

Functional Plant Biology

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Rudi Appels

Review: Yield stability for cereals in a changing climate

Nicola Powell, Xuemei Ji, Rudabe Ravash, Jane Edlington and Rudy Dolferus

539–552

A 34% increase in the world population by 2050 will require a 43% boost in productivity of staple crops such as cereals to meet food demand. Cereal productivity is increasingly challenged by climate change. Improving cereal yields will not only require increasing yield potential of current germplasm, but yield stability and reproductive stage abiotic stress tolerance will become increasingly important traits to incorporate in future germplasm.

Review: Tapetal development and abiotic stress: a centre of vulnerability

Roger W. Parish, Huy A. Phan, Sylvana Iacuone and Song F. Li

553–559

In many self-fertilising crop species the anther tapetum appears to be highly vulnerable to abiotic stress. Current knowledge about the response of anthers to cold, drought and heat is reviewed, in particular their effect on tapetal and microspore carbohydrate supply and the role of plant hormones. Identification of the molecular mechanisms involved in anther sensitivity to abiotic stress could facilitate targeted gene modifications as a means of reducing this sensitivity.

Genotypic variation in the accumulation of water soluble carbohydrates in wheat

C. Lynne McIntyre, David Seung, Rosanne E. Casu, Gregory J. Rebetzke, Ray Shorter and Gang Ping Xue

560–568

Water-soluble carbohydrates (WSC) stored in the stems are a major contributor to wheat grain yield and grain size especially under drought conditions. To help identify high WSC lines in wheat breeding programs, genetic markers for high WSC and the genes that control the amount of WSC are being identified. WSC is a complex trait, with many genes each of small effect, and high WSC is associated with higher levels of expression of genes involved in carbohydrate metabolism and lower levels of expression of genes involved in cell wall and amino acid metabolism than low WSC lines.

Cover illustration: Flow of carbon nutrients to developing pollen in the pollen sac of anthers. The diagram illustrates a section of an anther and the flow of sugars to developing pollen. In the dermis, symplastic (double-headed arrow) and active transport of sucrose (red arrow) occurs and within the tapetal layer the three broad classes of invertases that can break sucrose down to glucose and fructose, if they are expressed, are shown. CIN is the cytoplasmic invertase, VIN is the vacuolar invertase and IVR1 is the cell wall invertase. In the pollen sac layer the developing pollen (tetrad and uni-nuclear stages) from wheat are shown as acetocarmine-stained cells (lower left side of panel, photograph provided by R. Dolferus, CSIRO) and DAPI-stained fluorescent images (lower right side of panel, photograph provided by B. Dell, Murdoch University). The network involved in maintaining the sugars at an optimum level includes the interactions of a protein inhibitor with the cell wall invertase to moderate the breakdown of sucrose to glucose and fructose. The diagram was designed by H. Webster (PhD thesis, Murdoch University).

<p>Genome-level identification of cell wall invertase genes in wheat for the study of drought tolerance Hollie Webster, Gabriel Keeble, Bernard Dell, John Fosu-Nyarko, Y. Mukai, Paula Moolhuijzen, Matthew Bellgard, Jizeng Jia, Xiuying Kong, Catherine Feuillet, Frédéric Choulet, International Wheat Genome Sequencing Consortium and Rudi Appels</p>	<p>569–579</p>	<p>The family of genes called invertases serve a central function in plants to distribute, and control the flow, of sugar nutrients in the plant. Webster et al. have now defined the subfamily of genes that are relevant to early stage development of heads to the point where a suite of molecular markers or probes can be designed to track these important genes in breeding programs.</p>
<p>Tissue size and cell number in the olive (<i>Olea europaea</i>) ovary determine tissue growth and partitioning in the fruit Adolfo Rosati, Silvia Caporali, Sofiene B. M. Hammami, Inmaculada Moreno-Aliás, Andrea Paoletti and Hava F. Rapoport</p>	<p>580–587</p>	<p>The origin of differences in fruit tissue size and partitioning among olive cultivars is unknown. We found that tissue (i.e. endocarp and mesocarp) size in the fruit is determined by tissue cell number in the ovary, whereas tissue relative growth after bloom correlates with cell size in the ovary. These findings will impact fruit growth modelling and breeding in olive.</p>
<p>Reflectance indices as nondestructive indicators of the physiological status of <i>Ceratonia siliqua</i> seedlings under varying moisture and temperature regimes Júlio Osório, Maria Leonor Osório and Anabela Romano</p>	<p>588–597</p>	<p>The application of spectral reflectance techniques to investigate the impacts of environmental stresses on economically valuable Mediterranean species is important, given the predicted worsening of drought and warming in the region. We validated the use of reflectance indices to assess the physiological status of carob tree seedlings under such climate scenarios. This work adds to the growing body of literature concerning the fast monitoring of abiotic stress over large areas.</p>
<p>Nitrogen and oxygen isotope effects of tissue nitrate associated with nitrate acquisition and utilisation in the moss <i>Hypnum plumaeforme</i> Xue-Yan Liu, Keisuke Koba, Muneoki Yoh and Cong-Qiang Liu</p>	<p>598–608</p>	<p>Isotopic mechanisms in N utilisation are valuable for understanding how plants respond to changing environment and N availability. Nitrogen and O isotope effects of moss nitrate acquisition and assimilation were firstly elucidated by measuring isotopes of tissue nitrate. The covariance of ¹⁵N: ¹⁸O ratios following approximately 1 : 1 during nitrate reduction provided a key to interpret moss nitrate physiology.</p>
<p>Impact of ancestral wheat sodium exclusion genes <i>Nax1</i> and <i>Nax2</i> on grain yield of durum wheat on saline soils Richard A. James, Carol Blake, Alexander B. Zwart, Ray A. Hare, Anthony J. Rathjen and Rana Munns</p>	<p>609–618</p>	<p>Soil salinity is a major limitation on the growth and yield of all crop species, but especially of durum wheat, which lacks the ability to reduce sodium uptake into its leaves. This study describes the development of durum wheat breeding lines containing salt tolerance loci <i>Nax1</i> and <i>Nax2</i> and their performance in controlled environment and in fields of varying salinity. Results showed that enhanced sodium exclusion capability associated with <i>Nax2</i> resulted in improved grain yields of up to 25% in soils with high salinity.</p>