



# Visions for a Sustainable Planet

ASA, CSSA, and SSSA International Annual Meetings  
Oct. 21-24, 2012 Cincinnati, Ohio

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## 269-4 Effect of Glyphosate On Zn Adsorption/Precipitation On Aluminum Oxide: A Molecular Scale Study Using Spectroscopic Techniques.

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Tuesday, October 23, 2012: 4:00 PM

Duke Energy Convention Center, Room 207, Level 2



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Agricultural application of large amounts of glyphosate [N-(phosphonomethyl)-glycine] may affect the sequestration and bioavailability of heavy metals in soils due to the strong chelating property of glyphosate (GPS). Here we present how glyphosate influences the sorption of Zn, a typical heavy metal in contaminated soils, on aluminum oxide. Unlike most previous studies that mainly addressed the macroscopic sorption behavior using batch techniques, we focused more on understanding the sorption mechanism at the molecular level with a series of cutting-edge spectroscopic techniques including EXAFS, <sup>31</sup>P NMR and XRD.

Our macroscopic results revealed that at pH 5.5 glyphosate enhanced Zn sorption and higher glyphosate concentrations led to more Zn sorption, whereas at pH 8.0 lower concentrations of glyphosate ( $\leq 0.5$  mM) did not significantly influence Zn sorption, but Zn uptake was suppressed in the presence of higher concentrations glyphosate (e.g. 1mM). The sorption mechanism was well addressed by spectroscopic techniques. In the absence of glyphosphate, EXAFS analysis suggested that Zn adsorbed on aluminum oxide surface mainly as bidentate mononuclear surface complexes at pH 5.5, whereas Zn-Al layered double hydroxides (LDH) precipitates formed at pH 8. In the presence of glyphosate, in contrast, different Zn sorption mechanisms were revealed.

The EXAFS spectra of Zn/glyphosate sorption samples at either pH 5.5 or 8 are very similar, both of which correspond to the  $\equiv\text{AlO-GPS-Zn}$  ternary surface complexes instead of directly binding to the mineral surface. Formation of ternary surface complexes was also confirmed using <sup>31</sup>P solid state NMR spectroscopic analyses, which indicates that the phosphate group of the glyphosate molecules bind with the mineral surface and the carboxyl group binds to chelate Zn. The sequence of adding glyphosate and Zn could affect the sorption mechanism. Especially, at pH 8, Zn-Al LDH precipitates formed if Zn was added first, while no precipitates formed when glyphosate was added first or simultaneously with Zn.

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