

Functional Plant Biology

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Foreword: Drought effects and water use efficiency:
improving crop production in dry environments

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Review: Breeding for improved water productivity
in temperate cereals: phenotyping, quantitative
trait loci, markers and the selection environment

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Michelle Watt, A. G. (Tony) Condon,
Wolfgang Spielmeier and Rudy Dolferus** 85–97

The most likely traits to improve the grain yield of temperate cereals in water-limited environments are described. We also describe the most effective selection method and selection environment for each trait. Also, how to develop appropriate lines or populations for use in trait validation and breeding.

Review: Drought-induced changes in development
and function of grapevine (*Vitis* spp.) organs and
in their hydraulic and non-hydraulic interactions
at the whole-plant level: a physiological
and molecular update

**Claudio Lovisolo, Irene Perrone, Andrea Carra,
Alessandra Ferrandino, Jaume Flexas,
Hipolito Medrano and Andrea Schubert** 98–116

Grapevine responses to water stress are here addressed by examining perturbations to physiological and molecular processes at the root, shoot, leaf and berry levels. Long-distance signalling among organs is also considered. Features observed in different organs show that grapevine fits well as a complex model plant for studies on plant drought avoidance/tolerance.

Viewpoint: Adaptive phenotypic plasticity and plant
water use

Adrienne B. Nicotra and Amy Davidson 117–127

A water-wise plant uses water conservatively when it is scarce but maximizes uptake when water is abundant. We explore the possibility of plants that can change their phenotype in response to water availability to maximise fitness and discuss the relevance of such plasticity for land management under current climate change.

Partial rootzone drying and deficit irrigation increase
stomatal sensitivity to vapour pressure deficit
in anisohydric grapevines

**Marisa J. Collins, Sigfredo Fuentes
and Edward W. R. Barlow** 128–138

Application of PRD and DI irrigation to anisohydric Shiraz grapevines increased stomatal closure in response to high vapour pressure deficit (VPD) making the vines behave in a more isohydric-like manner. Results suggest that application of sustained moderate stress increased stomatal sensitivity to water loss and/or VPD.

Cover illustrations: (Left) Automatic rain-out shelter facility to investigate the value of traits for drought tolerance in wheat, near Cootamundra, New South Wales. Photo: Dr John Kirkegaard (CSIRO). (Right) Water management is an essential tool used by vineyard managers to optimize fruit quality and control canopy growth, Adelaide Hills, South Australia. Photo: Dr Brian Loveys (CSIRO).

<p>Differences in stomatal responses and root to shoot signalling between two grapevine varieties subjected to drought</p> <p>Alexandros Beis and Angelos Patakas</p>	139–146	<p>The role of chemical and hydraulic signals in stomatal responses under drought conditions was studied in two grapevine varieties (<i>Vitis vinifera</i> L. cvv. Sabatiano and Mavrodafni). The greater ability for drought adaptation might be attributed to the more efficient control on stomatal closure. Differences in both leaf ABA and xylem pH values might also contribute to the ability for adaptation in the two varieties.</p>
<p>Partitioning of assimilates to deeper roots is associated with cooler canopies and increased yield under drought in wheat</p> <p>Marta S. Lopes and Matthew P. Reynolds</p>	147–156	<p>Drought adaptation among contrasting sister lines was conferred by increased root mass at depth and associated with cooler canopy temperature, suggesting that the latter can be used as a surrogate of root depth. A trade-off between deep rooting and accumulation of water soluble stem carbohydrates was apparent.</p>
<p>Improvement of drought tolerance in white clover (<i>Trifolium repens</i>) by transgenic expression of a transcription factor gene <i>WXP1</i></p> <p>Qingzhen Jiang, Ji-Yi Zhang, Xiulin Guo, Mohamed Bedair, Lloyd Sumner, Joseph Bouton and Zeng-Yu Wang</p>	157–165	<p>A transcription factor gene, <i>WXP1</i>, was placed under the control of CER6 promoter and introduced into a commercial white clover cv. Patriot. Analyses of the transgenics under water-stress and water-recovery conditions revealed that the white clover plants carrying <i>WXP1</i> had improved physiological performance and enhanced tolerance to drought stress.</p>
<p>Stem solidness and its relationship to water-soluble carbohydrates: association with wheat yield under water deficit</p> <p>Carolina Saint Pierre, Richard Trethowan and Matthew Reynolds</p>	166–174	<p>Wheat genotypes with different levels of stem solidness were evaluated to assess the heritability and relationship among stem morphological properties, stem water-soluble carbohydrates (WSC) storage capacity and grain yield. An ideal plant ideotype to maximise WSC reserves in order to improve yield under water-limited conditions is proposed.</p>
<p>Improved plant nitrogen nutrition contributes to higher water use efficiency in tomatoes under alternate partial root-zone irrigation</p> <p>Yaosheng Wang, Fulai Liu, Mathias N. Andersen and Christian R. Jensen</p>	175–182	<p>PRI improves N nutrition and optimises N distribution in the canopy of tomato plants. Both strong ABA-based root-to-shoot chemical signalling and improved N nutrition and distribution contribute to the higher WUE in PRI plants. PRI is superior to DI in improving both water and nitrogen use efficiencies.</p>