Nanomaterials' surface properties modulating their foliar uptake and in planta fate; implication for plant protection products

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Résumé

Plants are the most important biomass pool of the critical zone. Their leaves represent a surface of deposition for atmospheric contaminants, but also a way to deliver products for plant protection. Nevertheless, little is known regarding the morphological, and physicochemical interplays modulating the uptake and transport of inorganics at the phylloplane. In this presentation, we will discuss our ongoing work looking for nanoparticles-plant surface interactions that can drive the uptake and transport of inorganic nanoparticles and their products of transformation.

Regarding foliar uptake, hydrophobic interactions seem to be driving nanoparticles' entrance. We, therefore, synthesized model 3nm gold nanoparticles with surfaces tuned for hydrophobicity and amphiphilicity. These AuNPs with modulated surface properties were deposited on the leaves of four model plants (basil, tomato, bell pepper, and corn) presenting a range of leaf surface-free energies. NP adhesion, uptake, and translocation were then evaluated. The results highlight how hydrophobic properties of the NPs and leaf wettability influenced NP adhesion, uptake and translocation. They also underline that a better understanding of cuticular uptake is one of the major knowledge gaps for predicting the behaviour of (in)organic particles at the phylloplane.

Considering NP fate in vivo, we studied the impact of phosphate coating of ZnO-based NPs on their distribution in vivo after foliar deposition on pepper leaves using a surfactant that disrupts the leaf cuticle. Zn location and distribution were studied at the cellular scale using μ-XRF and μ-XANES at the ESRF synchrotron. These tools allowed us to highlight differences in ZnO-based NP transformation and storage within the leaf, which seems to be driven by the phosphate shell coating the ZnO NPs.

These two examples highlight that modulating NP properties can be a valid strategy to tune inorganics' foliar bioavailability for improved plant nutrition and protection in compartments of interest.

Mots-Clés: nano, biota interfaces, foliar uptake, model nanoparticles, Plant Protection Products

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