Resolving the role of bacteria in reducing metal toxicity to plants

Bryne T. Ngwenya[1], Gbotemi A. Adediranr[1,2], Nyekachi Adele[1], J. Fred Mosselmans[3], Kate V. Heal[1]

[1]*School of Geosciences, University of Edinburgh, James Hutton Road, Edinburgh EH9 3FE*
[2]*Department of Chemistry, Umeå University Sweden, SE-901 87 Umeå, Sweden*
[3] *Diamond Light Source Ltd, Harwell Campus, Didcot*

The toxicity of metals to plants limits the effectiveness of phytoremediation to clean up metal-contaminated soils[1]. Inoculation of soil/seeds with some bacteria can improve plant growth but the mechanisms behind this phenomenon are contentious[2]. This talk will review results of experiments in which growth of *Brassica junco* in the presence of *Pseudomonas brassicacearum, Rhizobium leguminosarum* or both strains under zinc stress was combined with synchrotron-based micro-XRF imaging and XANES analysis to shed light on mechanisms behind the apparent metal tolerance.

Improved plant growth occurred when seeds were inoculated with either bacteria relative to controls, despite higher zinc concentrations in the plant tissues of bacteria-inoculated plants, as revealed by bulk analysis and by synchrotron-based micro-XRF imaging of roots[3]. Linear combination fitting of XANES data showed significant differences in zinc speciation between controls and bacteria treatments. Furthermore, the locus of the zinc depends on whether the bacterium is endophytic or rhizospheric[4]. Significantly, the same speciation profiles for bacteria-inoculated plants were observed regardless of the form in which Zn (dissolved in particulate) was applied to soil. Outstanding issues regarding identification of bacteria-induced speciation will be discussed.

References

1. Ebbs, S.D., Kochian, L.V. Toxicity of zinc and copper to Brassica species: implications for phytoremediation, *J. Environ. Qual*., **26**, 776–781 (1997).
2. Babu, A.G., Kim, J.-D., Oh, B.-T. Enhancement of heavy metal phytoremediation by *Alnus firma* with endophytic Bacillus thuringiensis GDB-1, *J. Hazard. Mater*. **250,** 477–483 (2013).
3. Adediran, G.A., Ngwenya, B.T., Mosselmans, J.F.W., Heal, K.V., Harvie, B.A. Mechanisms behind bacteria induced plant growth promotion and Zn accumulation in Brassica junco. *J. Hazard. Mater.,* 2**83**, 490-499 (2015).
4. Adediran, G.A., Ngwenya, B.T., Mosselmans, J.F.W., Heal, K.V. Bacteria-zinc co-localisation implicates enhanced synthesis of cysteine-rich peptides in zinc detoxification when *Brassica junco* is inoculated with *Rhizobium leguminosarum*. *New Phytologist.*, **209**, 280-293 (2016).

Email corresponding author: bryne.ngwenya@ed.ac.uk