2009 CSREES National Water Conference, St. Louis, MO

Mobility of Arsenic and Trace Contaminant Metals in Poultry Litter Amended Agricultural Soils

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Abstract:

Roxarsone (3-nitro-4-hydroxyphenylarsonic acid) is an organoarsenical compound used extensively in the poultry industry to control coccidial intestinal parasites, improve pigmentation, increase feed efficiency, and accelerate growth. The majority of the roxarsone is excreted unchanged in poultry manure, which, when mixed with the wood chips used as bedding material, is applied to nearby agricultural fields as inexpensive, low-moisture fertilizer valued for its high nutrient content and ability to improve soil aeration. Eight fields representing two soil types in McLean County, Kentucky, that had undergone varying levels of poultry litter amendment in the last decade were sampled and analyzed for total arsenic, total metals, and anion concentrations. Two samples of weathered poultry litter were also collected. The objectives of the study were to assess the mobility of the arsenic present in the two soil types and to identify relationships between total soil arsenic and the metals content (Ca, Mg, Fe, Mn, Zn), anion concentrations (nitrate, phosphate, sulfate, chloride) and clay content of the two soil types. It was found that the Karnak silty clay soil contained 6.9-8.1 mg/kg As and total arsenic concentrations were strongly correlated with manganese content ($R^2 = 0.9355$, direct relationship) while showing a weak, direct relationship to the sulfate ($R^2 = 0.6641$). The Belknap silty loam soil contained 4.0-8.8 mg/kg As and demonstrated strong correlations with fluoride ($R^2 = 0.9986$, inverse relationship) from all four fields and chloride ($R^2 = 0.9648$, direct relationship) in three of the fields. Furthermore, arsenic in both soil types was found to be strongly bound to soil particles (> 0.45 micron) during 24, 48, and 72 hour leaching studies with pH neutral deionized water and a variety of filtration scenarios. However, arsenic from the poultry litter samples was very loosely bound and the majority of it was extractable within the 24-hour leach period.

Impact Statement:

Unlike previous studies focusing on poultry litter derived arsenic, we found that the arsenic remains strongly bound to the Karnak and Belknap soils under consideration, thus posing no risk to adjacent surface waters.

Category: Agricultural BMPs
Type: Oral Presentation