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Quantifying N uptake from the subsoil: A biopore labelling field approach

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Enhancing the nutrient acquisition from the subsoil, i.e. the soil below the plough layer, is a resource efficient means to increase crop productivity. Therefore, the subsoil is currently receiving increasing research attention. To assess any individual subsoil's contribution to plant nutrition, it is essential to quantify the share of nutrients derived thereof. This, however, remains challenging, especially under in situ conditions.

Compared with topsoils, subsoil bulk is characterized by high penetration resistance and low concentrations of plant available nutrients, thus, rather adverse conditions for root growth. Nevertheless, since subsoils are not disturbed by tillage operations, they are structurally heterogeneous. Large sized biopores generated by plant roots and earthworms provide favorable physical conditions for enhanced rooting. As a result of low penetration resistance, high nutrient concentrations and high microbial activity in the drilosphere, biopores are considered hot spots for subsoil nutrient acquisition.

In a field approach on a conventionally managed Haplic Luvisol near Bonn, Germany, we labelled biopore walls in the subsoil with 15N by providing labelled lucerne (Medicago sativa L.) litter to anecic earthworms, and retrieved some of this labelled N in succeeding spring wheat (Triticum aestivum L.) and mallow (Malva sylvestris L.). Even though 15N in pore walls was heterogeneously distributed and 15N contents were elevated not only in biopore walls, but also in the bulk subsoil, our data suggest that the quantity of N derived from the subsoil drilosphere amounted to at least about 40% for mallow and 32% for wheat. These rather high values underline the importance of the subsoil drilosphere for crops' nutrient acquisition at the site under study. The experimental setup is promising, but needs to be further refined to allow precise quantification of N uptake from the different subsoil zones.