E3B The Elements of Bioremediation, Biomanufacturing & Bioenergy Metals in Biology

Durham University · University of Kent · Manchester 1824 The University of Manchester · UKRI Biotechnology and Biological Sciences Research Council

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Durham University · NW living water · Intelligent Gels

# Transcriptomic-based characterisation of gene expression in plant roots in response to a metal nanoparticle barrier

*"This project enabled us to take a concept and progress it into a game-changing product with significant global potential…the funding allowed us to establish high-level data sets, which we could not do in-house. This gives us the evidence that the product and concept has the potential to reduce the risk of sewer blockages that cause flooding and pollution.* Intelligent Gels

PROJECT AIMS: The ingress of plant roots into sewer pipe systems causes blockages, which increases maintenance costs. To address this problem, scientists at Durham University, together with Intelligent Gels and Northumbrian Water, are developing a metal-containing gel-based barrier that halts plant root growth and initiates lateral root growth (so that the plant continues to thrive) away from the sewer system. The aim of this project was to use a transcriptomic approach to provide a detailed molecular analysis of how a plant (*Arabidopsis*) responds to nanoparticles.

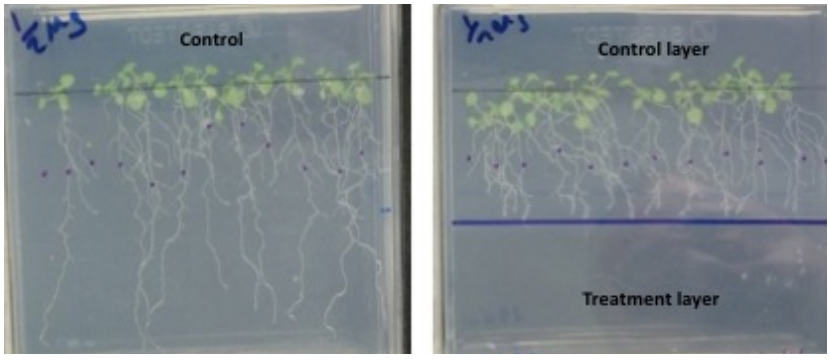
**OUTCOMES & NEXT STEPS:**

- Durham scientists are working with Intelligent Gels to commercialise the metal/gel formulation
- The PI has applied for proof of concept funding from the Northern Accelerator Pre-incorporation Fund to carry out additional experiments and to explore the feasibly of a spinout company
- A method to prevent root damage to infrastructure will be patented

RESULTS: Roots from *Arabidopsis* seedlings grown in a hydroponic system were treated with metal nanoparticles for 3 h and 24 h. A bioinformatic analysis of gene expression changes showed that genes linked to Gene Ontology terms including 'immune response', 'response to oxygen', 'response to pathogens', 'oxidoreductase activity' and 'heme binding' were upregulated compared with untreated roots. The expression of genes associated with 'cell wall biogenesis', cytoskeleton' and 'hormone response' were downregulated. These data are consistent with previously generated proteomic data and the observed growth inhibition of treated seedlings (image). The project partners are also developing novel nanoparticle/gel combinations, which inhibit root growth in a range of species including willow saplings.

KEY MESSAGE: Transcriptomic analysis identified signalling pathways used by plant root cells to respond to metal nanoparticles and redirect root growth.

Change in technology readiness level: 1 to 3




The growth of Arabidopsis seedling roots is inhibited by the novel treatment (right panel, below the blue line) compared with untreated seedlings (left panel). Only root growth is inhibited, and plant viability is maintained.