

# Functional Plant Biology

## Contents

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*Review: A pump/leak model of growth: the biophysics of cell elongation in higher plants revisited*

**Lars H. Wegner** 185–197

Growth is an issue of central importance in plant physiology and agriculture. Growing cells expand by generating an internal hydrostatic pressure – the turgor. A thorough revision of over 40 years of research suggests that turgor results from a steady-state between passive water uptake via aquaporins driven by an osmotic gradient (which is generally accepted) and by a secondary active water secretion, including a cotransport of water and solutes.

Aluminium-inhibited  $\text{NO}_3^-$  uptake is related to Al-increased  $\text{H}_2\text{O}_2$  content and Al-decreased plasma membrane ATPase activity in the root tips of Al-sensitive black soybean

**Dan Yang, Dongjie Chen, Ping Wang, Daihua Jiang, Huini Xu, Xiaolu Pang, Limei Chen, Yongxiong Yu and Kunzhi Li** 198–207

The study on the effect of Al stress on the absorption of  $\text{NO}_3^-$  N in soybean could provide a scientific basis for N management in acid soil. The results showed that Al stress could significantly inhibit the absorption of  $\text{NO}_3^-$  N in soybean; however, Mg and ascorbic acid could reduce the inhibition of  $\text{NO}_3^-$  N uptake by Al stress. The inhibition of nitrate uptake in soybean in acid soil is expected to be alleviated by applying Mg and ascorbic acid.

The seed-borne *Southern bean mosaic virus* hinders the early events of nodulation and growth in *Rhizobium*-inoculated *Phaseolus vulgaris* L.

**Mariadaniela López, Nacira Muñoz, Hernan Ramiro Lascano and María Luisa Izaguirre-Mayoral** 208–218

Seed-transmitted viruses are a major threat in tropical and subtropical fields, hindering the benefits of applying *Rhizobium* inoculants in legume crops. We developed an easy, 100% effective protocol to promote the infection of germinating seeds with a legume virus. This protocol will enable further research beyond our findings with *Phaseolus vulgaris* L. for improving cultural practices to reduce the incidence of viruses in tropical and subtropical legume crops.

Effects of drought stress on morphological, physiological and biochemical characteristics of wheat species differing in ploidy level

**Jian Yong Wang, Neil C. Turner, Ying Xia Liu, Kadambot H. M. Siddique and You Cai Xiong** 219–234

Modern polyploid wheat has diploid and tetraploid ancestors that may harbour beneficial drought resistance genes lost during domestication and subsequent breeding. We compared the morpho-physiological and biochemical responses to drought of eight accessions of wild and domesticated wheat differing in ploidy level, and show that modern polyploid wheat invests less biomass in roots and more in leaves and reproductive organs, particularly under drought.

Genotypic variation in soil water use and root distribution and their implications for drought tolerance in chickpea

**Ramamoorthy Purushothaman, Lakshmanan Krishnamurthy, Hari D. Upadhyaya, Vincent Vadez and Rajeev K. Varshney** 235–252

Knowledge on soil water use pattern is critical for adapting chickpea to drought. Drought reduced surface root distribution while enhancing the deeper ones. Water use from 15 to 30 and 90 to 120 cm soil depths were critical for best adaptation.

*Cover illustration:* Growth regulation according to a pump/leak model (see Wegner pp. 185–197). Note that cell turgor ( $P_T$ ) and, in turn, growth rate are varied at a constant osmotic gradient across the membrane. An increase of the hydraulic conductance of the membrane by de-novo synthesis or activation of aquaporins (left), leads to a decrease in the cellular water potential deficit (i.e. a less negative water potential) and an increase in  $P_T$  and in growth, whereas an increase in secondary active water transport (right) entails a downregulation of  $P_T$  and growth, associated with an increase in the water potential deficit. Note that only hydraulic effects are considered, that can be masked in a growing cell by a modulation of cell wall properties. Image by Lars Wegner.

Assessing the suitability of various screening methods  
as a proxy for drought tolerance in barley

***Md. Hasanuzzaman, Lana Shabala, Tim J. Brodrigg,  
Meixue Zhou and Sergey Shabala***

253–266

In a search for a convenient and rapid screening method for drought tolerance, barley genotypes were evaluated for a range of physiological and agronomical measures. Leaf chlorophyll fluorescence  $F_v/F_m$  ratio and the relative root growth rate of polyethylene glycol-treated seedlings were found to be the most suitable proxies for quantifying drought tolerance.

Warming alters the positive impact of elevated  
CO<sub>2</sub> concentration on cotton growth and physiology  
during soil water deficit

***Katrina J. Broughton, Renee A. Smith,  
Remko A. Duursma, Daniel K. Y. Tan,  
Paxton Payton, Michael P. Bange  
and David T. Tissue***

267–278

Alterations in climate factors such as rising CO<sub>2</sub> concentration ([CO<sub>2</sub>]), warming and reduced precipitation may have significant impacts on plant physiology and growth. Cotton was grown in the glasshouse at two [CO<sub>2</sub>] treatments (CA, 400 μL L<sup>-1</sup>; CE, 640 μL L<sup>-1</sup>) and two temperature treatments (TA, 28°C:17°C day: night; TE, 32°C:21°C day:night), and subjected to two progressive water deficit cycles, with a 5-day recovery period between the water deficit periods. CE may provide positive growth and physiological benefits to cotton under TA if sufficient water is available but CE will not mitigate the negative effects of rising temperature on cotton growth and physiology in future environments.