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Cesium is a specific inhibitor of the AKT1-KC1 complex-mediated potassium influx in *Arabidopsis*

Cesium (Cs^+) exists in nature at relatively low levels but occasionally accidental anthropogenic activities spread high levels of Cs^+ (most commonly radioactive) which contaminate the environment and enter the food chain. Cs^+ disrupts plant growth at high concentrations through pleiotropic effects and the part of the Cs^+ toxicity in plants is known to derive from competition and interference with potassium (K^+) due to the similarity in physicochemical properties between K^+ and Cs^+. K^+ is an essential nutrient, a lack of which causes serious growth retardation and physiological defects. In order to find the means to sustain plant growth in Cs^+-contaminated areas for phytoremediation purpose, the molecular mechanisms of how Cs^+ exerts its deleterious effects on K^+ accumulation in plants need to be elucidated. In *Arabidopsis thaliana*, K^+ uptake through the roots is considered to be mediated mainly by two players: *Arabidopsis* K^+ Transporter 1 (AKT1) and High Affinity K^+ Transporter 5 (HAK5). Expression of HAK5 is swiftly induced in response to K^+ deficiency while AKT1 is more responsible for low-affinity K^+ uptake. AKT1 forms a tetrameric complex with K^+ Rectifying Channel 1 (KC1) to exert proper function. Here, we show that mutation on a member of the major K^+ channel AKT1-KC1 complex renders *Arabidopsis thaliana* hypersensitive to Cs^+. Electrophysiological analysis demonstrated that Cs^+, but not sodium, rubidium or ammonium, specifically inhibited K^+ influx through the AKT1-KC1 complex. In addition, a lack of KC1 further led to an inability of *Arabidopsis* to accumulate K^+ in the plant body due to uncontrollable K^+ leakage through the homomeric AKT1 channel. These data indicate that Cs^+ is a specific inhibitor of the AKT1 complex-mediated K^+ influx and KC1 is essential to avoid K^+ leakage.

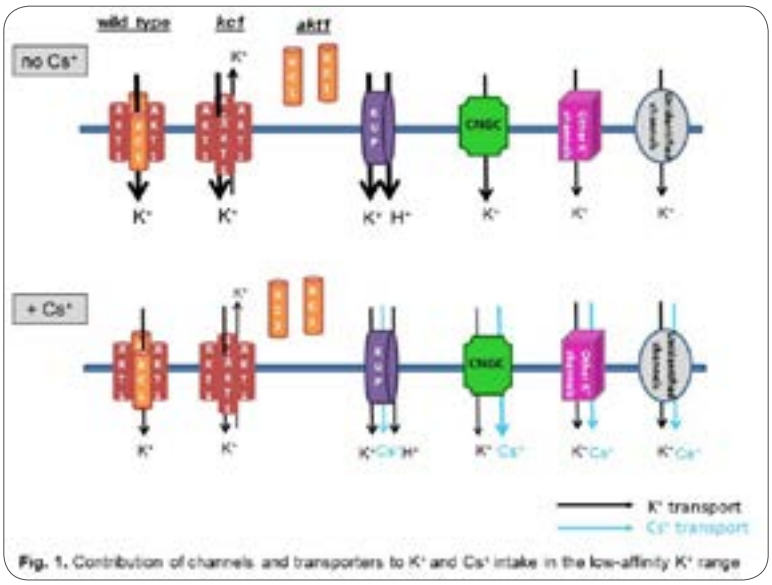

Fig. 1. Contribution of channels and transporters to K^+ and Cs^+ intake in the low-affinity K^+ range

Recent Publications

1. Takiguchi H, Hong J P, Nishiyama H, Hakata M, Nakamura H, Ichikawa H, Park C J and Shin R (2017) Discovery of E3 ubiquitin ligases that alter responses to nitrogen deficiency using rice full-length cDNA OvereXpressor (FOX)-hunting system. Plant Molecular Biology Reporter 35(3):343-354.
2. Adams E, Miyazaki T, Hayaishi-Satoh A, Han M, Kusano M, Khandelia H, Saito K and Shin R (2017) A novel role of methyl cysteinate and cysteine in cesium accumulation and response in *Arabidopsis thaliana*. Scientific Reports 7:43170.
3. Hong J P, Adams E, Yanagawa Y, Matsui M and Shin R (2017) AtSKIP18 and AtSKIP31, F-box subunits of the SCF E3 ubiquitin ligase complex, mediate the degradation of 14-3-3 proteins in *Arabidopsis*. Biochemical and Biophysical Research Communications 485(1):174-180.
4. Adams E, Chanban V, Khandelia H and Shin R (2015) Selective chemical binding enhances cesium tolerance in plants through inhibition of cesium uptake. Scientific Reports 5:8842.

Biography

Ryoung Shin, PhD is a Unit Leader and the Principal Investigator of Regulatory Network Research Unit, RIKEN Center for Sustainable Resource Science. She had worked on the molecular mechanisms of virus resistance in hot pepper and earned her PhD at Korea University in 2002. She moved to USA for her Postdoc Fellow and started to research on potassium sensing and signaling in plants at Donald Danforth Plant Science Center, St. Louis, USA. In 2008, she became the Unit Leader at RIKEN and continued to work on plant potassium deficiency signaling. Recently, her team expanded the research to radiocesium remediation after the accident at the Fukushima Nuclear Power Plant in Japan following the great earthquake in 2011 caused the spread of radiocesium over the surrounding areas.

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