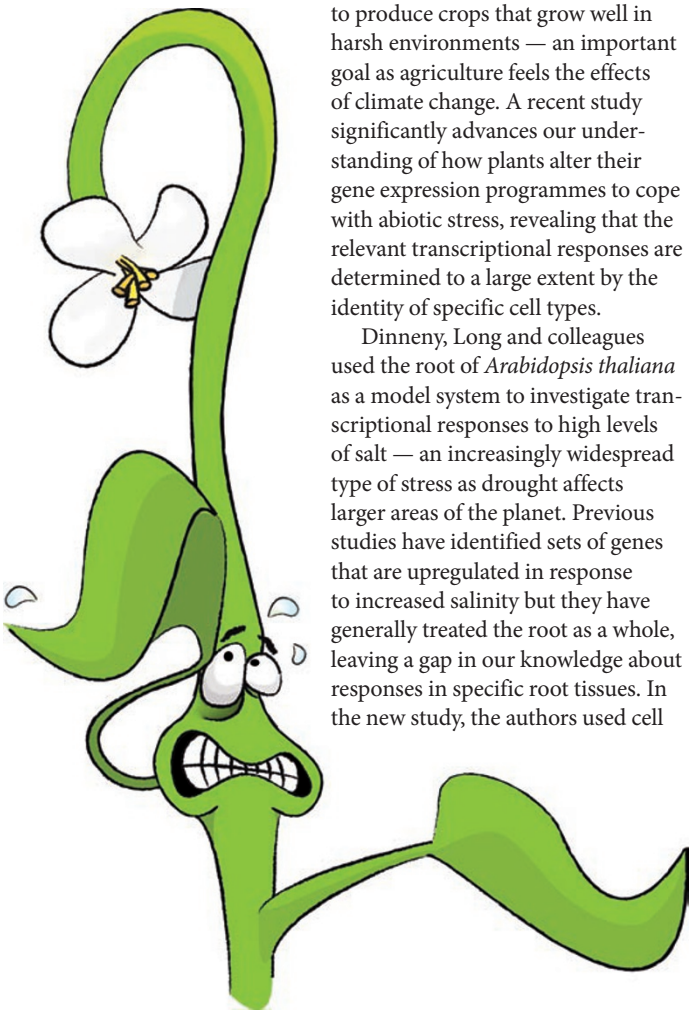
GLOBAL CHALLENGES

A sense of identity helps stressed-out plants



Understanding how plants cope with stressful conditions is essential if we are to use genetic approaches to produce crops that grow well in harsh environments — an important goal as agriculture feels the effects of climate change. A recent study significantly advances our understanding of how plants alter their gene expression programmes to cope with abiotic stress, revealing that the relevant transcriptional responses are determined to a large extent by the identity of specific cell types.

Dinneny, Long and colleagues used the root of *Arabidopsis thaliana* as a model system to investigate transcriptional responses to high levels of salt — an increasingly widespread type of stress as drought affects larger areas of the planet. Previous studies have identified sets of genes that are upregulated in response to increased salinity but they have generally treated the root as a whole, leaving a gap in our knowledge about responses in specific root tissues. In the new study, the authors used cell sorting to separate out cell types and monitored transcriptional changes in different longitudinal and radial root zones using microarrays.

A striking finding was that most genes that show expression changes in response to high levels of salt do so in a cell type-specific way, with a smaller number of genes being affected across multiple cell types. Furthermore, the authors showed clear differences in the functional categories of genes that are up- or downregulated in each root zone. Notably, genes that had been identified as being stress responsive in previous studies generally underwent transcriptional changes in more than one cell type, highlighting the need for studies that take differences between root zones into account.

How are these cell type-specific responses generated? Previous studies of canonical stress-response pathways have identified sequence elements that direct transcriptional activation or repression of target genes. However, promoter analysis revealed that these elements do not account for stress-mediated regulation of most genes that are regulated in a zone-specific way. Furthermore, components of stress-response signalling pathways — such as the hormone asbscisic acid — seem to regulate both zone-specific and more generalized expression changes, but through a different set of sequence elements to those that they use in canonical responses. To investigate the possible role of cell-fate specification in cell type-specific responses to salt stress, the authors examined expression profiles in three mutants that show abnormal epidermal cell-fate decisions and identified four sets of genes, the expression of which is both salt-sensitive and dependent on correct epidermal patterning.

Importantly, these findings extend to other types of abiotic stress: the authors showed that the transcriptional response to iron deficiency also has a large zone-specific component. So, this study sets the scene for a new direction in understanding how plants adapt to stress, centred on the interplay between regulators of cell identity and signals from the environment. Extending such studies to other types of stress and to agriculturally relevant species might ultimately lead to much needed new crop-improvement strategies.

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ORIGINAL RESEARCH PAPER Dinneny, J. R. & Long, T. A. *et al.* Cell identity mediates the response of *Arabidopsis* roots to abiotic stress *Science* 24 Apr 2008 (doi:10.1126/science.1153795)
FURTHER READING Takeda, S. & Matsuoka, M. Genetic approaches to crop improvement: responding to environmental and population changes. *Nature Rev. Genet.* **9**, 444–457 (2008)
WEB SITE
Philip Benfey's laboratory: http://www.biology.duke.edu/benfeylab/philip.htm