

Characterization of Nano-sized Colloidal Phosphorus Species in Pipe Drain and Trench Waters from a Fertilized Clay Soil Using Asymmetric Flow Field Flow Fractionation

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Abstract

The speciation of phosphorus (P) was investigated in pipe drain and trench water samples leached from a heavy clay soil under grassland of a dairy farm in The Netherlands. Water samples were collected at three times: (t1) in early spring, when P sources were absent for almost seven months, (t2) when rainfall followed the application of the solid cattle slurry fraction, and (t3) when rainfall followed within one day after dairy slurry application. Concentrations of Dissolved Reactive P (DRP), Dissolved Unreactive P (DUP), and Particulate P (PP) were determined. In addition, Asymmetric Flow Field-Flow-Fractionation (AF4) coupled to ICP-MS and UV-DAD was used to analyse the DUP speciation. Total P (TP) concentrations were highest at t3. At t1, TP concentrations were lowest, and dominated by DUP and PP. At t2 and t3, DRP concentrations strongly increased, and contributed >50% of the TP concentration. At t1 and t2, DUP was dominated by P associated to clay minerals (25-130 nm), with a small contribution of ternary complexes consisting of ortho-P bridged to dissolved organic matter by Al or Fe (1-5 nm). At t3, the presence of organic P nanoparticles was detected (10-50 nm). Based on their specific UV-spectrum, they are likely to be phospholipids, a major and highly soluble component of dairy manure. Since phospholipids can form vesicles >0.45 µm in size, they may explain the elevated PP concentrations measured at t3. In conclusion, the DUP speciation can vary in time and AF4 can be used to unravel the nature of DUP.