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PLANT AVAILABILITY OF POTASSIUM IN SOIL MINERALS:

What's Happening Near the Roots?

Dr. T. Scott Murrell
Director, Potassium Program
smurrell@ipni.net

Plants require a lot of potassium (K), and most of what plants need comes from the soil. Soils contain a variety of minerals that contain K in their structures, but that K is not readily available for use by the plant. The traditional view is that K in these minerals comes out in small quantities over long periods of time as soils age. Physical forces and chemical reactions slowly break down these minerals, a process called weathering, releasing K into the soil water where plants roots can take it up.

While this traditional view is correct for the bulk soil, weathering can occur quickly in the zone of soil right around and influenced by the root. This zone, called the rhizosphere, has a chemical and biological composition much different from the bulk soil.

Bacteria bloom in the rhizosphere. Bacterial populations are often several times those found in the bulk soil. As plant roots grow, they leave behind a lot of carbon. This carbon comes from dead cells and from chemical compounds they release, including mucilage, a gelatinous substance that lubricates the root tip as it extends into the soil. Soil bacteria need carbon, and the rich supply of it in the rhizosphere fuels their growth.

Some of the bacteria blooming in the rhizosphere can solubilize a portion of the K in soil minerals. Although there is still a lot to be understood about how they do it, at least some of the bacteria that have been isolated and studied produce acids and other carbon compounds that break the chemical bonds holding mineral structures together. As bonds break, K gets released and becomes available for uptake by roots.

Fungi are also abundant in the rhizosphere. They too need carbon. Like bacteria, some fungi exude acids that break down minerals and release K that can be taken up by the plant. In addition, fungi grow mycelia. As these tubular filaments grow, they exert physical forces on soil minerals that can also break their structural bonds and release K.

Plant roots can also exude their own acids and carbon compounds into the rhizosphere. These substances are released as the plant regulates the

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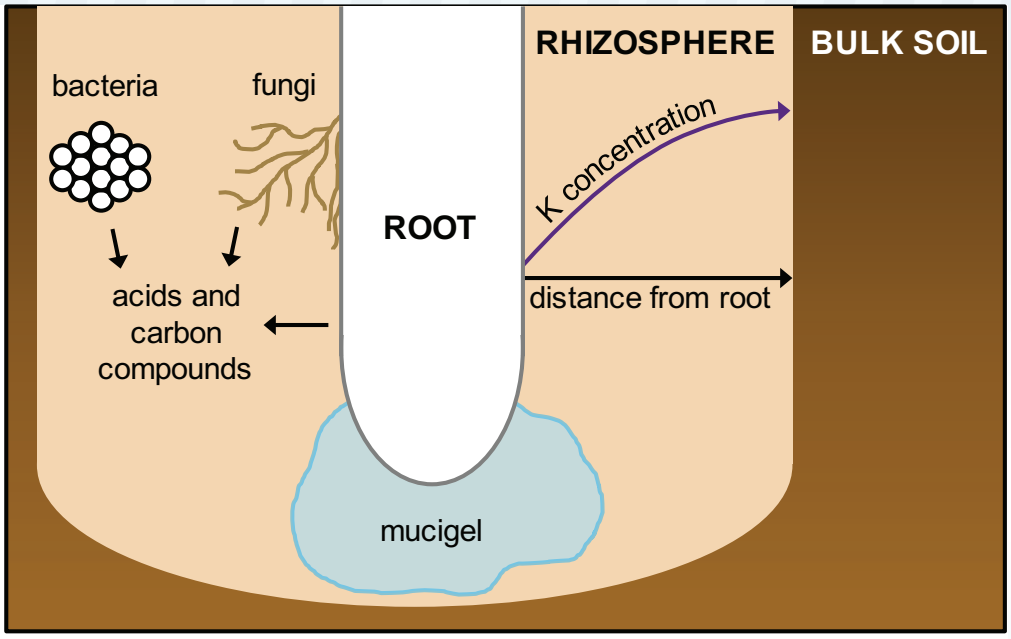

An generalized view of the plant and microbial mechanisms influencing the availability of K within the soil rhizosphere.

types and amounts of nutrients and other molecules in its roots.

Finally, as roots take up K from the soil, they deplete K in the rhizosphere to concentrations much lower than the bulk soil. Very low concentrations of K near the root can trigger the release of K from mineral structures.

All of these mechanisms arise from chemical and physical forces considered part of weathering. Rather than taking years, however, these processes working in the rhizosphere release K in a matter of days or weeks.

Even with all these mechanisms, a plant may still not be able to access enough K from the soil to meet its nutritional requirements. Scientists have come up with a variety of measurements that differentiate conditions when plants are accessing enough K and when they are not. Soil tests and plant tissue tests that are calibrated to crop growth and development have been extremely helpful in this regard. Future improvements in the accuracy and precision of these tests will need to consider how plant varieties differ in their abilities to acquire K. How different varieties alter their rhizosphere environment will be an important consideration.

IPNI International Plant Nutrition Institute

3500 Parkway Lane, Suite 550, Peachtree Corners, GA 30092-2844 U.S.
Phone: 770-447-0335 | Fax: 770-448-0439 | www.ipni.net