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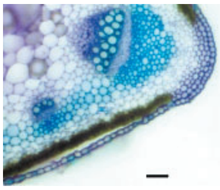
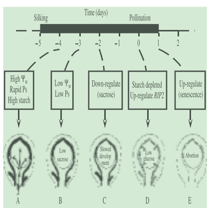
John Bryant takes a closer look at some of this month's Original Articles



Ice and a slice

For those of us who live in regions prone to frost in winter, one of the most fascinating phenomena is the ability of certain plants to survive exposure to temperatures below freezing, often in a repeated diurnal cycle of freeze–thaw which may last for several days or even weeks. How do they do it? In some frost-tolerant species, frosted plants look badly wilted, and indeed they are. In this issue, **Margaret McCully and colleagues (Canberra, Australia, pp. 665–674)** describe how cells of these plants lose water under freezing conditions and regain it during a thaw. The authors used plants of *Trifolium repens* (white clover) and *Escholschzia californica* (California poppy) frosted *in situ* where they grew. Petioles were taken at different times in the freeze–thaw cycle and examined by cryo-microscopy and by conventional light microscopy. It is well known that many frost-tolerant organisms are able to prevent intracellular ice formation and these plant species are no exception. Ice formation starts in the intercellular spaces and, as freezing proceeds, water is drawn from the cells, thus leading to wilting. What is so interesting about the species examined here is that significant ice formation ('blocks of extracellular icicles') form in a 'fault zone' between the epidermal layers and the parenchyma. However, the outer cell layers do not separate completely from the parenchyma; there are anchorage points opposite the vascular bundles that hold the layers together. Thus, the petiole does not fall to pieces despite the extensive ice formation. On thawing, the process is reversed: the ice melts, water is taken up by the cells, which regain their size and turgor, and the sub-epidermal space shrinks. Overall, this is a clear mechanism for avoidance of intracellular ice formation. However, in our understanding of the process, many questions remain, as the authors themselves indicate, including those concerning the developmental regulation of the fault zone and of the anchorage points.



Sugar saves the seed set

In the accompanying Content*Select* we noted that cells may lose water because of intercellular ice formation. However, cellular water deficit is more usually associated with a shortage of water under non-freezing conditions, particularly during drought. Many plants show some degree of tolerance to water deficit but that tolerance may vary according to the developmental stage of the individual plant. Thus, as pointed out by **McLaughlin and Boyer at the University of Delaware (pp. 675–689)**, maize (*Zea mays*) is especially vulnerable around the time of pollination when water deficit leads to abortion of ovaries and thereby reducing seed set. This in turn has been ascribed to inhibition of photosynthesis by water shortage. In support of this, previous work by these and other authors suggests that feeding sucrose may reduce the extent of ovary abortion. The authors have now made a thorough study of some of the molecular mechanisms underlying this phenomenon. Here they focus especially on expression of genes encoding sucrose-metabolizing enzymes. The authors used the increasingly popular technique of real-time quantitative PCR to estimate mRNA populations, showing that under conditions of water deficit, the expression of these genes is strongly down-regulated (although that of an invertase inhibitor remains high). In addition, as the water deficit, imposed by withholding water, becomes more severe, two senescence-associated genes are up-regulated and the expression of these genes may be linked specifically with ovary abortion. However, if sucrose is supplied, the down-regulation of genes encoding cell wall invertases is reversed although those encoding other sucrose-metabolizing enzymes are unaffected by addition of sucrose. These data thus show a correlation during water deficit

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between the fate of the ovary and the expression of some of the genes encoding sucrose-metabolizing enzymes. Future challenges include understanding the roles of all the sucrose-metabolizing enzymes during normal pollination and development, and also determining the significance of the differential responses to sucrose.

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