NAIST® Research Highlights

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Plant biology

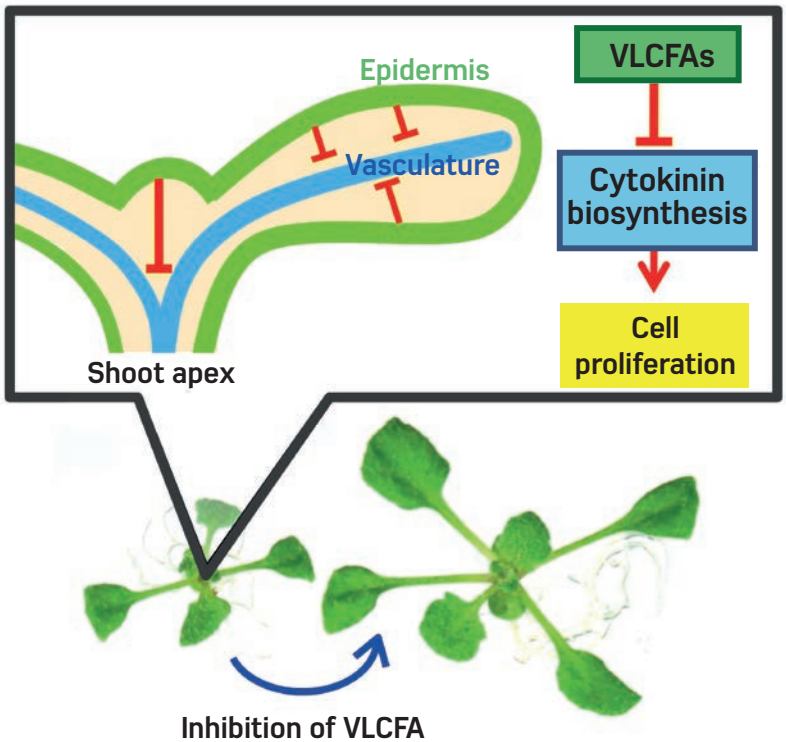
Surface signals control growth

The signalling processes governing plant organ growth have been found to originate within the surface layers of the plant

The outermost cell layer in plants, known as the epidermis, plays an important role in interactions between the plant and the environment. The epidermis also communicates with cells in inner layers to maintain optimal organ size by accelerating or restricting cell proliferation. Recent investigations by researchers at NAIST indicate that the epidermis is capable of sending signals to deeper plant tissues in order to control cell proliferation and shoot organ growth.

The epidermis is covered by a hydrophobic barrier called the cuticle, which protects plants from environmental hazards such as drought, and also helps guard against pathogen attacks. The cuticle is made of the polymer 'cutin', and a substance called 'cuticular wax', which is made up of very-long-chain fatty acids (VLCFAs).

Masaaki Umeda and co-workers at the NAIST Graduate School of Biological Sciences, together with scientists across Japan, have shown that VLCFA synthesis in the epidermis, and subsequent VLCFA-derived signalling to inner cell layers, is important for shoot organ growth regulation in the small flowering plant known as thale cress (*Arabidopsis thaliana*)[1].



Signals derived from very-long-chain fatty acids (VLCFAs) play an important role in maintaining organ size during continuous plant development. VLCFAs synthesized in the epidermis of the *Aribidopsis thaliana* plant can suppress the cytokinin accumulation around the vasculature and proliferation of cells in internal plant tissues.

"Knocking out the genes that are required for VLCFA synthesis in the plants resulted in severely impaired cuticular wax layer formation," explains Yoko Okushima, a member of Umeda's team. "This had such an impact on plant development that it was difficult to ascertain the exact outcomes related to low VLCFA content."

To examine the effect of disrupting VLCFA synthesis in more detail, Umeda's team gradually reduced the levels of VLCFA in *Arabidopsis* plants using different doses of a synthetic VLCFA inhibitor called cafenstrole, an active ingredient in commercial herbicides. The results showed that reducing VLCFA content increased the expression of a protein called IPT3, which promoted biosynthesis of a growth hormone called cytokinin in the inner plant layers. This led to excess cell proliferation.

"VLCFA synthesis in the epidermis suppresses this excess cell proliferation in internal tissues," explains Okushima. "Signals derived from VLCFAs regulate cytokinin biosynthesis inside the plant and determine shoot organ growth. Interestingly, the mild inhibition of VLCFA synthesis using a low concentration of cafenstrole actually produced larger aerial organs without inhibiting cuticular wax layer formation. VLCFA synthesis may therefore be a possible target for technologies aimed at increasing plant biomass."

Umeda and his team are continuing their investigations into this interesting regulatory signalling pathway. Their current studies aim to uncover how VLCFAs regulate cytokinin biosynthesis and cell proliferation via intercellular signalling.

Reference

1. Nobusawa, T., Okushima, Y., Nagata, N., Kojima, M., Sakakibara, H. & Umeda, M. Synthesis of very-long-chain fatty acids in the epidermis controls plant organ growth by restricting cell proliferation. *PLOS Biology* **11,** e1001531 (2013).

More information about the group's research can be found at the Plant Growth Regulation webpage:
http://bsw3.naist.jp/eng/courses/courses105.html