Retention and Leaching of Nitrate after Nitrification of Pig Manure on Variable Charge Soil (Nitisol)

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On the island of Réunion (Indian Ocean), livestock manure is commonly recycled by spreading it on crop fields. However, the area is limited and problems of nitrate pollution of groundwater may arise. This study aimed at assessing the risks related with nitrate leaching and retention in a variable charge soil (Nitisol) after pig manure amendment, by quantifying (i) the nitrification of pig manure and the acidification of the soil solution, (ii) the lag times in nitrate and chloride breakthrough curves, and (iii) the amount of nitrate retained in the soil. We constructed 3 large columns filled with a packed Nitisol. The soil moisture, the water potential, and the drainage flow were continuously monitored and stored in a datalogger respectively with TDR probes and micro-tensiometers (17, 30, 55 and 85 cm depth) and limnigraphs at the outlet of the columns. After pig manure amendment on 2 columns, the columns were irrigated with amounts of water corresponding to three years of typical annual rainfall level (3600 mm).
Manure nitrification was rapid and not limited since ammonium concentrations in the soil solution were always very low. Nitrification led to acidification of the soil solution down to 55 cm depth. The chloride and nitrate breakthrough curves differed at all depths. At 17 cm depth, the very clearcut leaching peaks were reached earlier for chloride (0.27 pore volume of water application) than for nitrate (0.43 pore volume) mainly because of nitrification kinetic. On a soil column scale (0–85 cm), lag time differences between these anions were less significant and driven principally by the high competition for anion adsorption in this soil. Nitrate retention can be seen as an advantage since nitrate remains longer available for crop roots; however, it also represents a leaching risk in the long run, since adsorption is a reversible process.