Crops wilting in the field present a nightmare scenario, and on the face of it one we understand all too clearly. But plant hydraulic conductance is complex, and cause for considerable debate and controversy over the years as scientists have sought to reach a better understanding. New work by Patrizia Trifiló et al. published in Journal of Experimental Botany shows that water transport beyond the xylem is important in explaining the decline of whole-leaf hydraulic conductance with dehydration. Lawren Sack and colleagues comment on the work in their non-specialist Insight article in the same issue of the journal, and note that the work will change the way plant physiologists and ecologists think about water transport.

The contribution of vascular and extra-vascular water pathways to drought-induced decline of leaf hydraulic conductance

Why are leaves hydraulically vulnerable?

The difficulty of getting to grips with plant hydraulics is particularly acute in the leaves, where the relative simplicity of stem xylem gives way to almost overwhelming complexity as the water finds its path through the intricate venation and mesophyll to the atmosphere. Trifiló et al., however, used the rehydration kinetic and vacuum chamber methods to look at the effects of drought leaf hydraulics in revealing detail. Species were carefully chosen to cover a wide range of leaf mass per area, and included two evergreen trees (Aleurites moluccana in the Euphorbiaceae, and Magnolia grandiflora in the Magnoliaceae), a deciduous tree (Quercus rubra, Fagaceae) and a deciduous vine (Vitis labrusca, Vitaceae).

Commenting on the research, Sack et al. emphasise the importance of ‘vulnerability’, the decline of whole-leaf hydraulic conductance with dehydration, and note how many studies have shown this occurring before turgor loss. Trifiló et al. confirm this, but go much further. Measurements were taken of hydraulic resistance in the whole leaf, leaf xylem and extra-vascular pathways in the four contrasting species, and it was shown that relative hydraulic contributions are species-specific.

Sack et al.: ‘This research is especially significant because it clearly shows the potential roles of both xylem and outside-xylem pathways in controlling Kleaf [whole-leaf hydraulic conductance] vulnerability and, by extension, whole-plant hydraulic conductance and productivity. These findings will change the way plant physiologists and ecologists think about water transport, with a major potential role for living tissues as well as xylem in control of the system.’

They go on to say: ‘If Kox [outside-xylem conductance] decline turns out to be the major driver of
Kleaf decline, this will shift our understanding of water transport in the whole plant, and thus in the entire soil–plant–atmosphere continuum.’

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