

Abstract

Due to its essential role in plant metabolism and often low availability in the soil, sufficient potassium uptake and management are among the challenges plants face to survive in different environments. Since all potassium functions are related to the transport of the monovalent cation K^+ , research focuses on the transporters responsible for K^+ uptake and allocation.

In addition to playing an essential role in potassium nutrition, K^+ transporters also mediate the uptake of pollutants such as Cs. Radioisotopes ^{134}Cs and ^{137}Cs released from nuclear bomb tests and nuclear power plant accidents remain in the environment and their accumulation in plants is being studied to reveal the risks of crop production in contaminated soils as well as the possibility of remediating contaminated soil through plants. Ion transport also seems to be a major driver of plant adaptation to unfavourable environments. Several ion transporters appear to be involved in the adaptation of *Arabidopsis arenosa* populations to serpentine soils, including the potassium transporter AaKUP9.

This thesis summarises my effort to characterise two transporters from KT/HAK/KUP family, AtKUP7 and AtKUP9, in *Arabidopsis thaliana*, and related projects. For AtKUP9, I have significantly expanded the knowledge of its involvement in physiological processes. I studied the root growth phenotype of *atkup9* and showed that under K^+ deficient conditions, growth is unevenly distributed in favour of the primary root over the lateral roots and this phenotype cannot be reversed by auxin application. I detected *AtKUP9* expression throughout the plant body and showed that it is significantly increased and shifted under low-K conditions. I found an altered carbohydrate allocation in *atkup9* plants. *Atkup9* retained large amounts of soluble carbohydrates in shoot as well as it contained more starch in K^+ deficiency. All these results suggest the participation of AtKUP9 in various physiological processes that remain to be investigated in future. It is obvious that AtKUP9 affects pathways that control the growth of root system and its architecture.

I further summarised the relationship between K^+ availability and the growth and development of the root system in a review paper. I examined how and why root growth is reduced under K^+ deficiency in general, including the low root-to-shoot ratio and root system architecture changes. Emphasis was placed on the associated signalling and nutrient localisation. The effect of K^+ availability on stress tolerance and cell growth was also summarised.

Characterisation of AtKUP7 focused on its role in Cs translocation in the plant body and I showed that *atkup7* plants take up and allocate to the shoot less $^{134}Cs^+$ than wild type. Although this do not translate into increased Cs tolerance in *atkup7*, it suggests that AtKUP7 is a transporter that mediate Cs accumulation in plants and Cs translocation to shoot, which is of ecological importance.

Finally, within a project related to a role of AaKUP9 in serpentine adaptation, I took part in a characterisation of multiple colonisations of serpentine habitats by *Arabidopsis arenosa*. I analysed root system traits of three pairs *A. arenosa* populations *in vitro* on medium simulating low Ca/Mg ratio typical for serpentine soils. These results help to describe parallel adaptations as well as to discern interesting non-parallel adaptation among the populations, such as the relatively low Ca/Mg ratio in the tissue of one of the studied populations. It is clear that while two populations manage their uptake of Mg^{2+} and Ca^{2+} , third population is able to withstand unfavourable Ca/Mg ratio in its tissue.

Keywords: Potassium, membrane transporters, osmoregulation, root system, caesium