

# Functional Plant Biology

## Contents

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Cryptic crassulacean acid metabolism (CAM)  
in *Jatropha curcas*

**Klaus Winter and Joseph A. M. Holtum**

711–717

*Jatropha curcas* (Euphorbiaceae) is a drought-tolerant shrub or small tree that is a candidate bioenergy feedstock. *J. curcas* exhibits features diagnostic of low-level crassulacean acid metabolism (CAM), a water-conserving mode of photosynthesis. Studies of plants with low-level CAM activity are key for our understanding of how plants have transitioned from C<sub>3</sub> to CAM.

A possible link between hydraulic properties  
and leaf habits in *Hevea brasiliensis*

**Jun-Wen Chen and Kun-Fang Cao**

718–726

Rubber tree is an evergreen tree from the Amazon rainforest; however, we have never understood why it changes into a deciduous species in introduced ranges, such as the Xishuangbanna region, China. To analyse the reason for this change in leaf habit, a co-occurring native evergreen tree was selected as a comparison. This study found that seasonal drought is the main reason for leaf shedding in rubber tree in introduced ranges.

Variation potential induces decreased PSI damage  
and increased PSII damage under high external  
temperatures in pea

**Vladimir Sukhov, Lyubov Surova, Oksana Sherstneva,  
Albina Bushueva and Vladimir Vodenev**

727–736

In higher plants, local damage induces a unique electrical signal: variation potential, which influences numerous physiological processes; however, its role in plant life is not clear. We showed that variation potential decreases PSI damage, increases PSII damage and raises the resistance of the whole plant under heating. Thus variation potential can increase the probability of plant survival under high temperatures.

Spatial heterogeneity in stomatal features during  
leaf elongation: an analysis using *Rosa hybrida*

**Dimitrios Fanourakis, Ep Heuvelink  
and Susana M. P. Carvalho**

737–745

Stomatal features are determined by examining an area that does not exceed 1 cm<sup>2</sup>. This study reveals a considerable within-leaf heterogeneity in these features, with implications in studying stomatal initiation or estimating stomatal conductance. We show that the sampling scheme for stomatal traits ought to be a function of the leaf developmental stage, the feature under study and the growth environment.

Dynamic response of plant chlorophyll fluorescence  
to light, water and nutrient availability

**M. Pilar Cendrero-Mateo, A. Elizabete Carmo-Silva,  
Albert Porcar-Castell, Erik P. Hamerlynck,  
Shirley A. Papuga and M. Susan Moran**

746–757

Chlorophyll fluorescence is under consideration as a potential tool for assessing plant physiological status over large areas using remote sensing sensors. This study demonstrated that under growth light conditions, chlorophyll fluorescence is a versatile and robust indicator of crop stress in response to both water and nitrogen deficit. This study provides support for the use of remotely-sensed chlorophyll fluorescence as a proxy to monitor plant stress dynamics from space.

*Cover illustration:* Microscopic observation and necrotic spot analysis between transgenic and wild-type tobaccos (see Qin *et al.* pp. 802–815). (a) Microscopic structure observation from paraffin section, (b) necrotic spot sizes analysis, (c) top view of the upper leaf without TMV-inoculation. Abbreviations: CN-HAK1, trans-*CN-HAK1* plants; CN, trans-*CN* plant; WT, wild-type plant. Images in (a) by Yang Xiang and images in (b) and (c) by Li-Jun Qin.

Novel insights into the *Citrus sinensis* nonhost response suggest photosynthesis decline, abiotic stress networks and secondary metabolism modifications

**Lucas D. Daurelio, M. Laura Tondo, M. Soledad Romero, Paz Merelo, Adriana A. Cortadi, Manuel Talón, Francisco R. Tadeo and Elena G. Orellano**

758–769

*Citrus* species are one of the most important fruit crops worldwide but pathogen attacks cause significant losses in their production. With the aim of contributing to finding solutions, the fundamental defence mechanism known as the nonhost response was studied in sweet orange and the participation of novel features was determined. These results contribute to our overall comprehension of this defence strategy in nonmodel tree plants.

Interactive effect of biochar and plant growth-promoting bacterial endophytes on ameliorating salinity stress in maize

**Saqib Saleem Akhtar, Mathias Neumann Andersen, Muhammad Naveed, Zahir Ahmad Zahir and Fulai Liu**

770–781

Salinity stress constraints plant growth and reduces crop yield. Incorporation of biochar and plant growth-promoting endophytic bacteria containing 1-aminocyclopropane-1-carboxylate deaminase and exopolysaccharide activity in the soil could mitigate salinity stress in maize either by decreasing sodium uptake or by maintaining nutrient balance. Therefore, inoculation of plants with endophytic bacterial strains along with biochar amendment could be an effective approach for sustaining crop production in salt-affected soils.

Photon flux density and temperature-dependent responses of photosynthesis and photosystem II performance of apple leaves grown in field conditions

**Dennis H. Greer**

782–791

The interaction of light and leaf temperature on the photosynthetic process is important to understand how climate affects productivity. This study documents the interaction on photosynthesis but also the performance of PSII across different light and temperature conditions. Modelling the photosynthetic response has enhanced understanding of the photochemical and non-photochemical contributions to photosynthesis in different light and temperature conditions.

Alkaloid production and capacity for methyljasmonate induction by hairy roots of two species in Tribe Anthocercideae, family Solanaceae

**Suzanne M. Ryan, Kathleen D. DeBoer and John D. Hamill**

792–801

Within the family Solanaceae, tribe Anthocercideae and the genus *Nicotiana* (tobacco) diverged from common ancestral stock ~15 million years ago. Cultured roots of the Anthocercideae species *Cyphanthera tasmanica* and *Anthocercis ilicifolia* spp. *ilicifolia* produce the medicinally useful tropane alkaloid hyoscyamine and also the pyridine alkaloids nicotine and nornicotine. We observed that treatment of these roots with low levels of the wound hormone methyl jasmonate led to increased levels of nicotine/nornicotine but not hyoscyamine, possibly indicating evolutionary conservation of mechanisms underpinning wound-stress induction of pyridine alkaloid metabolism for defensive purposes.

Selectable marker-free co-expression of *Nicotiana rustica* CN and *Nicotiana tabacum* HAK1 genes improves resistance to tobacco mosaic virus in tobacco

**Li-Jun Qin, Dan Zhao, Yi Zhang and De-Gang Zhao**

802–815

Disease-resistance genes and mineral nutrition play an important role in improving plant resistance to pathogens. TMV-resistance gene CN with K-enrichment gene HAK1 synergistically improved TMV-resistance in selectable marker-free tobaccos by adjusting potassium status, regulating resistance defence and affecting K<sup>+</sup>-involved biotic stress-resistance. This study provided a way for screening new varieties of marker-free and antiviral tobaccos.