

PHYTOEXTRACTION OF TRACE METALS WITH *Noccaea Caerulescens* FOR URBAN AGRICULTURE DEVELOPMENT

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Introduction

Urban soil contamination with trace metals (Pb, Cd, Cu, Zn,...) is a serious threat to the development of urban agriculture as crops grown in urban gardens are prone to accumulate trace metals up to toxic levels for human consumption (Finster, Gray, & Binns, 2004). Phytoextraction – a soil remediation technique based on the use of plants accumulating trace metals – is considered as a potentially cost-effective and environmentally-friendly alternative to conventional methods such as excavation (Cunningham & Ow, 1996). One of the most promising candidates for phytoextraction is the Zn/Cd/Ni hyperaccumulating plant *Noccaea caerulescens* (McGrath et al., 2006). When considering the use of contaminated soils for crop cultivation, it is of high relevance to consider removing only the bioavailable metal pools a concept known as bioavailable contaminant stripping (Hamon & McLaughlin, 1999). Bio- or phytoavailability can be determined indirectly with the use of various chemical extractants or directly by measuring the uptake of reference plants (Meers et al., 2007).

The main objective of this project is to test the suitability of phytoextraction for lowering trace metals phytoavailability for vegetable cropping. We first tested different cultural practices with two contrasted accessions of *N. caerulescens* to optimize Cd and Zn extractions. We then tested the trace metal accumulation in wild rocket growing on soils previously phytoremediated or not by *N. caerulescens*.

Methods

Field trials were conducted on two urban wastelands and one community garden in Brussels (Belgium). Various cultural practices (e.g. compost amendment, nitrogen fertilization, planting density) were tested on 2 accessions of *N. caerulescens* (Wilwerwiltz and Ganges) to maximize biomass production and phytoextraction efficiency. Pot trials were conducted on 14 soils collected in Brussels to characterize the potential of phytoextraction of *N. caerulescens* and the phytoavailability of trace metals for *Rucola selvatica* (wild rocket). Different extractants (e.g. CaCl₂, NH₄NO₃, NH₄⁺ acetate, EDTA) were used to characterize the metal contamination in the 14 soils and compare the different norms associated. Lastly, pot trials are currently conducted on phytoremediated soils in order to estimate the decrease of trace metal phytoavailability for *R. selvatica*, after one, two and three years of phytoextraction.

Results

Field trials showed that one crop of *N. caerulescens* can lower exchangeable concentrations at the soil surface (0 - 30 cm) by around 5-10 % for Cd and around 8-15 % for Zn (ac. EDTA based extraction). Wilwerwiltz accession appears to be more efficient for Zn phytoextraction and also more resistant to herbivory than Ganges accession which is generally used in phytoextraction trials. The test of cultural practices showed that nitrogen fertilizers addition enhances *N. caerulescens* biomass production (+ 30 %), while compost lowers the metal foliar accumulation due to immobilization (up to – 40 % [Cd]); nitrogen fertilized plants accumulate less metals in their shoots probably due to a dilution effect (– 32 % [Cd]; – 27 % [Zn]). The comparison of two contrasted planting densities (50 vs 100 plants/m²) showed that the highest one yielded a larger biomass production, but a reduced individual biomass due to competition, suggesting that an intermediate density would be optimal.

Our study of trace metal phytoavailability showed first that legal thresholds based on different extractions do not yield similar pollution status of the 14 soils analyzed in this experiment. Secondly, regulatory thresholds used in Brussels - based on soil total concentrations - were not reliable to predict on which soil metal levels in *R. selvatica* would exceed the legal standards for Cd and Pb set by the EU commission.

Conclusion

Our experiments are one of the first field trials to specifically test if phytoextraction allows to lower trace metal accumulation in subsequent vegetable cropping in urban environments. They show promising results for lowering Cd and Zn bioavailable concentrations in urban soils. Phytoextraction could be a realistic technique to enable a safe implementation of urban agriculture on urban wastelands.

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