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How do plants manage their microelements? Untangling the Zn transport mechanisms between lateral roots

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Plants provide nearly all the calories and micronutrients required for the human diet. Plant productivity and nutritional value are influenced by the uptake and distribution of microelements, such as zinc, which is essential for plant development. Zn is absorbed by plant roots from the soil and transported to the shoots, yet the mechanisms governing Zn distribution within and between plant organs are not well understood. This study investigates these mechanisms, particularly under conditions of partial zinc deficiency.

The objective was to determine the mechanisms of Zn distribution between lateral roots by analyzing Zn distribution and speciation in plants grown in both Zn-heterogeneous (parts of the root system in Zn-sufficient and other parts in Zn-deficient conditions) and Zn-homogeneous media (either Zn-sufficient or Zn-deficient). Achieving high sensitivity and minimal sample preparation was crucial for preserving Zn distribution and its chemical forms, which was accomplished using the POLYX (μXRF) setup.

Roots were mounted between 3,6μm foil sandwich, allowing for fresh sample analysis. We were able to achieve spot resolution up to 5 μm but most efficient (time/results) were μXRF maps were acquired with 100 μm resolution. The results (Fig 1) demonstrated a strong Zn signal within whole root system, that is in parts that were grown in Zn deficient and Zn sufficient medium. Those results indicate Zn transport from Zn-sufficient to Zn-deficient roots. Zn was also not uniformly distributed, suggesting the presence of storage sites within the root system. Higher Zn levels in upper roots suggested that younger roots have a greater capacity for Zn uptake.

This study successfully utilized the POLYX beamline to analyze Zn distribution in plant root systems, revealing significant insights into Zn transport mechanisms. Our findings highlight the dynamic nature of Zn redistribution in plants, especially under nutrient deficiency, and provide a basis for further studies on nutrient transporters responsible for Zn distribution within plants.

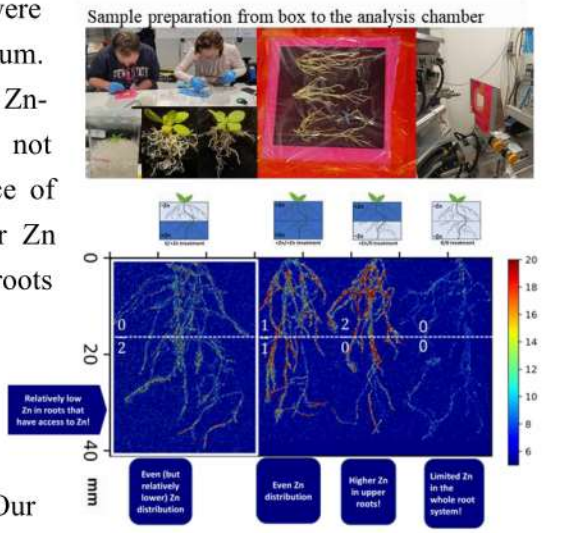

Fig 1 Zn elemental maps shows that Zn is distributed between lateral roots within the root system. Representative roots grown in homogenous (0/0 and 1/1 μM Zn) and heterogenous (2/0 and 0/2 μM Zn) medium. Spot size is 100 μm the background intensity was cut off (scale started at certain indicted count) and images in white rectangle were measured not simultaneously with 3 other roots systems.