

# Functional Plant Biology

## Contents

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Characterisation of genes involved in galactolipids and sulfolipids metabolism in maize and *Arabidopsis* and their differential responses to phosphate deficiency

**Feng Wang, Dong Ding, Jiaxin Li, Lin He, Xiaoxuan Xu, Ying Zhao, Bowei Yan, Zuotong Li and Jingyu Xu**

279–292

The synthesis and metabolism of lipids in photosynthesis membrane plays important roles in plant development and stress adaptation. In this study, for the first time, the genes involved in plastidic lipids metabolism were identified from maize and their differential roles in responses to low-phosphate and environmental stresses were revealed. The findings will be conducive to generate improved crops adapted to phosphate starvation and other abiotic stresses.

Two phosphatidylinositol 3-kinase components are involved in interactions between *Nicotiana benthamiana* and *Phytophthora* by regulating pathogen effectors and host cell death

**Shan Lu, Jia Yu, Lina Ma and Daolong Dou**

293–302

Phosphatidylinositol 3-phosphate (PtdIns(3)P), synthesised by the phosphatidylinositol 3-kinase (PI3K) complex, regulates various processes in plants and has a function in plant–*Phytophthora* interactions. We demonstrate that two PI3K component genes (*NbVPS15* and *NbVPS34*) responsible for generating PtdIns(3)P in *Nicotiana benthamiana* regulate the effector stability of *Phytophthora* pathogens and cell death induced by effectors. Our results provide new insights into the regulation of plant resistance to *Phytophthora* and uncover a new function of *vacuolar protein sorting* genes in *N. benthamiana*.

Promoting pepper (*Capsicum annuum*) photosynthesis via chloroplast ultrastructure and enzyme activities by optimising the ammonium to nitrate ratio

**Jing Zhang, Jianming Xie, Yantai Gan, Jeffrey A. Coulter, Mohammed Mujitaba Dawuda, Jihua Yu, Jian Lv, Jing Li, Xiaodang Zhang, Chaonan Tang, Cheng Wang, Tianhang Niu and Alejandro Calderón-Urrea**

303–317

The unbalanced application of N fertilizer has resulted in enormous energy consumption and adverse environmental consequences worldwide. Optimum development is attainable when ammonium and nitrate are supplied to the plants at an appropriate ratio. This experiment reveals that an ammonium: nitrate ratio of 25:75 is the most appropriate for improved photosynthetic capacity in chilli pepper. This can improve the growth and development of this popular vegetable for the benefit of farmers.

Activation of potassium released from soil by root-secreted organic acids in different varieties of tobacco (*Nicotiana tabacum*)

**Zhi-Xiao Yang, Shi-Zhou Yu, Ying-Chao Lin, Wei-Jun Zhang, Yi Wang, Ren-Gang Wang, Shi-Xiao Xu, Tie-Zhao Yang and Gang Xue**

318–326

In this study we examined tobacco varieties for ability to induce activation of slowly available potassium. High levels of organic acids exudates resulted in higher levels of available potassium. These findings suggest that some tobacco varieties may be useful for improving nutrient conditions in agricultural soils.

Molecular characterisation and expression analysis of NAC transcription factor genes in wild *Medicago falcata* under abiotic stresses

**Liquan Zhang, Xuhui Jia, Jingwei Zhao, Agula Hasi and Yiding Niu**

327–341

The *NAC* genes, which play important roles in plant growth and stress responses, were identified and molecularly characterised in wild *Medicago falcata*. The expression patterns of *NAC* genes were analysed in different tissues in response to abiotic stress. This study provided basic information on *NAC* genes in wild *M. falcata*: *MfNAC35* and *MfNAC88* have been found as potential candidate genes for molecular genetic breeding.

*Cover illustration:* The glycerolipid metabolism network of maize and *Arabidopsis* under low-phosphorus stress. Image by Feng Wang and Dong Ding.

<p>Effects of contrasting shade treatments on the carbon production and antioxidant activities of soybean plants</p> <p><b>Muhammad Ali Raza, Ling Yang Feng, Nasir Iqbal, Imran Khan, Tehseen Ahmad Meraj, Zeng Jin Xi, Muhammad Naeem, Saeed Ahmed, Muhammad Tayyab Sattar, Yuan Kai Chen, Chen Hui Huan, Mukhtar Ahmed, Feng Yang and Wenyu Yang</b></p>	342–354	<p>Slight shading could be an effective approach for growing soybean in intercropping systems. Soybean responds to slight shade by producing larger leaves to intercept more sunlight. Compared with severe-shading, soybean maintained the optimum chlorophyll contents, high net photosynthetic rate, and improved antioxidant enzyme activities under slight-shading. Through configuring the space deployment in the intercropping system, slight shade could be helpful for optimum growth and yield. Redesigning photosynthesis through slight shade for intercropping systems could meet global food and bioenergy demand.</p>
<p>Genetic variation for leaf carbon isotope discrimination and its association with transpiration efficiency in canola (<i>Brassica napus</i>)</p> <p><b>Shek M. Hossain, Josette Masle, Andrew Easton, Malcolm N. Hunter, Ian D. Godwin, Graham D. Farquhar and Christopher J. Lambrides</b></p>	355–367	<p>Drought is a major constraint to canola production in Australia and around the world. We studied the genetic variation in a wide range of canola germplasm for transpiration efficiency (TE) – a trait that has value when selecting for drought tolerance in breeding programs. We show there is a large amount of variation for TE in the germplasm studied, and it could be selected for by studying the carbon-isotope composition of leaf material produced in the early vegetative phase of growth.</p>
<p>Effect of N supply on the carbon economy of barley when accounting for plant size</p> <p><b>Ana Clarissa Alves Negrini, John R. Evans, Brent N. Kaiser, A. Harvey Millar, Buddhima C. Kariyawasam and Owen K. Atkin</b></p>	368–381	<p>Nitrogen (N) availability has a profound impact on plant growth. Our research revealed that N availability had little effect on the physiological and leaf morphological components of growth. Rather, the variation in plant growth in response to N was largely due to shifts in biomass allocation. Plants allocated more biomass to roots at the cost of leaves to improve N uptake under low N. This pattern of response to N was maintained when accounting for plant size.</p>