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Development of Rainfed-adapted, Fertilizer-efficient Temperate Rice Varieties by *Pup1* Introgression

Ian Paul Navea[1], Jae-Hyuk Han[1], Na-Hyun Shin[1], Yeong-Ju Lee[1], Joong Hyoun Chin[1]*

[1]Department of Integrative Biological Sciences and Industry, Sejong University, 209, Neungdong-ro, Gwangjin-gu, Seoul 05006, Korea

[Abstract]
Water and phosphorus (P) fertilizer are two of the most critical inputs in rice cultivation. Under climate change scenarios and urbanization, irrigation and fertilizer are becoming limiting factors often leading to significant decrease in yield whenever supplied scarcely. It has been shown that the *Pup1* QTL confers tolerance to P starvation and improved early-stage root vigor in *indica* rice grown in the tropics. However, whether the QTL works in *japonica* rice genetic background grown in temperate regions remains to be elucidated. Here, we have introgressed the *Pup1* QTL into three temperate rice varieties MS11, TR22183, and Dasan using marker-assisted backcrossing and next generation sequencing. The selected lines all harbored the full *Pup1* QTL with recurrent parent genome recovery rates ranging from 66.5% to 99.8%. Evaluation of the introgression rice lines grown in South Korea under low inputs of P and water revealed early vegetative growth advantage relative to that of the recurrent parents. Under rainfed condition, *Pup1* introgression lines had yield advantage ranging from 7.2 to 19.9% and 24 to 26% in P non-supplied soil and P-supplied soil, respectively compared to that of the recurrent parents suggesting that *Pup1* confers enhanced yield under low P and water inputs in temperate rice genetic background grown in temperate climate. In terms of early vegetative growth, temperate *Pup1* introgression lines showed a similar trend on the extent to which *Pup1* promotes yield advantage in temperate rice in comparison with *indica* control *Pup1* introgression line IR64-Pup1.

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*Corresponding author: Email. jhchin@sejong.ac.kr Tel· +82-2-3408-3897