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The effect of soil mineral composition and dust input on potassium availability to plants.

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Potassium (K) is amajor Earth element in Earth's crust, and an essential macronutrient involved in various plant processes including enzymatic activity, cell development, and osmotic balance. Potassium is naturally available to the plant through the weathering of primary and secondary minerals, such as K-feldspar and illite, and organic matter recycling. Potassium concentrations and bioavailability vary greatly between mature, and younger, alkaline soils rich in K-bearing minerals.

Potassium fertilization recommendations typically rely on soil test that estimate the exchangeable-K pool, (i.e., K adsorbed onto clay mineral surfaces, oxides, and organic matter), accounting to 1% to 2% of the total soil K. The prevailing paradigm assumes that exchangeable-K represents the capacity of the soil to supply plant-available-K. However, studies spanning both short- and long-term experiments (ranging from several growth seasons to decades), have reported little to no response to K fertilization in alkaline soils. These findings suggest that such soils supply more K than exchangeable-K tests indicate, raising questions regarding the intrinsic soil-K reservoirs, and the extent to which they supply K to plants.

In this study, we apply geochemical tracers, specifically K/Rb, and $^{87}Sr/^{86}Sr$ isotopic ratios, to trace and quantify the contribution of different K-bearing mineral phases (soil K pools) to the plan available-K pool. We are particularly interested in interlayered-K in clay mineral, and structural K, primarily found in K-feldspar.

Our results from a long-term experiment on four different agricultural soils- some rich, and others poor in K- support our hypothesis that the alkaline and clay-rich soils, particularly those in regions receiving substantial annual dust input, supply plant-available K beyond the estimates provided by standard exchangeable-K tests. Furthermore, changes in the composition of the geochemical tracers, indicate the release of K from different mineral pools in the soil.

Over time, we suggest, that agriculturally driven enhanced weathering of the illite and K-feldspar, releases significant amounts of K, that had been previously considered unavailable. Given the abundance of these mineral phases in the Eastern Mediterranean regional dust, we further suggest that dust deposition and location along the dust gradient, play a significant role in replenishing and maintaining soil K levels.