【Grant-in-Aid for Scientific Research (S)】

Biological Sciences (Agricultural Sciences)

Title of Project : Production of Super High-yielding Rice Plants for Environmental Conservation as the Green Evolution II

Amane Makino
(Tohoku University, Graduate School of Agricultural Sciences, Professor)

Research Project Number : 16H06379 Researcher Number : 70181617
Research Area : Plant Nutrition
Keyword : Rice, Photosynthesis, High yields, Biomass, Nitrogen

【Purpose and Background of the Research】

Rice is the most important food crop in the world, accounting for more than 20% of global food production. Breeding of semi-dwarf rice varieties in the 1960s made a great contribution to increasing yield potential, which is called as the Green Revolution. The success in semi-dwarf breeding was caused by photosynthetic enhancement and enlargement of sink capacity depending on large input of N fertilizer. On the other hand, large inputs of N fertilizer in turn have drawn much attention to the environmental impact of N application practices. Therefore, it is important how the yield potential should be increased while limiting the environmental impact of N management practices.

After the success in semi-dwarf breeding, the main targets of rice improvement have moved to the introduction of disease and insect resistance, grain-quality improvements and shortened growth duration. Concerning yield potential, developing hybrid rice and new-plant-type rice with large panicle has been focused. However, there has been no actual increase in the yield potential since the release of the first semi-dwarf cultivars.

The purpose of this study is to construct super high-yielding rice plants with both improvements in source and sink capacities (Figure). To enhance photosynthesis, Rubisco efficiency should be optimized and enhanced. To enlarge sink capacity, the large-grain alleles will be introduced.

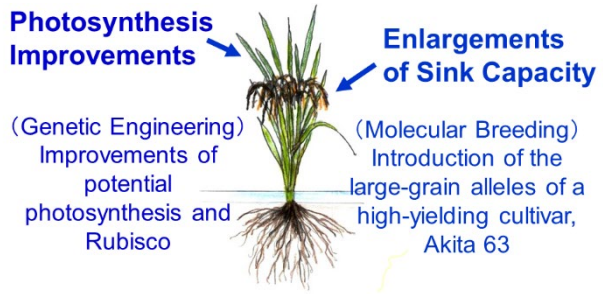

Figure: A super high-yielding rice has higher photosynthetic capacity as well as large sink capacity.

【Research Methods】

We will first produce transgenic rice plants with overproduced key components of electron transport system and Calvin-Benson cycle and Rubisco activase, and then their traits will be introduced into the Rubisco-overproduced rice plants. At the same time, we will also construct near-isogenic lines with the large-grain alleles of a high-yielding cultivar, Akita 63 and crossbreed them with the rice plants with enhanced photosynthetic capacities. Lastly, we will evaluate biomass production and yield of the final rice lines using the isolated fields at the P1P level.

【Expected Research Achievements and Scientific Significance】

The demand for rice food is projected to increase by more than 30% by 2025 because of an exponential increase in the population of Asian and Africa. Therefore, we must construct super high-yielding rice plants as the Green Evolution II while limiting the environmental impact of N management practices.

【Publications Relevant to the Project】

- Sudo E, Suzuki Y and Makino A (2014) Whole-plant growth and N utilization in transgenic rice plants with increased or decreased Rubisco content under different CO_2 partial pressures. *Plant Cell Physiol.* 55: 1905-1911.
- Makino A (2011) Photosynthesis, grain yield and N utilization in rice and wheat. *Plant Physiol.* 155: 125-129.

【Term of Project】 FY2016-2020

【Budget Allocation】 108,300 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.agri.tohoku.ac.jp/syokuei/index-j.html
amanemakino@m.tohoku.ac.jp