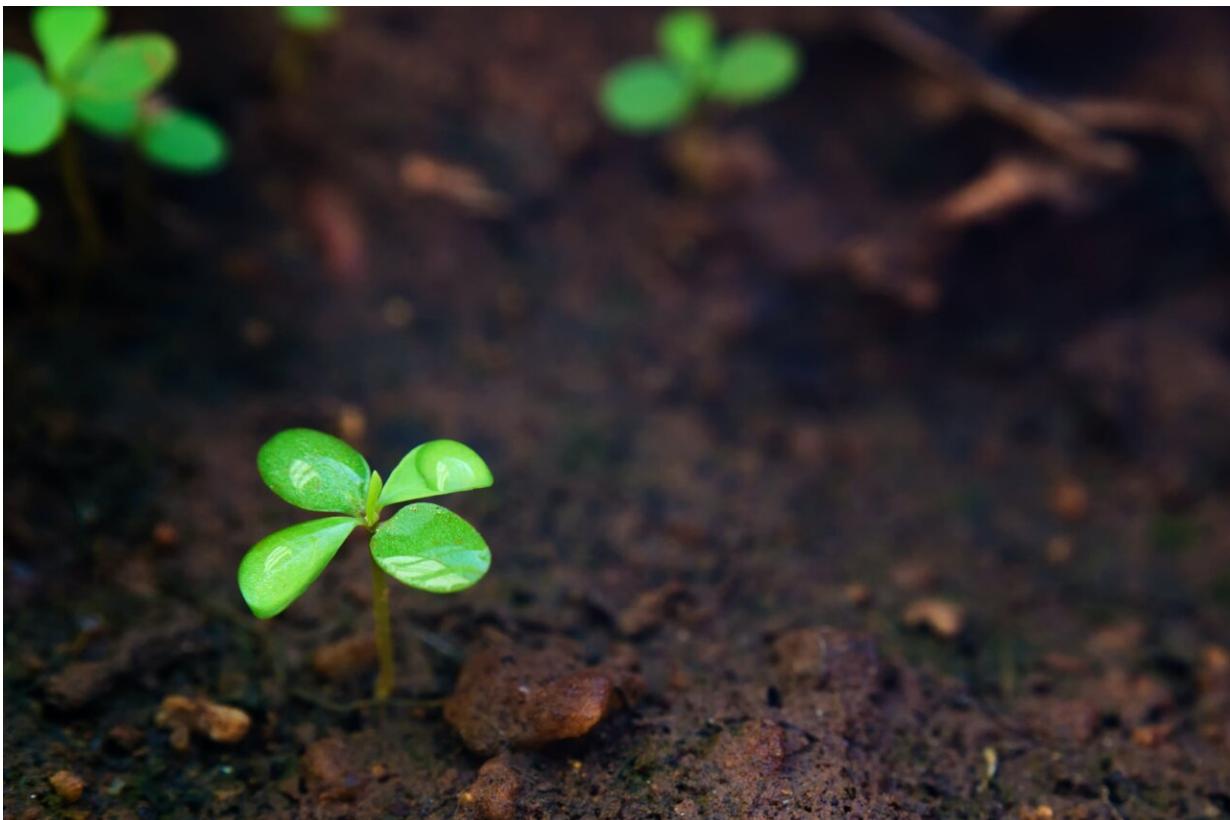


# Unraveling how potassium bound to soil minerals is made bioavailable for uptake by plants

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A combination of X-ray absorption spectroscopy and computational methods has revealed the unique bonding environment of potassium

associated with organic acids.

Potassium is an essential element for plant growth. However, soils generally have low amounts of [potassium](#) readily available to plants. Luckily, soils contain potassium in [soil](#) minerals, and there are many species of microbes that can weather [mineral](#) surfaces by secreting organic acids that dissolve the minerals, thereby releasing potassium.

A recent study [published](#) in *The Journal of Chemical Physics* shows that the bonding [environment](#) of potassium in different organic acids has different signatures that can be detected using X-ray techniques. The signature of the bonding environment can inform whether potassium is associated with carbon, nitrogen, or oxygen.

Microbial mineral weathering has been shown to be a promising pathway to sustainably increase the availability of potassium (K) to plants. However, the mechanisms underlying microbial K transformations are poorly resolved.

To better understand how microbes source K from minerals, a multi-institutional team of scientists performed X-ray absorption spectroscopy (XAS) at the Stanford Synchrotron Radiation Lightsource (SSRL) on K-organic salts, including acetate, citrate, nitrate, oxalate, and tartrate, which are frequently observed as acids secreted by soil microbes. The organic salts display XAS spectra, each of which demonstrates numerous unique features.

To identify the electron moves that cause some unique spectral features in the organic salts, the team used computational tools and expertise from scientists at the Environmental Molecular Sciences Laboratory (EMSL), a Department of Energy, Office of Science user facility, and Pacific Northwest National Laboratory to simulate experimental spectra. The team analyzed the K-organic [salt](#) bonding in detail to explain why

XAS spectral shapes differ.

Their results also indicated that XAS spectra were associated with the entire compound, despite similar bonding environments around the K ion of each organic salt. The improved understanding of K bonding environments with organic compounds provides an important toolkit to understand how K is transformed by microbial processes and made bioavailable for plant uptake.

Results from this research are some of the first of their kind—identifying the particular signature of potassium organic acids. This understanding will allow future researchers to fingerprint the type of organic compound that is bonded to potassium in complicated biological and environmental samples, something that was not previously known to be possible until now.

A further impact of this research is the characterization of these signatures; this will allow future studies to spatially distinguish between these potassium organic molecules in natural soil. Overall, this research is important to general understanding of how potassium is cycled between the soil matrix, microorganisms, and plants.

**More information:** Jocelyn A. Richardson et al, X-ray absorption spectroscopy and theoretical investigations of the effect of extended ligands in potassium organic matter interaction, *The Journal of Chemical Physics* (2024). [DOI: 10.1063/5.0183603](https://doi.org/10.1063/5.0183603)

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