Beyond the Green Revolution: new approaches for improving nitrogen use efficiency and grain yield in rice

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Nitrogen fertilization is essential to increase grain yield, whereas it also promotes stem and leaf elongation and makes crop plants more susceptible to lodging, resulting in yield lose. The Green Revolution of the second half of the 20th century, which was based on the adoption of semi-dwarf cereals which had an increased harvest index, was responsible for worldwide crop yield increases and enhanced global food security. However, introduction of semidwarf genes *sd1* and *Rht* into rice and wheat caused the reduction of panicle (or ear) branching and nitrogen uptake capacity, and increase in grain yields required significant increases in nitrogen fertilization levels, which in turn resulted in what are now well documented deleterious impacts on the environment. To uncover the role of the DELLA protein in control of nitrogen uptake and assimilation, we performed a yeast two-hybrid screening to identify DELLA-interacting proteins. In the further experiments we showed an interactive network for gibberellin control of nitrogen acquisition and nitrogen-mediated growth responses. In addition, we also show that a rice major QTL, which act through the determination of both panicle architecture and nitrogen growth responses. The different *DEP1* alleles confer different nitrogen- mediated growth responses. Importantly, *dep1* plants are not only semidwarf but also had increased nitrogen-use efficiency. The DEP1 protein physically interacts with Gα (RGA1), and Gβ (RGB1) and reduced RGA1 or enhanced RGB1 activity represses nitrogen-mediated growth. Thus, the modulation of both GA and G-protein signalling represents a strategy to simultaneously improve nitrogen use efficiency and grain yield.