Nickel Phytoextraction by Seven Populations of Hyperaccumulating Brassicaceae.

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Context

Hyperaccumulator plants are able to accumulate one or several metals at high concentration. For nickel (Ni), the threshold concentration is fixed at **1000 mg kg^{-1} of Ni** in dry matter of shoots.

Hyperaccumulator plants can be used to extract metals from contaminated soils or from soils naturally rich in Ni called ultramafic soils. Then, Ni sequestered in plants can be recovered by hydrometallurgical processes for metal recycling.

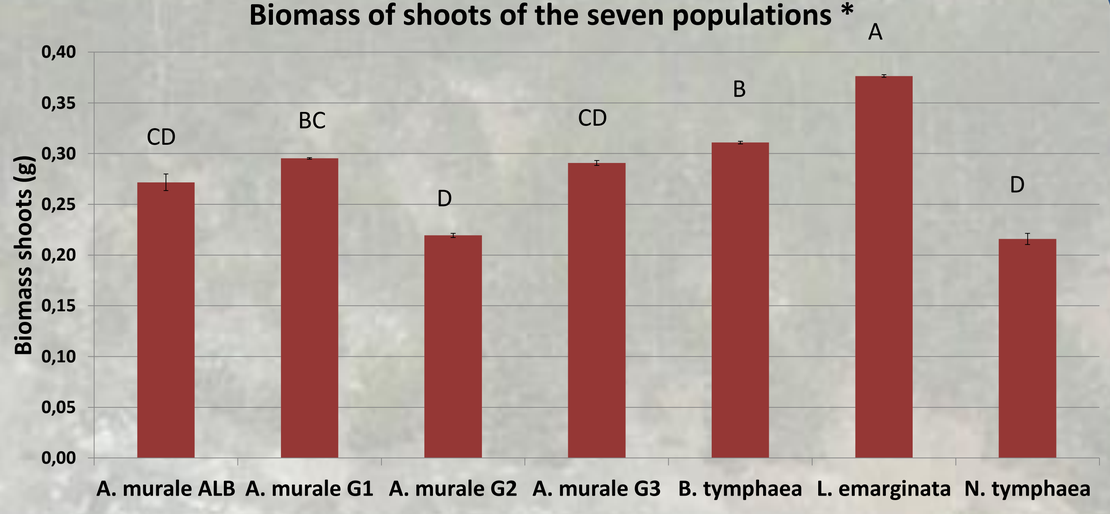
The optimisation of agronomic practices for growing these plants is a current challenge. It involves the selection of efficient plants, i.e. plants with **high biomass production** and **high concentration of metals in their shoots.**

This research is part of the LORVER project (www.lorver.org) aiming at creating a production sector of non-food plant biomass for industrial purposes, the biomass being grown on degraded sites and industrial by-products. The present objective is to evaluate the phytoextraction potential of various Ni hyperaccumulators across species, populations and individuals.

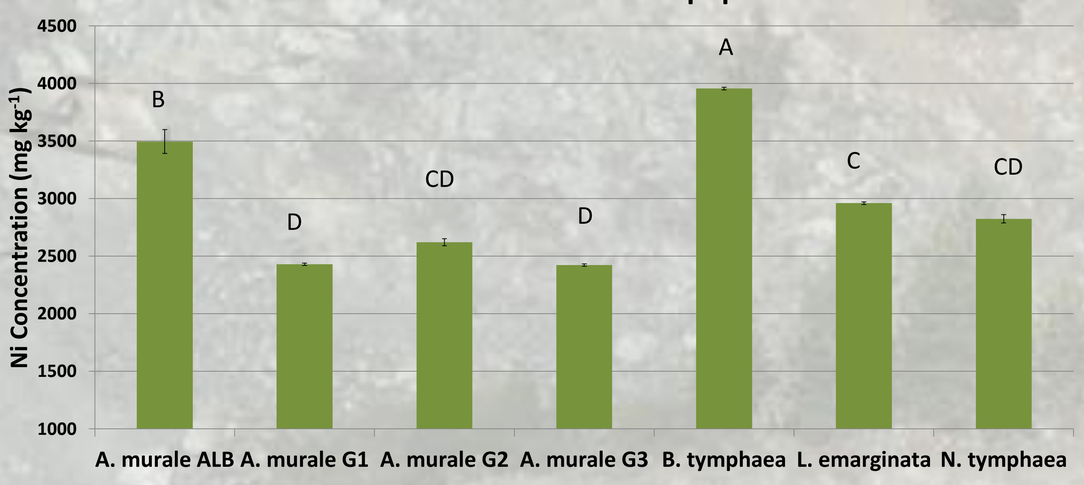
Results

**Error bars represent standard errors*

Biomass of shoots of the seven populations *



Ni Concentration in shoots of each population *



- ❖ *L. emarginata* has the highest biomass (mean: 0.38 g) whereas the highest Ni concentration has been recorded in *B. tymphaea* (mean: 3 956 mg kg^{-1}) (Wilcoxon, p<0.05).
- ❖ The 4 populations of *A. murale* have led to different results, the best one being *A. murale* ALB.
- ❖ In terms of Ni quantity, *L. emarginata* , *B. tymphaea* and *A. murale* ALB (results not show here) are the more efficient populations.

