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**Novel quantitative trait loci for the strong-culm and high-yield related traits in rice detected from the F<sub>2</sub> population between the super thick-culm and super grain-bearing line ‘LTAT-29’ and the high-yielding variety ‘Takanari’**

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**Abstract**

Lodging is a serious issue in rice production, because it drastically decreases the biomass production and grain yield. Since the Green Revolution, the lodging resistance has been increased by lowering the moment of above-ground parts due to the short culm by the semi-dwarf gene *sd1*. However, it has been pointed out that *sd1* alone has suppressive effects for biomass production and yield. To increase rice yield, the long-culm and large panicle type varieties with a superior lodging resistance need to be developed. To improve the lodging resistance and yield of these type varieties, it would be effective to identify novel alleles for these traits underlying natural variations in rice and to pyramid these alleles to a single rice variety. In order to perform this strategy, we have developed new rice lines derived from crosses among varieties with superior alleles. At first, TULT-gh-5-5 was selected from a cross between strong culm and high biomass variety Leaf Star and high-yielding variety Takanari, and TUAT-32HB was selected from a cross between high-yielding variety Akenohoshi and Takanari. Then, we developed the super thick-culm and super grain-bearing line, LTAT-29 derived from a cross between TULT-gh-5-5 and TUAT-32HB. In the current study, to identify the QTLs and genes relating to the strong culm and the high yield of LTAT-29, we performed QTL analysis using SNPs markers with F<sub>2</sub> population derived from a cross between LTAT-29 and Takanari. LTAT-29 has never lodged throughout the growth period despite it had long culms and heavy panicles. LTAT-29 had a larger outer diameter of the culm and twice the size of the section modulus than Takanari. As a result, the bending moment at breaking of LTAT-29 was significantly larger than that of Takanari. Brown rice yield of LTAT-29 was 9.2 t ha<sup>-1</sup> about 10% higher than that of Takanari due to the larger number of spikelets per panicle. LTAT-29 had a greater number of secondary branches per panicle. In the F<sub>2</sub> population between LTAT-29 and Takanari, we found continuous frequency distributions in the section modulus and the spikelet number per panicle. Two QTLs increased the section modulus by the alleles of LTAT-29 were detected on Chr.1L and Chr.2L. One QTL increased the spikelet number per panicle of Takanari by the allele of LTAT-29 was detected on Chr.1L, and two QTLs increased the number of secondary branches per panicle by the alleles of LTAT-29 were detected on Chr.1L and Chr.4L. It was found that the alleles of these QTLs were the *japonica* type originated from Leaf Star or Akenohoshi. The novel QTLs for the traits related to super thick-culm and super grain-bearing and their combinations could be utilized for improving the lodging resistance and yield in rice varieties.

Keywords: high-yielding variety, lodging resistance, QTL, rice, strong culm

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