No. 1022

Molecular Physiology of the Novel Cation-Binding Protein and Vacuolar Function, which are Related to Salt Tolerance of Plant

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Summary

In salinity soils, plant growth is severely suppressed due to water potential reduction, cellular dehydration, and ion toxicity. However, many plants survive or even thrive at high salt levels. Salt tolerant plants can synthesize compatible solute, exclude salt, compartmentation of excess ions in the cytoplasm into vacuoles, and suppress influx of salt ions. In addition to these biochemical mechanisms, we found that a novel signal transducing protein, PCaP2, is involved in response to salt stress. We revealed the following points.

(1) PCaP2 has an ability to bind phosphatidylinositol phosphates (PtdInsPs) and Ca^{2+}/calmodulin (Ca^{2+}/CaM) complex, which are involved in signal transduction. Under normal conditions, PCaP2 masks the physiological function of PtdInsPs. Under stress conditions, the free Ca^{2+} concentration in the cytoplasm increases and the formation of Ca^{2+}/CaM complex is stimulated. When the Ca^{2+}/CaM complex binds PCaP2, PCaP2 releases PtdInsPs. The released PtdInsPs and its hydrolysis products, PI_3 and diacylglycerol, might activate specific ion channels and protein kinase C. We revealed the first half reaction by the in vitro experiments using recombinant PCaP2 and its mutant forms.

(2) *Arabidopsis thaliana* lines over-expressing PCaP2 showed good germination rate more than 80% even in 80 mM NaCl, although the rate of wild type seeds was less than 50%. Probably PCaP2 works as a suppressor element under salt stress to maintain the integrity of plants. However, over-expression of PCaP2 causes unbalance of the PCaP2. Under the conditions, plants overexprssing PCaP2 might grow without a break.

(3) Vacuolar accumulation of Na^+ depends on the Na^+/H^+ exchanger and vacuolar proton pumps, H^+-pyrophosphatase (H^+-PPase) and H^+-ATPase. *A. thaliana* has three genes for H^+-PPase; one belongs to the type I and the others to the type II. We clarified that the type II H^+-PPases are localized in the Golgi membrane and their protein amount account for only less than 0.2% of that of the type I (vacuolar type enzyme). Thus, the contribution of type II enzyme is negligible for understanding salt tolerance in plants.