Biometals
DOI 10.1007/s10534-013-9690-7

Plants fabricate Fe-nanocomplexes at root surface to counter and phytostabilize excess ionic Fe

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Received: 19 August 2013 / Accepted: 25 November 2013

Abstract While evaluating the impact of iron nanoparticles (NPs) on terrestrial plants we realized potential of root system of intact plants to form orange–brown complexes constituted of NPs around their roots and at bottom/side of tubes when exposed to $FeCl_3$. These orange–brown complexes/plaques seen around roots were similar to that reported in wetland plants under iron toxicity. Transmission electron microscopy coupled with energy dispersive X-ray analysis revealed that orange–brown complexes/plaques, formed by root system of all 16 plant species from 11 distinct families tested, were constituted of NPs containing Fe. Selected area electron diffraction and powder X-ray diffraction spectra showed their amorphous nature. Thermogravimetric and fourier transform infra-red analysis showed that these Fe-NPs/nanocomplexes were composed of iron-oxyhydroxide. These plant species generated orange–brown Fe-NPs/nanocomplexes even under strict sterile conditions establishing inbuilt and independent potential of their root system to generate Fe-NPs. Root system of intact plants showed ferric chelate reductase activity responsible for reduction of Fe^{3+} to Fe^{2+}. Reduction of potassium ferricyanide by root system of intact plants confirmed that root surface possess strong reducing strength, which could have played critical role in reduction of Fe^{3+} and formation of Fe-NPs/nanocomplexes. Atomic absorption spectrophotometric analysis revealed that majority of iron was retained in Fe-nanocomplexes/plaques, while only 2–3 % was transferred to shoots, indicating formation of nanocomplexes is a phytostabilization mechanism evolved by plants to restrict uptake of iron above threshold levels. We believe that formation of Fe-NPs/nano-

Electronic supplementary material The online version of this article (doi:10.1007/s10534-013-9690-7) contains supplementary material, which is available to authorized users.

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Published online: 21 December 2013