LETTER

Evidence for effects of manufactured nanomaterials on crops is inconclusive

Priester et al. (1) recently investigated the growth of soybean in soil amended with ZnO and CeO_2 manufactured nanomaterials (MNMs). It is laudable that the study used soil: Too few studies to date do this. However, we question the agronomic and environmental relevance of this study because of a lack of control experiments with a soluble salt (for ZnO) and with larger-scale particles (for ZnO or CeO_2), lack of consideration of environmentally relevant exposure pathways, and unrealistic levels of exposure. As noted by the authors, nano-ZnO does not reach soils in "neat" form, unless used as a fertilizer; it is most likely to be applied with biosolids (2). Nano-ZnO, similarly to other dissolving metallic MNMs, has been shown to be rapidly converted to sulfides during waste water treatment (e.g., ref. 3). Therefore, it is likely that mostly Zn derived from MNMs, and not nano-ZnO, will enter the soil by application of biosolids. As Zn in biosolids used on agricultural land is strictly regulated in the large majority of countries, the legislative measures to prevent detrimental effects, including nano-ZnO, through this pathway are already in place. The expected increase in concentrations of nano-ZnO in biosolid-treated soils in the United States is in the order of 2 μg/kg per year (2), many orders of magnitude smaller than the concentrations used by Priester et al. (1).

Nano-CeO_2 is used as a fuel additive (catalyzer), but it seems unlikely that the amount deposited on agricultural land would reach 100 mg/kg [the lowest addition rate used by Priester et al. (1)], as suggested by the authors. Exposure modeling puts nano-CeO_2 concentration originating from use in fuels at 0.32–1.12 mg/kg in soils close to roads (4)—at least a factor of 100 lower than the lowest concentration used by Priester et al. (1). What is therefore needed is a proper assessment of the pathways of CeO_2 movement and the worst-case concentrations that are likely to occur.

We also need to point out that the results reported by Priester et al. (1) are often difficult to interpret because impacts occurred at the lowest nano-CeO_2 addition but not at larger applications. Although changes in MNM agglomeration and/or association with soil constituents may theoretically give rise to concentration-related nonmonotonous bioavailability (i.e., higher availability at lower concentrations due to less agglomerated particles), the authors have not included any data on characterization of the MNMs used before, during, or after incubation, and no attempt to measure the bioavailable Zn or its speciation was made. Furthermore, nano-ZnO did not negatively affect the majority of the parameters investigated (in most cases in fact biological parameters were positively affected). Because proper dose–effect curves cannot be derived from the few concentrations tested, and the results obtained suffered from incongruences, it seems that the results do not support the dramatic conclusions made by the authors. Although it is important to be vigilant and protect agricultural production and ecosystem functions, it is premature to say that deleterious effects such as those the authors suggest may actually occur.

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