Quantifying the toxicity of mixtures of metals and metal-based nanoparticles to higher plants

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Propositions

For the doctoral thesis "Quantifying the toxicity of mixtures of metals and metal-based nanoparticles to higher plants" by Yang Liu, Leiden University, 2015

1. The observed competition of common cations in surrounding media assists in explaining variations in toxicity modeling of metals to lettuce (this thesis).

2. Based on the concept of 'additivity', the biotic ligand model (BLM) can be extended to predict a mechanistic link between the accumulation of metal ions at the root surface and the toxicity of various metal mixtures (this thesis).

3. Finding a statistically significant deviation from additivity in metal mixtures can be the starting point of further mechanistic research concerning toxicologically relevant interactions (this thesis).

4. The commonly known independent action (IA) model can be preliminarily used as a predictive tool for assessing mixture effects of metal-based nanoparticles (NPs) (this thesis).

5. The remaining variation in the estimated effects of metal-based NPs can be caused by the antagonistic effects observed between dissolved metal species and undissolved particles (this thesis).

6. Mutual impacts among soluble metal species as well as particulate fractions of metal-based NPs lead to much more complicated combined effects of Cu NPs and ZnO NPs as compared to mixtures of Cu and Zn nitrates (this thesis).

7. There is a need to establish a standard approach for deciding when effects are either less-than-additive or more-than-additive in a statistically robust manner (Van Genderen et al., 2015).

8. Given the prospect of impending regulatory activity, it is time to advance beyond qualitative characterization, analysis, and modeling of metal mixture toxicity. (Meyer et al., 2015)

9. Future testing for mixture effects will take advantage of the ongoing revolution in biology and biotechnology (Løkke et al., 2013).

10. Knowledge on plant toxicity of engineered nanomaterials is at the foundation stage (Rico et al., 2011).

11. Life is about choices. Some we regret. Some we're proud of. We are what we choose to be. (Graham Brown)