Vacuolar phosphate efflux transporters in land plants

With the support by the National Natural Science Foundation of China, the research team led by Prof. Yi KeKe (易可可) at the Key Laboratory of Plant Nutrition and Fertilizer, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, identified the vacuolar phosphate efflux transporters in land plants, which was published in *Nature Plants* (2019, 5: 84—94).

Phosphorus is an essential macronutrient for plant growth and development. Phosphate (Pi) is the major form of phosphorus that can be easily used by plants. However, the amount of Pi in the soil that is available to the plant is often limiting for growth. Plants have evolved different strategies to adapt to changes in Pi availability, including efficient Pi storage/remobilization machineries. After being absorbed by plant roots, most of the Pi is stored in vacuole. This vacuolar reservoir is used to buffer Pi changes in the cytoplasm in response to changes in metabolic demand and Pi availability in soil. However, the mechanism of release of vacuolar Pi store to cytoplasm in plants is still unknown. In the issue of *Nature Plants*, Yi's group reported the identification of vacuolar Pi efflux transporters (OsVPE) in land plants.

They identified two proteins involved in vacuolar Pi efflux (OsVPE1 and OsVPE2) in rice, which are homologues of glycerol 3-phosphate transporter (GlpT) in *Escherichia coli*. They demonstrated that these two proteins are localized to the tonoplast and the expression levels are upregulated by Pi starvation. Different from GlpT in *Escherichia coli*., which is a Glycerol 3-phosphate/Pi antiporter, the OsVPEs can directly catalyze Pi transport across membranes in yeast and oocyte cells. Nuclear magnetic resonance analysis showed that overexpression of *OsVPE1* or *OsVPE2* significantly reduced the vacuolar Pi level in rice. On the other hand, vacuolar Pi levels in the *Osvpe1 Osvpe2* double mutants are significantly higher than that of WT plants. Furthermore, the release of stored Pi from vacuoles is slower in the *Osvpe1 Osvpe2* double mutant than in wild type under Pi-deficient conditions. These results suggest that OsVPE1 and OsVPE2 contribute to vacuolar Pi export. Furthermore, they demonstrated that the VPEs are conserved in land plants. They propose that vacuolar membrane localization of VPEs is ancient in land plant GlpT proteins, which probably evolved from endoplasmic reticulum- or plasma membrane-localized GlpT proteins among ancestors of land plants. Therefore, it suggests that an ancient GlpT has been recruited and neofunctionalized for vacuolar Pi efflux during land plant evolution. These findings should accelerate research to address how plants coordinate the vacuolar Pi transport activity with the cellular metabolism and environmental fluctuations to ultimately improve crop production under changing Pi conditions.

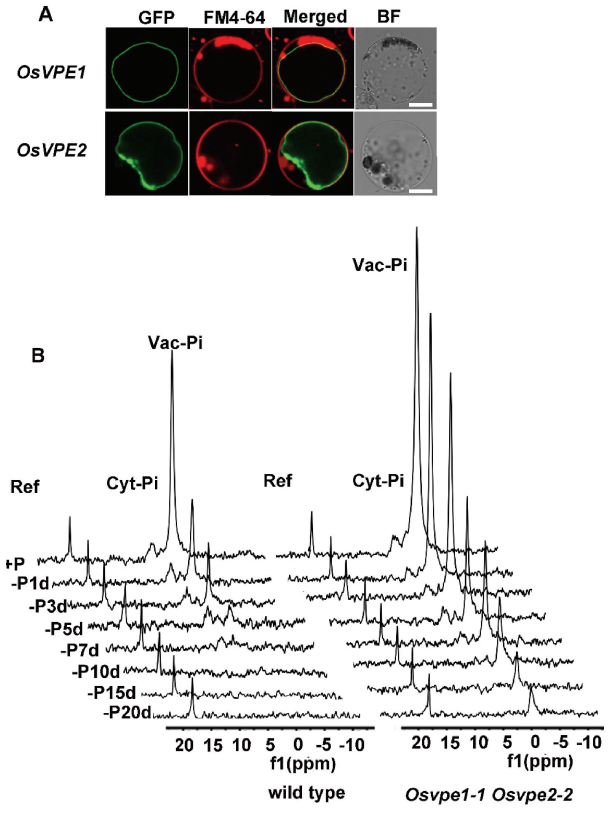

Figure OsVPE1 and OsVPE2 are vacuolar Pi efflux transporters.