastern hemlock trees leading to a decline in health and mortality. During early infestation, HWA-induced decline in the health of eastern hemlock is not initially caused by compromised water transport or needle loss. Our results contribute to efforts to understand the mechanisms leading to the demise of eastern hemlocks.

The regulator of G-protein signalling protein mediates D-glucose-induced stomatal closure via triggering hydrogen peroxide and nitric oxide production in *Arabidopsis*

**Shumei Hei, Zhifeng Liu, Aixia Huang and Xiaoping She**

509–518

Stomatal guard cells sense and respond to sugar, but the means by which they do so have not been fully elucidated. Our study showed that RGS1, a putative receptor for D-glucose, mediates D-glucose-induced  $\text{H}_2\text{O}_2$  and NO production in guard cells and subsequent stomatal closure. The data suggest that photosynthetic product D-glucose, as an integrative signal, coordinates plant  $\text{CO}_2$  uptake with water loss.

Seasonal variations of leaf chlorophyll–protein complexes in the wintergreen herbaceous plant *Ajuga reptans* L.

**Olga Dymova, Mikhail Khristin, Zbigniew Miszalski, Andrzej Kornas, Kazimierz Strzalka and Tamara Golovko**

519–527

In the perennial herbaceous wintergreen plant *Ajuga reptans* (bugle), the photosynthetic apparatus (PSA) is reorganised during winter. The aim of this work was to examine the structural changes in the pigment–protein complexes of PSA. Changes in aggregation of the thylakoid protein complexes were observed including a restructuring of the PSI–PSII megacomplex and the PSII–LHCII supercomplex parallel to changes in the zeaxanthin-dependent protective mechanism.

Identification of *MdDof* genes in apple and analysis of their response to biotic or abiotic stress

**Qing Yang, Qiuju Chen, Yuandi Zhu and Tianzhong Li**

528–541

In the study presented we identified *MdDof* genes in apple and analysed their response to biotic/abiotic stress. The aim of the work was to give references to understand the function of *MdDof* genes generally and serve as a reference for studies of Dof zinc finger genes in other plants. Finally, we fit the original images into the software Photoshop 6.0 for bigger pictures.

*Cover illustration:* A putative model of CaHSP22.5 leads to optimal chilling tolerance via antioxidant enzymes under chilling stress (see Li *et al.* pp. 575–585). ER, endoplasmic reticulum; UPR, unfolded protein response; ROS, reactive oxygen species; LHC, light-harvesting complex. Image by Meifang Li

Structural and functional characterisation of two novel durum wheat annexin genes in response to abiotic stress  
**Marwa Harbaoui, Rania Ben Saad, Nihed Ben Halima, Mouna Choura and Faïçal Brini** 542–552

Abiotic stress reduces the grain yield of cereal crops. Here, we show that the two durum wheat annexin genes, *TdAnn6* and *TdAnn12*, are induced by different abiotic stresses and heterologous expression in yeast improves tolerance to different stresses. These results show that the two annexins are potentially useful candidate genes for engineering abiotic stress tolerance in cultivated plants.

Hydrogen sulfide may function downstream of hydrogen peroxide in mediating darkness-induced stomatal closure in *Vicia faba*  
**Yinli Ma, Jiao Niu, Wei Zhang and Xiang Wu** 553–560

We proved for the first time the effects of H<sub>2</sub>S, a novel gasotransmitter, on darkness-induced stomatal closure and the relationship with H<sub>2</sub>O<sub>2</sub> in *Vicia faba*. Here we found that H<sub>2</sub>S mediated darkness-induced stomatal closure in *Vicia faba* and it acted downstream of H<sub>2</sub>O<sub>2</sub> in this process. This work enriches the signalling network during darkness-regulated stomatal movement and provides evidence for further research.

XopR TTSS-effector regulates *in planta* growth, virulence of Indian strain of *Xanthomonas oryzae* pv. *oryzae* via suppressing reactive oxygen species production and cell wall-associated rice immune responses during blight induction  
**Geeta Verma, Manju Sharma and Kalyan K. Mondal** 561–574

Bacterial pathogens secrete effectors to modulate plant immunity, enabling unlimited pathogen growth inside host, and causing disease. *Xanthomonas oryzae* pv. *oryzae* executes XopR effector to suppress immune responses in rice for its growth and subsequent blight disease. This finding provides insights into understanding the key weapon used by the pathogen, and will help to identify the novel targets for disease management.

Constitutive expression of *CaHSP22.5* enhances chilling tolerance in transgenic tobacco by promoting the activity of antioxidative enzymes  
**Meifang Li, Lusha Ji, Zefeng Jia, Xinghong Yang, Qingwei Meng and Shangjing Guo** 575–585

Chilling stress limits the productivity and geographical distribution of many plants throughout the world. Accumulation of the endoplasmic reticulum-located small heat shock protein *CaHSP22.5* enhanced photochemical activity and oxidation resistance and alleviated endoplasmic reticulum stress caused by chilling stress in transgenic tobacco plants. *CaHSP22.5* could be useful for improving the tolerance of chilling-sensitive plant types.