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Soil K-bearing minerals: Key sources of plant-available potassium

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Mineral samples used as standards for fitting of X-ray powder diffraction (XRPD) data, including biotite (trioctahedral mica; black platy mineral at lower left). Details of the method

are described in Kurokawa et al. (2025). Photo courtesy of Kohei Kurokawa, Kyoto Prefectural University.

Potassium in soil exists in forms that plants can use immediately or that are slowly released from minerals, providing an important long-term nutrient source for crops. A study of 322 soils in Japan found that different extraction methods target different mica minerals, showing that soil parent material determines both the amount of slowly available potassium and how it appears in soil tests, improving the ability to estimate long-term soil fertility.

Potassium (K), an essential plant nutrient found in soil, is either readily available for plant uptake or slowly released from soil minerals. This slowly released K (also known as non-exchangeable K) is an important long-term K source for crops. Understanding which minerals supply non-exchangeable K helps improve fertilizer management and sustain soil fertility.

Despite their widespread use, two extraction methods for non-exchangeable K—the boiling nitric acid method and the tetraphenylborate method—do not provide consistent results because their reactivity with soil minerals remains unclear. This knowledge gap limits the ability to interpret soil tests and identify soils with high K-supplying ability.

A research team investigated 322 agricultural soils across Japan to determine which minerals respond to each extraction method. They quantified major soil minerals using X-ray powder diffraction. The study showed that trioctahedral micas [Micas(Tri)], which release K readily, react preferentially with the boiling nitric acid method. In contrast, the tetraphenylborate method targets dioctahedral micas [Micas(Di)], which release K slowly. Cluster analysis revealed that soils characterized by granitic parent material contain abundant trioctahedral micas and high amounts of non-exchangeable K as determined by the boiling nitric acid method.

These findings highlight that the soil parent material controls both the amount of non-exchangeable K and its response to different extraction methods. This understanding allows for the estimation of long-term K fertility across agricultural landscapes.

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Kurokawa, K., Nakao, A., Suzuki, A., Wakabayashi, S., Fujimura, S., Eguchi, T., Shinano, T., & Yanai, J. (2025). Soil K-bearing minerals respond differently to various potassium extraction methods targeting phytoavailability. *Soil Science Society of America Journal*, 89, e70160. https://doi.org/10.1002/saj2.70160

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