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## Characterizing Effects and Potential Mechanisms of the Major QTL “Pup1” in Rice (*Oryza sativa* L.)

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### Abstract

Phosphorus deficiency is an important factor limiting rice (*O. sativa*, L.) yields under upland or rainfed lowland conditions. But especially in developing countries farmers are facing financial difficulties with increasing costs of fertilizers.

A major QTL improving P uptake rates on P20deficient soils was identified in backcross populations between the indica/aus landrace Kasalath (high P uptake), and the japonica cultivar Nipponbare (low P uptake). Nipponbare near isogenic lines (NILs), carrying the Pup1 (P uptake 1) donor allele from Kasalath, were shown to have higher tolerance of phosphorus deficiency.

Consequently, the objectives of this study were to 1) characterize the effects of the major QTL Pup1 in Pup120NILs under a range of P and water supplies, and 2) to identify possible mechanisms.

A greenhouse experiment with 3 replications was conducted at the International Rice Research Institute (IRRI) in the Philippines. The NILs [14-4 (+Pup1) and 14-6 (-Pup1)] were grown on two different soils (Siniloan and Pangil) with two water treatments (fully irrigated and drought stressed), and 2 nutrient treatments (+P and -P). The observations showed that +Pup1 NILs showed higher tiller number and plant height under P deficient conditions. At the end of the experiment a higher leaf area index was found for the +Pup1 NILs. Both NILs in Pangil soils under -P conditions showed a higher plant height in the drought treatment than under fully irrigated conditions. Furthermore, NILs containing the +Pup1 QTL showed less leaf symptoms of Fe-toxicity which occurred after some time in the fully irrigated -P treatment in the Siniloan soils.

To additionally characterize Pup1 we conducted a second pot experiment with Pup1 NILs and the varieties IR64 and Vandana with the objective to determine the ability of the roots to penetrate hardpans (wax layers) and deeper rooting. NILs containing the +Pup1 QTL had more roots penetrating the wax layer than -Pup1 NILs, but IR64 and Vandana performed better than both NILs.

It can be summarized that the Pup1 QTL did in most cases improve plant performance. However, the selected water, fertilizer, and soil treatments caused some unexpected interaction effects modifying the plant response and the effect of the Pup1 QTL.

**Keywords:** Drought, phosphorus deficiency, QTL, rice