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Editorial

# Different Grain-filling Properties of High-yielding Rice

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## EDITORIAL

Recently developed high-yielding rice varieties with extra-large sink capacity often have unstable grain filling. Therefore, understanding the factors that limit grain filling is important for further improvement of rice grain yield. Because grain-filling is decided by the complex sink–source balance, grain-filling ability is extremely difficult to gauge. In this study, we compared grain-filling-related traits of three high-yielding cultivars with high sink capacity. We found that the translocation of non-structural carbohydrates (NSC) from stem to panicle during early ripening and grain filling was significantly lower in Momiroman than in Hokuriku 193 and Teqing, whereas dry matter accumulation of the whole plant did not differ among the cultivars throughout ripening. The NSC-components, sucrose and starch were both remained higher in stems of Momiroman than other cultivars. ADP-glucose pyrophosphorylase (AGPase; EC 2.7.7.27) activity was not enhanced and α-Amylase (EC 3.2.1.1) and β-Amylase (EC 3.2.1.2) activities weren't impeded within the stems.

Rice is one of the world's most important crops; and its yield must be improved to feed the increasing global population. In Japan, the demand for high-yielding rice for animal feed has increased; to match it, many high-yielding cultivars are developed. Although they commonly have extra-large sink capacity (total number of spikelets per unit area ×filled grain weight), the grain-filling ability of different cultivars varies considerably. Chinese high-yielding cultivars, called 'super rice', also have unstable grain filling

Momiroman is a Japanese high-yielding cultivar that showed one of the highest sink capacities but low grain-filling ratio in Tsukubamirai, Ibaraki, in the Kanto region of Japan. Another Japanese high-yielding cultivar Ho-kuriku 193 (H193) showed the highest yield with a relatively high grain-filling ratio at the same location. We compared the grain-filling properties and stem-carbon metabolism of Momiroman and H193 in terms of the sink–source balance. We also tested a Chinese high-yielding indicacultivar, Teqing. Based on these analyses; we deduced the possible factors limiting grain filling of high-yielding cultivars, which could be a target trait for achieving high yield potential.

At full heading, at about 20 days after heading (DAH) and at maturity, 10 plants per plot were harvested. The heading date and full-heading date were defined as the dates when about 50% and 80%, respectively, of panicles had emerged. The total shoot weight per m2of the 10 plants was calculated. The weight of every part was calculated from that of the whole shoot multiplied by the ratio of the part within the 2 representative plants.

At maturity, two panicles from three plots (total six panicles) with marked upper a spikelets were harvested from each cultivar. Panicles were freeze-dried in vacuum; marked spikelets were kept for the analysis of grain growth rate and the other spikelets were divided into six groups: upper A–C and lower A–C. Grains with hull of each group were weighed individually using an automatic counting and weighing system (QWCALC, NK-Systems, and Aichi, Japan).

We compared the grain-filling-related traits of Momiroman, which has high sink capacity but low grain-filling ratio, with those of H193 and Teqing. Examination of the sink–source balance revealed essential differences in grain-filling properties and led to the conclusion that low sink strength is likely the major cause of low grain filling in Momiroman. Although further studies to investigate the rate-limiting steps in sucrose breakdown and starch synthesis in the endosperm of Momiroman are needed to prove this hypothesis, this study provides basic knowledge for improving the grain filling of high-yielding rice cultivars.

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