Conclusions

The intra- and inter- population variabilities of Ni accumulation in the four species are very high. This screening enables us to retain *L. emarginata*, *B. tymphaea* and *A. murale* ALB as the most promising populations for Ni phytoextraction.

Furthermore, the individuals accumulating the highest mass of Ni also concentrate Ca, Mn, and Co.

However, these results have been recorded for 70 d aged individuals. Elemental concentrations depend on the phenological stage. Indeed, the measured metal concentrations are lower expected for individuals collected in the field at the flowering stage.

Materials and methods

ULTRAMAFIC SOIL	
pH	6.14
C/N	12.6
CEC	31.3 cmol^{+} kg^{-1}
[Ni] $_{total}$	1480 mg kg^{-1}
[Ni] $_{DTPA}$	83 mg kg^{-1}

Ultramafic soil has been sampled in the Vosges mountains. Pots were prepared with 70 g of soil; 70 plants of each population were grown during 70 d in controlled conditions.

PLANTS: 7 populations
- ✓ *Alyssum murale* (ALB : from Albania and G1, G2, G3: from Greece)
- ✓ *Bornmuellera tymphaea* (BORN)
- ✓ *Leptoplax emarginata* (LEPT)
- ✓ *Noccaea tymphaea* (NOC)

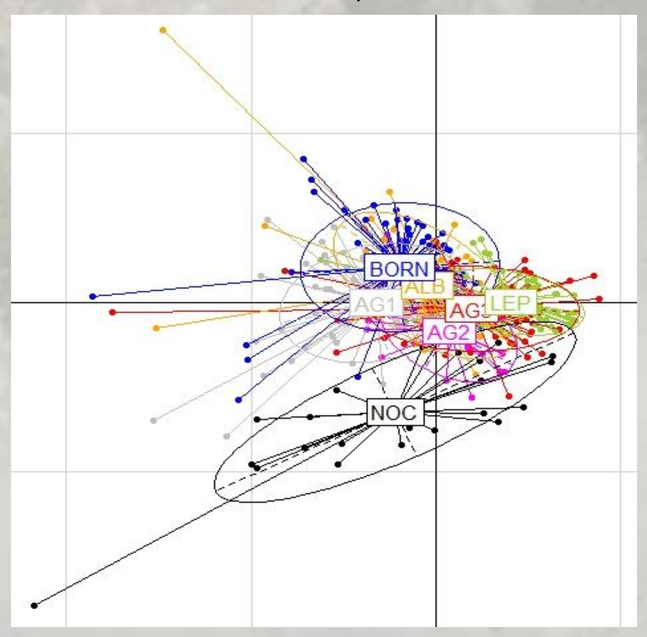
Cropping → **70 days**

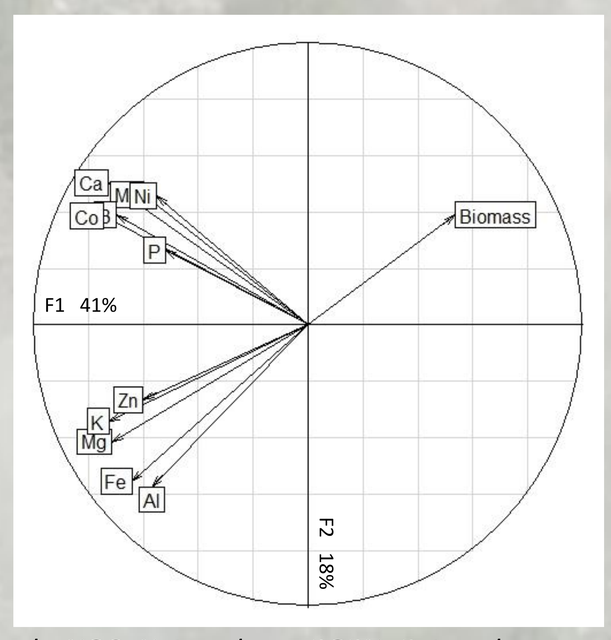
Harvest

Analyses

- Dry biomass weight
- Metal concentrations (ICP)
- (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn and Ca, K, Mg, Na, P)

A **principal component analysis** has been run with all the metal concentrations above 10 mg$_{metal}$ (kg$_{dry\ matter}$)$^{-1}$. Therefore, Cr, Cu, Cd and Na have been neglected (however it was noticed that Cd concentration was 18 times higher in *N. tymphaea* than in the other ones).





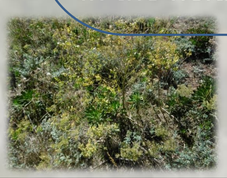
AG1, AG2, AG3 and ALB: four populations of *A. murale*, NOC: *N. tymphaea*; BORN: *B. tymphaea*; LEPT: *L. emarginata*.

- ❖ Concentrations of Ni, P, Ca, Co Mn and B are correlated. At the same time, Zn, Fe, Al, Mg and K concentrations are correlated but not with the previous group.
- ❖ Biomass production is opposed to concentration of Zn, Mg, Fe, K and Al in shoots.

Perspectives

This study brings criteria to select the optimal population and individuals for further hydrometallurgical process.

This work could be extended to multicontaminated matrices, including tolerance to a co-contamination as a screening factor of hyperaccumulators.



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