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Mitigation of PFAS in Agricultural Fields Using Sorbent Materials

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Per- and polyfluoroalkyl substances (PFAS) are a special class of man-made chemicals that are ubiquitous, recalcitrant and toxic. PFAS get into agricultural soil primarily through wet/dry deposition, irrigation with PFAS-contaminated water, and land application of biosolids. While biosolids are a great source of slow-release nutrients that plants love, the tendency for the bioaccumulation and biomagnification along the food chain of PFAS raises a concern for the sustainable land application of biosolids and continued operation of farms with soils that are already contaminated with PFAS. In this study, we employed immobilization strategies via a series of batch sorption experiments, a column study, a greenhouse study and a field study by using four sorbent materials (pyrolyzed biosolids, ACH-WTR, wood-ash and wood-biochar) for the mitigation of PFAS in PFAS contaminated agricultural soils and land applied biosolids.

Overall results showed that that sorption of perfluoroalkyl acids (PFAAs), including PFHxS and PFOS, increased with increasing ACH-WTR concentrations in batch sorption experiments. In a six-month long column study, leachates from ACH-WTR-amended columns contained 32% less total PFAS compared to those from biosolids-only control columns, with PFOS mobility specifically reduced by 68%. Likewise, amending PFAS-contaminated soils with 6 wt% wood-ash decreased total PFAS uptake in grass leaves by 83% and significantly enhanced plant growth in the 1-year long, multiple harvest greenhouse study. Correspondingly, soil-to-plant translocation factors (TFs) were significantly lower ($P < 0.01$) in the 3 wt% and 6 wt% wood-ash treatments than in the control for most PFAS. First-year field results indicate that both wood-ash and wood-biochar amendments can reduce PFAS uptake into grass leaves, with wood-ash exhibiting greater effectiveness. However, interpretation of the field-scale efficacy will require data from the second-year harvest, as PFAS uptake by plants is influenced by both initial contaminant concentrations and the duration of root-zone exposure.