Copper isotope fractionation during uptake and translocation in strategy I and strategy II plants

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Copper is an essential micronutrient for plant growth, yet is a toxin at above optimal concentrations. It currently remains unclear how plants mobilise, absorb and translocate Cu in soil-plant systems. It has been reported that strategy I plants (dicotyledons or non-graminaceous monocotyledons) can reduce Cu(II) by the secretion of Fe(III) reductases, and that strategy II plants (graminaceous monocotyledons) can complex and absorb Cu(II) using Fe(III) complexing phytosiderophore root exudates [1, 2]. Stable isotopes have the potential to provide in situ information on these mechanisms [3]. This knowledge can assist in developing better agricultural management strategies to enhance uptake in Cu deficient conditions, to limit Cu uptake to allow faster revegetation on contaminated lands, and to trace contamination sources.

A controlled hydroponics experiment that examined the fractionation of Cu isotopes was conducted to assess Cu uptake and translocation mechanisms in higher plants. *Lycopersicum esculentum* (Roma Tomatoes, strategy I), and *Avena sativa* (Oats, strategy II), were grown under nutrient conditions that controlled Cu speciation for 30 days, with an iron deficiency induced on half the plants for the last 6 days of growth.The plants were harvested and separated into roots, stems and leaves for isotopic analysis.

It was expected that if Cu were taken up through Fe acquisition mechanisms, Fe deficiency would increase Cu uptake. Indeed, Cu concentrations were significantly higher in the Fe-deficient plant roots of both species. Furthermore, preliminary Cu isotope data ($\delta^{65/63}$Cu) show Fe-deficient tomato roots being *ca.* 0.5‰ lighter than Fe-sufficient plants, with an average $\Delta^{65}Cu_{(root\text{-}solution)}$ of -2.3‰ in the Fe-deficient tomato plants. The strong negative fractionation suggests reduction of Cu(II) is occuring prior to uptake, possibly at the root surface. Oat roots also showed a light isotopic composition, with a $\Delta^{65}Cu_{(root\text{-}solution)}$ of ca. -1.0‰. However, no significant difference was observed between the control and Fe-deficient oat roots.

Copper isotope data from plant tissues, together with solid-phase Cu speciation from synchotron-based bulk X-ray absorbance spectroscopy, will be used to infer Cu uptake and translocation mechanisms in higher plants.

[1] Welch, R.M. et al., (1993) *Planta,* **190(4)**, 555-561.
[2] Chaignon, V. et al., (2002) *New Phytologist*, **154(1)**, 121-130.
[3] Jouvin, D., et al., (2012) *Environmental Science and Technology*