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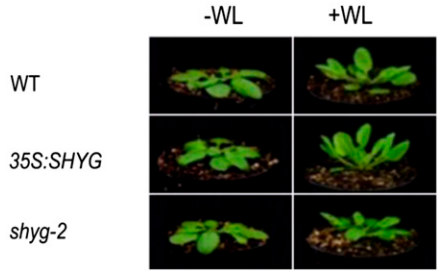
IN BRIEF

A NAC Transcription Factor for Flooding: *SHYG* Helps Plants Keep Their Leaves in the Air

Like struggling swimmers trying to keep their heads above water, rosette plants lift up their leaves when faced with flooding. Instead of flailing arms and legs, plants use hyponastic petiole growth to improve their chances of keeping leaves in contact with the air. During this hyponastic growth, cells on the abaxial side of the petiole elongate more than those on the adaxial side, changing the angle of the petiole (see figure). Ethylene is a major regulator of this process (reviewed in Polko et al., 2011), and new work from **Rauf et al. (pages 4941–4955)** describes a NAC transcription factor that mediates flooding-induced hyponastic growth via regulation of an ethylene biosynthesis enzyme.

Rauf et al. characterized *SPEEDY HYPONASTIC GROWTH* (*SHYG*; ANAC047), which encodes a group III NAC transcription factor family member and is induced upon waterlogging (i.e., root submergence) in *Arabidopsis thaliana*. Whereas *shyg* mutants had much reduced hyponastic petiole growth in response to waterlogging, *SHYG* overexpression lines had increased responsiveness, consistent with *SHYG* mediation of flooding-induced hyponastic growth. In addition, more than a dozen genes related to cell expansion responded to the level of *SHYG* expression, providing further support for the idea that *SHYG* is an upstream regulator of the process.

One of the early effects of flooding is the accumulation of ethylene in the plant. Treatment of plants with the ethylene precursor 1-aminocyclopropane-1-carboxylic acid (ACC) led to increased induction of *SHYG* expression as well as increased hyponastic petiole growth in response to waterlogging. Interestingly, Rauf et al. identified the ethylene biosynthesis gene *ACC OXIDASE5* (*ACO5*) as a downstream target activated by SHYG and demonstrated that *ACO5* is necessary for SHYG's induction of hyponastic growth upon flooding. This suggests that a positive feedback loop involving ethylene functions in the flooding response.



Hyponastic leaf movement induced by waterlogging (WL) is mediated by *SHYG*. Leaves from plants overexpressing *SHYG* (*35S:SHYG*) show more upward movement than do those from wild-type (WT) plants, whereas *shyg* mutant leaves move less. (*Reprinted from Rauf et al. [2013], Figure 2.*)

The authors went on to examine natural variation of the SHYG-*ACO5* regulatory module, finding little induction of *SHYG* and *ACO5* in an *Arabidopsis* accession that is less responsive to waterlogging. Together, this work represents a solid advance in our understanding of flooding biology, placing ethylene and SHYG in a regulatory cascade leading to localized cell expansion in the petiole. It also emphasizes that plants use NAC transcription factors to respond to a host of biotic and abiotic stresses (reviewed in Nuruzzaman et al., 2013), in this case to save themselves from drowning.

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REFERENCES

Nuruzzaman, M., Sharoni, A.M., and Kikuchi, S. (2013). Roles of NAC transcription factors in the regulation of biotic and abiotic stress responses in plants. Front. Microbiol. **4:** 248.

Polko, J.K., Voesenek, L.A.C.J., Peeters, A.J.M., and Pierik, R. (2011). Petiole hyponasty: An ethylene-driven, adaptive response to changes in the environment. AoB Plants **2011:** plr031.

Rauf, M., Arif, M., Fisahn, J., Xue, G.-P., Balazadeh, S., and Mueller-Roeber, B. (2013). NAC transcription factor SPEEDY HYPONASTIC GROWTH regulates flooding-induced leaf movement in *Arabidopsis*. Plant Cell **25:** 4941–4955.

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