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Vertical Nutrient Fluxes in a Traditional Mountain Oasis of Northern Oman

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Abstract

Little is known about nutrient turnover in irrigated oasis agriculture as a criterion to assess their sustainability over time. Recent data on horizontal fluxes of nitrogen (N), phosphorus (P) and potassium (K) from a representative ancient mountain oasis in northern Oman indicated annual per hectare surpluses of 131 kg N, 37 kg P and 84 kg K. The fate of these surpluses remained, however, unclear. The purpose of this study therefore was to measure vertical nutrient fluxes (gaseous emissions of N_2O, NH_3 and CH_4 and leaching losses of N, P and K) in a farmer's field planted to alfalfa (*Medicago sativa* L.) across space and time. To this end a 12V battery-powered photo-acoustic multi-gas monitor (INNOVA 1312–5) was fitted to a custom-made Teflon-coated PVC cuvette of 0.30 m diameter and 10 l volume. The cuvette contained a battery-powered ventilator and allowed not only direct readings of the afore-mentioned gases in the field but also simultaneous records of the temperature and moisture of the air contained therein at an interval of up to 5 min. Detection limits for N_2O, NH_3 and CH_4 were 20 $\mu g\,kg^{-1}$, 200 $\mu g\,kg^{-1}$ and 400 $\mu g\,kg^{-1}$, respectively. Leaching losses below the major root zone of annual crops following irrigation events were determined with ceramic suction plates and cumulatively with custom-made resin cartridges of 0.11 m surface diameter.

Intensive measurements from spring 2005 with respective minimum and maximum air temperatures of 7 and 42°C yielded gaseous N emission rates equivalent to 2–24 kg N_2O, 1–104 kg NH_3-N and 3–1200 kg CH_4 per hectare and year. These values were strongly dependent on soil temperature and time after irrigation (soil moisture) but to an only smaller degree on the presence of manure compost. Leaching losses amounted to 2–6 % of the applied irrigation water whose nutrient concentrations allowed a first estimation of the range of such losses across the year. While further tests will certainly need to be conducted to assess the precision of these measurements, the results indicate the possibility to obtain real-time measurements of vertical nutrient losses from farmers' fields under difficult agro-environmental conditions with a high emission variability in time and space.

Keywords: Animal manure, gaseous N emissions, nutrient leaching, photo-acoustic gas monitor

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