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Effects of cadmium and arsenic on root development and auxin distribution in *Arabidopsis thaliana* Heynh (L.) plantlets

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The "heavy" metal cadmium (Cd) and the semimetal arsenic (As) are very toxic elements for all organisms and the environment, where they are released from natural and, mostly, anthropogenic sources (Nagajyoti *et al.*, 2010). Neither Cd nor As are essential elements for plants, but they may easily be absorbed through the root system by using the same transporters of some essential nutrients, and then accumulated in plant tissues, thus entering the food chain (Verbruggen *et al.*, 2009). These pollutants may cause serious damages in sensitive plant species, as *Arabidopsis thaliana*, in particular to the root, the first organ with which they come in contact. In the most severe cases the root development and function are completely compromised because of alterations to the cells of the apical meristem, and the quiescent centre (QC) contained in it, and of root primary tissues (Brunetti *et al.*, 2011). Damages to the root apparatus have negative consequences on plant growth, development and productivity.

The architecture of the root system and the correct histological organization of the roots are finely regulated by the QC. The QC definition and maintenance over time, in primary (PR), lateral (LRs) and adventitious roots (ARs), are controlled by auxin level in its and in the surrounding cells (Della Rovere *et al.*, 2013 and references therein). For these reasons the research was aimed to investigate, in addition to morphological alterations due to the two pollutants, their effects on QC maintenance and functioning, and on auxin level and distribution in the root. Effects of Cd and/or As on auxin transport were also studied in the ARs by expression analyses of the reporter gene *uidA* driven by the promoters of two IAA polar carriers coding genes, i.e. *PIN1* (efflux carrier) and *LAX3* (influx carrier).

To the aim, *A. thaliana* plantlets were grown *in vitro*, in the presence of different concentrations of Cd, as $CdSO_4$, and/or As^V (arsenate), as $Na_2HAsO_4 7H_2O$. In order to favor LR or AR formation, different light conditions were chosen, i.e. long-day exposition preceded or not by continuous darkness. Primary root and hypocotyl length, LR and AR density were evaluated. In addition to an untransformed line (Columbia ecotype), *A. thaliana* transgenic GUS lines were used to investigate the QC definition (*QC25::GUS*line) and free IAA distribution (*DR5::GUS*line) and transport (*PIN1::GUS* and *LAX3::GUS*lines).

The results show that Cd and/or As^V presence significantly inhibited the PR and hypocotyl growth. The mean density of LRs and ARs were significantly higher in the plantlets exposed to either Cd alone or both pollutants, while As^V inhibited AR formation. Histochemical GUS analyses indicate that Cd compromised more than As^V the regular QC definition and functionality in the RLs, while, in the ARs, As^V had more drastic effects, putatively related to a reduction on auxin levels during AR development, as shown by the analyses of As^V-treated *DR5::GUS* plantlets. Both Cd and As^V disturbed the expression patterns of the auxin transporters genes, especially in the early stages of AR development.