The influence of arbuscular mycorrhizal fungi on caesium accumulation by plants - determined by external caesium supply?

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Caesium isotopes

- Radionuclides ^{134}Cs and ^{137}Cs:
  - Emission of harmful β and γ radiation
  - Rapid incorporation into biological systems
  - Long half-lives
- Sources of radiocaesium contamination are global fallout and accidental release from nuclear facilities.
- Natural concentrations of the stable isotope ^{133}Cs in soil are several orders of magnitude higher than concentrations of radioactive isotopes.

Potassium transport proteins

Caesium (Cs) is chemically similar to potassium (K). Root uptake mechanisms cannot differentiate between these elements easily. Several K transporters can contribute to Cs uptake by roots. In K-replete plants Cs uptake is mediated by VICC, but in K-deficient plants Cs uptake is mediated by KUP (Fig. 1).

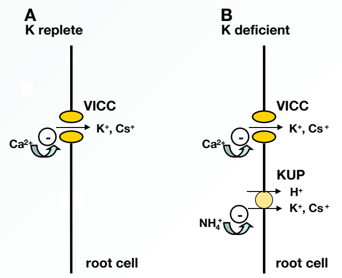

Figure 1: Caesium uptake across the plasma membrane of root cells under (A) K-replete and (B) K-deficient conditions. VICC (voltage-independent cation channels); KUP (high-affinity K/H symporters). Hampton *et al.* (2005) *Nukleonika* **50**, S3-S8

Arbuscular mycorrhiza

Most vascular plants live in symbiosis with arbuscular mycorrhizal (AM) fungi. These can improve plant K nutrition and might therefore influence plant Cs uptake.

Hypothesis

If AM fungi improve plant K status, then Cs uptake by mycorrhizal roots would occur mainly through VICC and AM fungi would decrease the accumulation of Cs by reducing the abundance of KUP.

Material and Methods

Experiment 1: An *in vitro* system was used to grow *Medicago truncatula* (Fig. 2) in association with *Glomus sp*. The plants were cultivated under K-deficient conditions with the addition of 0.05 mM Cs and harvested after nine weeks. Concentrations of elements were measured using ICP-MS. Mycorrhizal colonisation rate was 9.8%.

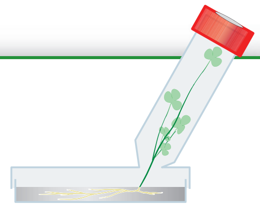

Figure 2: *In vitro* system for growing *M. truncatula*.

Experiment 2: *M. truncatula* was grown in association with *Glomus intraradices* in pots containing 0.64kg of a sand:clay mixture. The plants were cultivated under K-replete conditions with the addition of different amounts of ^{133}Cs and ^{134}Cs (Table 1) and harvested after ten weeks.The activity of ^{134}Cs was determined using a gamma-spectrometer.

per pot	A	B	C	D	E
^{134}Cs [Bq]	3125	6500	12500	25000	50000
^{133}Cs [µg]	0.1	0.4	2	10	50

Table 1: Supply of ^{133}Cs and ^{134}Cs.

Results

Mycorrhizal colonisation does not affect K or Cs concentrations in roots or shoots of *M. truncatula* plants at high external Cs supply (Expt 1, Fig. 3).

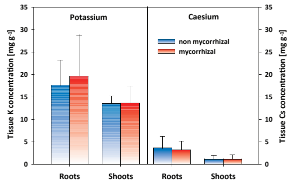

Figure 3

Mycorrhizal colonisation does not affect Cs concentrations in roots (data not shown) or shoots of *M. truncatula* plants grown at different supplies of external Cs (Expt 2, Fig. 4).

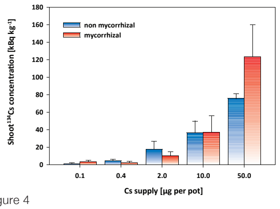

Figure 4

High external Cs concentrations reduce mycorrhizal colonisation in *M. truncatula* (Expt 2, Fig. 5).

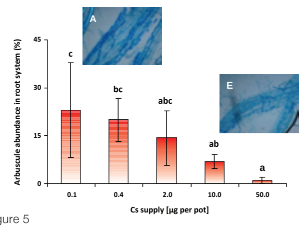

Figure 5

Conclusions

- High external Cs concentrations interfere with the induction of AM symbiosis
- Arbuscular mycorrhizal fungi do not influence Cs accumulation by *Medicago truncatula*

Acknowledgements

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