On the Inside

Endo-1,4-β-Glucanase and Cellulose Synthesis

Although cellulose is the major cell wall polysaccharide in plants, the enzymes that contribute to its production have generally proven to be recalcitrant to study by traditional enzymology. The study of cellulose-deficient, radial swelling (rsw) mutants of Arabidopsis is beginning to yield valuable insights into cellulose synthesis. For example, the gene RSW1, which appears to code for a glycosyltransferase, has recently been linked to cellulose production. In this issue, Lane et al. (pp. 278–288) examine the effects of the rsw2 mutation, which is non-allelic to RSW1. They report that rsw2 is, in fact, allelic to KORRIGAN, a gene that encodes for a putative membrane-bound endo-1,4-β-glucanase whose dysfunction has previously been linked to abnormalities in cell expansion and division. The rsw2 mutant shows radial swelling in the root and hypocotyl; reduced axial growth; smaller leaves, stems, and flowers; and impaired anther dehiscence. These morphological aberrations are accompanied by gross anatomical abnormalities (Fig. 1). The effects of the rsw1 and rsw2 mutations were found to be additive in part. It is interesting that cellulose synthesis in Arabidopsis reveals homologies to cellulose synthesis in Agrobacterium tumefaciens where two genes, celA and celC, also encode for a glycosyltransferase and an endo-1,4-β-glucanase, respectively.

Magnetic Resonance Imaging (MRI) of Cavitating Xylem Vessels

Transport of water through xylem vessels may become disrupted by the cavitation of water columns under high levels of tension or freezing temperatures. Such vessels would normally be lost to water transport unless mechanism exist to reconnect the column. The mechanism by which cavitated vessels become repaired remains controversial, particularly in light of recent claims that cavitated vessels can be repaired even when water in neighboring conduits is under tension. In this issue, Holbrook et al. (pp. 27–31) use high-resolution MRI to show that individual xylem vessels in grape (Vitis vinifera) vines do spontaneously refill following caviation (Fig. 2). This non-destructive technique should prove most useful in studying the mechanisms underlying the repair of cavitated vessels.

Unidentified Signal Regulates Apical Dominance in Pea

The ramosus1 (rms1) mutant of pea (Pisum sativum) exhibits reduced apical dominance. Granting rms1 scions to wild-type (WT) rootstocks restores the WT phenotype to the scion, suggesting that rms1 affects apical dominance by altering the levels of a branching inhibitor originating from the rootstock. Although cytokinins (CKs) originate in the root and have been implicated in apical dominance, they are poor candidates for this mysterious factor: CKs tend to promote branching when applied directly to buds, and rms1 mutants, in fact, have reduced levels of CKs in their xylem sap. Indole-3-acetic acid, another hormone long implicated in apical dominance, is also unlikely to be the mysterious branching inhibitor affected by the rms1 mutation given the basipetal polarity of its movement. In this issue, Foo et al. (pp. 203–209) report on the results of several grafting experiments that shed further light on this yet-to-be-identified branching inhibitor. First, they report that the grafting of a small (0.5–1.0 cm) WT interstock between an rms1 scion and rootstock almost completely inhibits lateral branching. Second, a WT and an rms1 shoot growing from the same mutant rootstock exhibit their normal differences in branching patterns, but if they are both grafted to a WT rootstock, the branching of both types of scions is inhibited. Third, the simultaneous grafting of rms1 scions to both WT and rms1 rootstocks leads to an inhibition of branching in the mutant scion. Thus, all evidence points to the existence of a graft-transmissible, long distance inhibitor of branching in WT peas.
**Our Expanding Knowledge of β-Expansins**

Expansins are a family of plant proteins essential for acid-induced cell wall loosening. Sequence comparisons indicate that there are two classes of expansins, α and β, which despite sharing only about 20% amino acid identity, have in common, in addition to their cell wall-loosening abilities, a number of highly conserved motifs. To date most studies have focused on α-expansins, but in this issue two studies provide new insights into the molecular biology of β-expansin structure and function. Wu et al. (pp. 222–232) report on their isolation and characterization of 13 of the more than 30 expansin DNAs in maize (*Zea mays*). Their data indicate that the expression patterns of α- and β-expansin genes run the gamut from general and overlapping to highly specific and localized. Unlike the case with Arabidopsis, the β-expansins of maize are more numerous and highly expressed than are α-expansins. Although β-expansins are apparently less common in dicots, their function in these plants is no less fascinating. A case in point is Cim1, a β-expansin from soybean (*Glycine max*) that increases 20- to 60-fold after treatment of CK-starved soybean suspension cells with CK. Previous studies have revealed that this accumulation stems from increased Cim1 stability. Downes et al. (pp. 244–252) employ antibodies to Cim1 to reveal three processing intermediates that are involved in the maturation and degradation of this species of β-expansin. CK and auxin are reported to act synergistically to induce the accumulation of Cim1, and the onset of Cim1 expression is correlated with the growth of soybean cultures. Cim1 is rapidly and specifically degraded as soybean cultures reach stationary phase.

**Anion Channels and Al³⁺ Resistance**

The high levels of Al³⁺ that typify many types of acid soil are considered to be one of the major constraints to increasing crop yields worldwide. In many plants, the binding of toxic Al³⁺ by organic anions released from the roots comprises a major mechanism of Al³⁺ resistance. Reinforcing other recent findings published in Plant Physiology (Piñeros and Kochian, 2001; Zhang et al., 2001), two articles in the present issue offer mechanistic details of the anion channel that mediates this efflux of organic ions. Kollmeier et al. (pp. 397–410) used the patch clamp technique to investigate Al³⁺-induced currents in the root tips of maize. Pre-incubation of intact roots with low concentrations of Al³⁺ induced a citrate- and malate-permeable anion channel in 80% of the protoplasts derived from the zone 1 to 2 mm from the root tip. When Al³⁺ was applied to the protoplasts in the whole-cell configuration, anion currents were elicited in 10 min. The anion channel blockers niflumic acid and 4,4'-dinitrostilbene-2,2'-disulfonic acid strongly inhibited both the Al³⁺-induced anion currents and the release of organic acids. The protein synthesis inhibitor cycloheximide had no effect on the elicitation of the anion current by Al³⁺, suggesting that channel activation is mediated posttranslationally. The data of Osawa and Matsumoto (pp. 411–420) suggest that this posttranslational mechanism may involve protein phosphorylation. They report that K-252a, a broad-spectrum inhibitor of protein kinases, prevents the induction of malate release by Al³⁺ in an Al³⁺-resistant cultivar of wheat (*Triticum aestivum*). The transient activation of a 48-kD protein kinase was observed to precede the initiation of malate efflux, and its activation was abolished by K-252a. K-252a rendered this normally resistant cultivar sensitive to the toxic effects of Al³⁺.

**LITERATURE CITED**

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