

Impact of Emerging Nano-Agrichemicals on the Simultaneous Control of Arsenic and Cadmium in Rice Paddies

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Abstract : Rice paddies are frequently co-contaminated by arsenic (As) and cadmium (Cd), both of which demonstrate a high propensity for accumulation in rice grains and cause global food safety and public health concern. Even though different agricultural management strategies have been explored for their simultaneous control in rice grains, a viable solution is yet to be developed. Interestingly, several nanoagrichemicals, such as the zinc nanofertilizer and copper nanopesticide have displayed strong potential to reduce As or Cd accumulation in rice tissues. In order to determine whether these nanoagrichemicals can lower the accumulation of both As and Cd in rice, a series of bench studies were performed. Our results show that zinc oxide nanoparticles at 100 mg/Kg significantly lowered both As, and Cd in rice roots and shoots in flood irrigated rice seedlings, while equivalent amount of zinc ions only reduced As concentration in rice shoots. Zinc ions significantly increased Cd concentration in rice shoots by almost 30%. The results demonstrate a unique 'nano-effect' of zinc oxide nanoparticles, which is ascribed to the slow releasing of zinc ions from nanoparticles and the formation of different transformation products in these two treatments. We also evaluated the effect of nanoscale soil amendment, silicon oxide nanoparticles (SiO₂NPs) on the simultaneous reduction in both flooding and alternate wet and dry irrigation scheme. The effect of SiO₂NPs on As and Cd accumulation in rice tissues was strongly affected by the irrigation scheme. While 2000 mg/kg of SiO₂NPs significantly reduced As in rice roots and insignificantly reduced As in rice shoots in flooded rice, it increased As concentration in rice shoots in alternate wet and dry irrigation. In both irrigation scenarios, SiO₂NPs significantly reduced Cd concentration in rice roots, but only reduced Cd concentration in rice shoots in alternate wet and dry irrigation. Our results demonstrate a marked effect of nanoagrichemicals on the accumulation of As and Cd in rice and can be a potential solution to simultaneously control both in certain conditions.

Keywords : arsenic, cadmium, rice, nanoagrichemicals

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