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Why a mutant rice called Big Grain1 yields such big grains

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Credit: Earth100/Wikipeidia

(Phys.org)—Rice is one of the most important staple crops grown by humans—very possibly the most important in history. With 4.3 billion inhabitants, Asia is home to 60 percent of the world's population, so it's unsurprising that around 90 percent of the world's rice crops are grown on the Earth's largest and most populous continent.

With the expected gains in human populations in the coming decades, plant research is yielding bigger crops and more food (and even some controversy). But it seems likely that the stigma attached to modified crops will diminish as the need to feed increasing numbers of people becomes more urgent.

One of the criteria by which rice yields are measured is grain size. Though this comprises an important metric, and increasing grain size is a key agricultural goal, researchers still don't know how developmental signals in rice regulate grain size. Recently, a group of researchers in Beijing, China reported the identification of a dominant mutant rice called Big Grain1 that shows an extra-large grain phenotype. They've published their findings in the *Proceedings of the National Academy of Sciences*.

Seed size, among other traits, is controlled by various hormones, including auxin, which exists predominantly in the form of indole-3-acetic acid in plants. It's a regulator of plant growth and development, stem elongation and vascular development, and the primary auxin signaling pathway is largely understood. However, due to the complexity of hormone transport in auxin responses, it has not yet been determined how auxin regulates grain size.

The rice mutant Big Grain1 is a dominant mutant with extra-large grain size. The researchers demonstrated that Big Grain1 encodes a novel plasma membrane-associated protein that is highly sensitive to auxin. The researchers also report that manipulation of the expression of auxin transport gene BG1 greatly increases grain size and the overall productivity of the plant.

They note that BG1 is localized to plasma membrane, is expressed in the vascular tissues of the plant, and is induced by auxin treatment. Further, the mutant rice plant has increased sensitivity to auxin, whereas a knockout variant bred for nonexpression of BG1 had reduced sensitivity to the hormone. And the Big Grain1 plant expressed enhanced basipetal auxin transport, while the BG1 knockout variant had reduced transport. "Therefore," the authors write, "it is very likely that BG1 plays an important role in controlling plant growth and development through regulating auxin transport."

The researchers succeeded in establishing a connection between auxin transport and grain size. This discovery resulted in practical application, as they also demonstrated that modulating auxin transport can increase grain size, presenting a promising strategy for increasing yields to feed growing populations around the world. Still, both auxin signaling and auxin transport are poorly understood, even though the hormone has been studied for more than 80 years. "Because grain weight depends to a large extent on the hull development and endosperm maturation, the role of auxin transport in coordination of this process needs to be further developed," the authors write.

More information: "Activation of Big Grain1 significantly improves grain size by regulating auxin transport in rice." *PNAS* 2015 ; published ahead of print August 17, 2015, DOI: 10.1073/pnas.1512748112

Abstract

Grain size is one of the key factors determining grain yield. However, it remains largely unknown how grain size is regulated by developmental signals. Here, we report the identification and characterization of a dominant mutant big grain1 (Bg1-D) that shows an extra-large grain phenotype from our rice T-DNA insertion population. Overexpression of BG1 leads to significantly increased grain size, and the severe lines exhibit obviously perturbed gravitropism. In addition, the mutant has increased sensitivities to both auxin and N-1-naphthylphthalamic acid, an auxin transport inhibitor, whereas knockdown of BG1 results in decreased sensitivities and smaller grains. Moreover, BG1 is specifically

induced by auxin treatment, preferentially expresses in the vascular tissue of culms and young panicles, and encodes a novel membrane-localized protein, strongly suggesting its role in regulating auxin transport. Consistent with this finding, the mutant has increased auxin basipetal transport and altered auxin distribution, whereas the knockdown plants have decreased auxin transport. Manipulation of BG1 in both rice and Arabidopsis can enhance plant biomass, seed weight, and yield. Taking these data together, we identify a novel positive regulator of auxin response and transport in a crop plant and demonstrate its role in regulating grain size, thus illuminating a new strategy to improve plant productivity.

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