

5-11 Why Can Common Reed Grow in Salt Water?

— Visualization of Sodium Exclusion from the Root using a Positron-Emitting Tracer Imaging System —

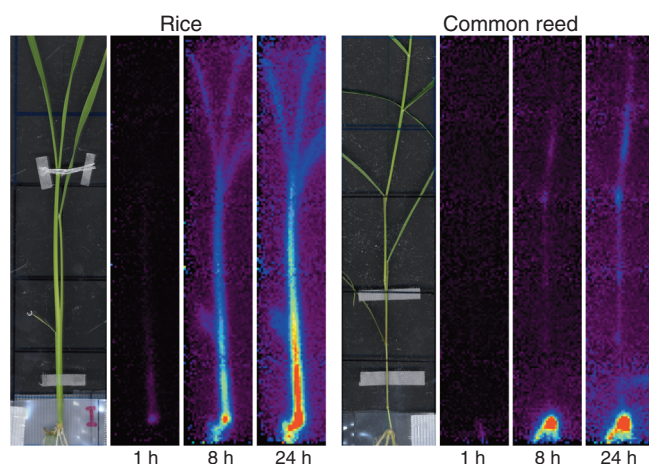


Fig.5-28 Sodium distribution after feeding ^{22}Na into the nutrient solution

^{22}Na moved to the upper shoot in a rice plant (left), whereas ^{22}Na was accumulated in the shoot base in a common reed (right). Red and blue colors indicate high and low ^{22}Na concentration, respectively.

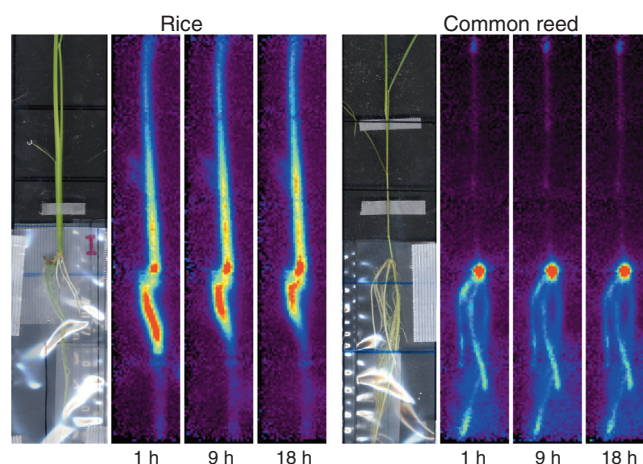


Fig.5-29 Sodium distribution after removing ^{22}Na from the nutrient solution

^{22}Na continuously moved upward in the root of the rice plant (left), whereas ^{22}Na was excluded downward in the root of the common reed (right).

Sodium is not an essential element for most plant species but is a toxic element. Therefore, the growth of rice is often inhibited in paddy fields that have suffered seawater by a tsunami or a typhoon. On the other hand, the common reed, which is classified to the same family as rice, has the ability to withstand a high sodium ion (Na^+) concentration (i.e., it has a high salt tolerance), and therefore, it can grow in the wetlands of brackish water near river mouths, where freshwater and seawater mix.

A previous study of the mechanism behind salt tolerance in common reeds reported that the Na^+ concentration in the fluid through the xylem is lower in the shoot than in the root. Since the xylem is the tissue that transports water and solutes including Na^+ from the root to the shoot, this result suggests that the common reed has the ability to retrieve Na^+ from the xylem in the region between the root and the shoot. However, there has been no direct evidence of this ability. Thus, in this study, we have tried to directly observe the Na^+ movement in an intact common reed using a positron-emitting tracer imaging system (PETIS) that can noninvasively visualize the movement of various radioactive tracers.

Common reeds and rice plants were cultivated in a nutrient solution containing Na^+ at a high concentration (approximately one-tenth that of seawater). After ^{22}Na , a radioactive tracer of sodium, was fed into the solution, we observed the ^{22}Na movement from the solution to the shoot for 24 h using PETIS.

We found that ^{22}Na was continuously transported to the upper shoot in the rice plants, whereas it was strongly accumulated in the shoot base but not transported to the upper shoot in common reed plants (Fig.5-28). Furthermore, we replaced the original solution with a fresh nutrient solution without ^{22}Na and traced the ^{22}Na movement inside the plants for 18 h. Using the serial PETIS images (Fig.5-29), we quantitatively analyzed time-course changes of ^{22}Na in small consecutive compartments set along the plant axis. As a result, ^{22}Na ions in the root of the rice plant moved continuously upward, but in contrast, those in the common reed moved downward to the root tip. These results indicate that the common reed has the ability to exclude Na^+ downward from the shoot base and consequently maintains low Na^+ concentration in its shoot.

In this study, we elucidated the common reed-specific mechanism of Na^+ exclusion, and we are now exploring the genes involved in Na^+ retrieval from the xylem and Na^+ exclusion from the root. We expect to produce a salt-tolerant rice plant by introducing the genes of the common reed in the future.

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Reference

Fujimaki, S., Suzui, N. et al., Base to Tip and Long-Distance Transport of Sodium in the Root of Common Reed [*Phragmites australis* (Cav.) Trin. ex Steud.] at Steady State under Constant High-Salt Conditions, *Plant and Cell Physiology*, vol.56, issue 5, 2015, p.943-950.