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The Involuntary Circular Economy of (Nano)Plastics

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Nanoplastics (NPs), plastic particles smaller than 1 µm, represent an increasing threat to ecosystems and human health due to their ubiquity, persistence, and high surface reactivity. They can be classified as primary, when intentionally produced for industrial or cosmetic applications, or secondary, resulting from the progressive degradation of larger plastic debris in the environment. Because of their small size, these particles escape conventional filtration systems and have been detected from the peaks of the Himalayas to the sediments of the deepest ocean trenches, highlighting their widespread global distribution.

This ubiquity translates into an inevitable presence in the water cycle, including both drinking water and treated wastewater (TWW). Both are increasingly used for the irrigation of food crops, especially in urban areas facing water scarcity. Despite the advantages of TWW reuse - such as its high nutrient content - these waters may contain other emerging contaminants, as toxic metals. Recent studies suggest that NPs may facilitate the transport and uptake of other pollutants by plants, enhancing their entry into the food chain.

To investigate the fate and potential effects of nanoplastics present in irrigation water used for food crops, germination and growth assays were carried out using lettuce (*Lactuca sativa*) as a model plant. Plants were irrigated with water of different compositions, including both tap water and treated wastewater, to which polymethylmethacrylate nanoparticles (used as model nanoplastic particles) were added. These particles were introduced either alone or in combination with toxic metals (Ni, Cd, Cr, and Pb), at maximum legal concentrations.

The study aimed to evaluate how these two types of contaminants influence seed germination, plant development, and whether they are absorbed and translocated within the plant tissues when present individually or simultaneously in irrigation water. The results, which are still preliminary, reveal unexpected interactions between nanoplastics and metals, with implications for pollutant uptake and plant response mechanisms.

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