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Titanium dioxide and zinc oxide nanoparticles restrict wheat growth

Nanoparticles (NPs) have unique physical and chemical properties, but their increasing use in technological innovations has raised concerns about possible risks to the environment and human health. A new Chinese study has assessed the effects of NPs on plants and ecosystems. The findings indicated that NPs restrict wheat growth and damage soil ecosystems, which may have implications for the environment, agricultural productivity and human health.

NPs are particles sized less than 100 nanometres (nm), up to 10,000 times smaller than the diameter of a human hair. They have powerful properties due to unique physical and chemical characteristics and large surface area relative to size, which give them the potential to improve quality of life and contribute to industrial competitiveness in Europe. However, some NPs have also been shown to be toxic to many species, including bacteria, algae, invertebrates and vertebrates. According to the EU's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)[1], NPs are not *per se* dangerous, but there are many uncertainties about their safety. Therefore, safety assessment of NPs must be conducted on a case-by-case basis.

Most studies have investigated the toxicity of NPs in aquatic environments and the effects of NPs on terrestrial plants and ecosystems remain largely unknown. NPs are being considered for or are already used in a large number of commercial and consumer applications, such as batteries, cosmetics, coatings and anti-bacterial clothing, as well as biocides and pesticides, which are very likely to enter the soil environment. Consequently, this raises concerns about potential health risks associated with food contamination through agricultural products.

The researchers examined the toxicological impacts of titanium dioxide and zinc oxide NPs, two common industrial additives with various applications, on wheat growth and soil health in a field in China. To assess the soil's health, the researchers focused on the activity of enzymes in the soil, which are highly sensitive to change and provide a good indicator of soil quality and health. The soil was classified as loamy clay with a pH of 7.36, and each NP, with various sizes under 100nm, was mixed separately in the top 20cm. The organic concentration was 4.6%, and the contents of titanium and zinc elements were 4307.5 mg/kg and 214.5 mg/kg, respectively. After the contaminants aged for two months, wheat was sown to make the soil reflect field conditions – the behaviours of aged and freshly added contaminants in the environment differ. Data on the wheat's biomass (overall size), uptake of NPs, the elements' contents in harvested wheat, and the activities of soil enzymes were collected and statistically analysed.

The results revealed that both NPs reduced the wheat's biomass, and thus were harmful to the plant. The titanium dioxide NPs, considered to have low solubility, remained in the soil for long periods and stuck to the plants' cell walls, which might create potential environmental risks for deeper soil layers. Additionally, a few individual small-sized titanium dioxide NPs (around 20nm) were able to penetrate the cell wall. The zinc oxide NPs, known to have higher solubility than titanium dioxide, dissolved in the soil and increased the wheat's uptake of toxic zinc. Both NPs significantly reduced activity for several soil enzymes: soil protease, catalase, and peroxidise.

The study indicates that both titanium dioxide and zinc oxide NPs were toxic to the terrestrial environment, either directly or indirectly through their effects on soil. To confirm the size-dependent effects of each NP's toxicity, further studies are needed. However, the authors suggest these NPs and findings should be of interest to decision-makers associated with agricultural and chemical policies, as well as ecosystem protection.

1. See: http://ec.europa.eu/health/scientific_committees/emerging/index_en.htm

Source: Du, W., Sun, Y, Ji, R., Zhu, J., Wu, J. & Guo, H. (2011) TiO2 and ZnO nanoparticles negatively affect wheat growth and soil enzyme activities in agricultural soil. *Journal of Environmental Monitoring*. 13:822-828.

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