Antagonistic genes control rice growth

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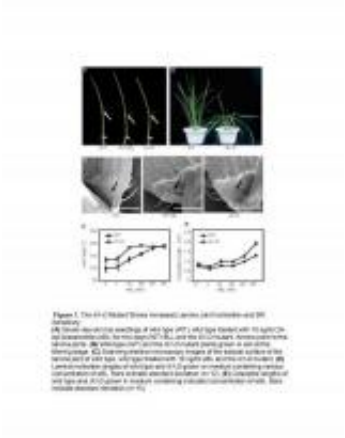

Wild rice and rice treated with steroids are shown in these images. Credit: The Plant Cell

Scientists at the Carnegie Institution, with colleagues, have found that a plant steroid prompts two genes to battle each other—one suppresses the other to ensure that leaves grow normally in rice and the experimental plant *Arabidopsis thaliana*, a relative of mustard. The results, published in the December 15, 2009, issue of *The Plant Cell,* have important implications for understanding how to manipulate crop growth and yield.

In plants, steroid levels reflect environmental and internal signals and control many processes. Steroid hormones called brassinosteroids (BRs) start their action on the surface of the cell and, through a molecular relay, send signals into the cell's nucleus to turn on or off specific genes, particularly those that are critical to regulating plant growth and

development. Although a lot has been discovered about how the steroid affects genes in Arabidopsis, much less was known in crop plants such as rice.

Co-author Zhi-Yong Wang at Carnegie's Department of Plant Biology explained the work: "We knew that the steroid is very important for activating genes that control cell growth in Arabidopsis as well as in rice. One of the most sensitive responses to the steroid is leaf bending in rice, caused by expansion of the upper cells at the joint between leaf blade and leaf sheath. We wanted to determine how the steroid functioned in rice. We found that the steroid affects two genes encoding (or producing) proteins that turn other genes on or off; they are called transcription factors. In rice, when a gene called Increased Leaf Inclination1 (ILI1) is turned on, it causes leaf bending. Interestingly, we found that the ILI1 protein also binds to another transcription factor, called IBH1, and inhibits its function. When there is too much ILI1 protein, the leaves bend excessively making the plant shaggy. When IBH1 level is high, cell growth is stopped at the joint and the rice is very erect, taking up less space. In normal rice plants the balance between ILI1 and IBH1 keeps growth in check."

This pair of genes provides a unique tool to control the leaf angle, which is important for crop yield because erect leaves improve light capture and allows rice plants to be planted at higher density for a higher yield per hectare.

Through a series of experiments, the researchers determined how the steroid and genes interact. They found that brassinosteroid oppositely regulate these genes—ILI1 was activated and IBH1 was repressed. As such, the steroid tips the balance between their protein products, ILI1 and IBH1, to initiate cell growth.

"It appears that the steroid causes the IBH1 genes to stop the production

of IBH1 protein, and in the meantime increases the production of the ILI1 protein, which turns off IBH1's inhibition of cell growth. This ensures that the cell grows to just the right length according to the level of steroid," commented Wang.

The researchers performed similar experiments on the mustard, which showed that steroid interacted with the mustard genes the same way. "Since similar genes are doing the same thing in these different plants, this process is likely to be very old and found in many different higher plants. The more we learn about such mechanisms, the closer we will come to better engineering crops to feed a growing population," concluded Wang.

Provided by Carnegie Institution