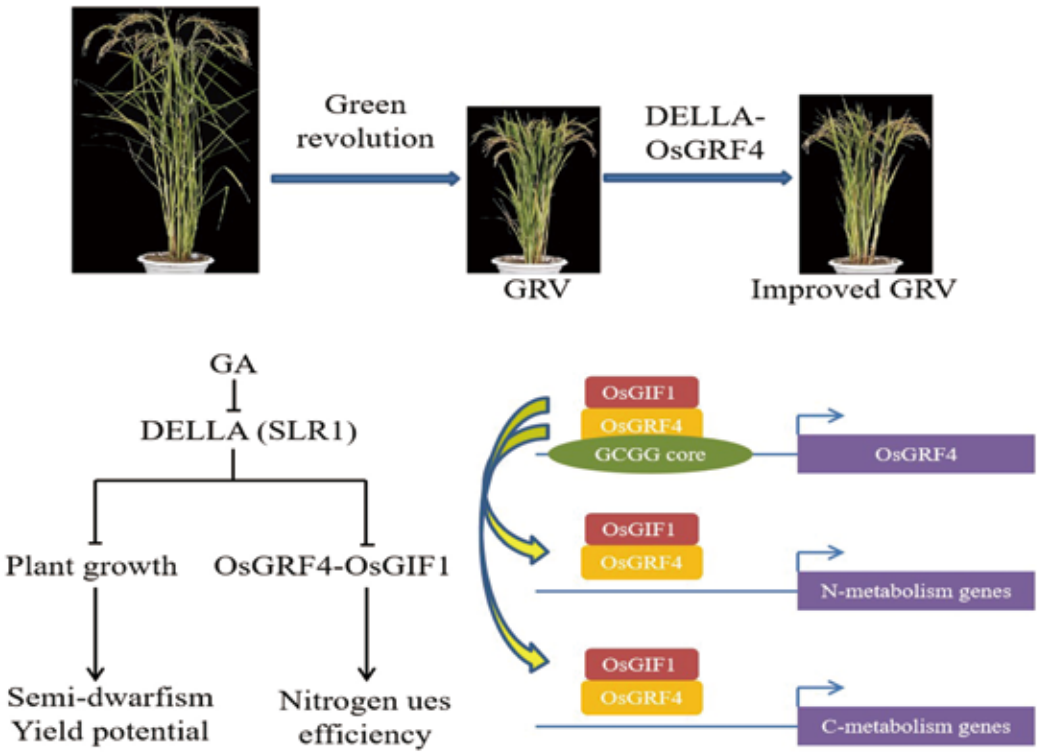
Have It Both: Enhancing Nitrogen Response in Rice While Inhibiting Its Height

Reported by SONG Jianlan

Application of inorganic nitrogen fertilizers in agricultural production has greatly increased the yields and hence helped enhanced global food security. However, increased application of such fertilizers does not necessarily increase productivity; in fact, the marginal effect produced by such fertilizers decreases with the amount of use once it reaches a threshold. Moreover, excessive use of chemical fertilizers has brought about environmental problems such as soil acidification, water eutrophication and extra emissions of greenhouse gases.

The solution to the problem lies in improving the efficiency of nitrogen fertilizers. A strategy is to breed



CAS scientists unravels the mystery of how the metabolism promoter GRF4 and the growth inhibitor DELLA, two competing sides, interact with each other, and thereof provides a solution to push the balance in the direction of promoting nitrogen assimilation while maintaining the benefits of dwarfism. (Credit: IGDB)

new crop varieties that are more responsive to nitrogen intake, thereby increasing their production at a smaller cost of fertilizers. This, however, demands an in-depth understanding of the inherent mechanisms in the organism that regulate growth, nitrogen assimilation and carbon fixation, and also how they interact with each other to maintain a balance.

The first round of the "green revolution" featured the breeding of yield-enhancing semi-dwarf varieties of crops. By introducing a growth inhibitor named DELLA, scientists bred crop varieties that are resistant to lodging, even in the case of intensive nitrogen intake. Every coin has two sides, however, and in this case unwanted results appeared. The benefit given by DELLA came with the cost of decreased responsiveness to nitrogen intake. How to break this link has been a headache for biologists.

A team at the **CAS Institute of Genetics and Developmental Biology (IGDB)** led by Prof. FU Xiangdong successfully broke through and offered a solution. After working on it for seven years, they successfully identified and extracted from a yield-enhancing rice variety a GROWTH-REGULATING FACTOR 4 (GRF4) transcription factor. Also, they demonstrated that it promotes and integrates nitrogen assimilation, carbon fixation and growth, whereas DELLA inhibits these processes and reduces the efficiency of nitrogen use. They further unraveled the mystery of how these competing mechanisms interact with each other and maintain a balance, and provided a pathway for increasing the efficiency of nitrogen use without sacrificing the benefits of dwarfism.

Their research has thus offered a solution for modulating the plant growth and metabolic co-regulation, and has hence enabled novel strategies for future sustainable food security. A commentary in *Nature* remarked that this has blown the horn for a new round of green revolution.

Reference

Shan Li, Yonghang Tian, Kun Wu, Yafeng Ye, Jianping Yu, Jianqing Zhang, Qian Liu, Mengyun Hu, Hui Li, Yiping Tong, Nicholas P. Harberd, **Xiangdong Fu***, Modulating Plant Growth–Metabolism Coordination for Sustainable Agriculture. *Nature* 560, 595-600 (Published: 2018/08/01, 2018). doi: 10.1038/s41586-018-0415-5