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Decoupled relationship between diffusive fluxes and concentrations of nitrogen in soil

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Intensive agricultural crop production largely depends on the input of nitrogen (N) fertilizers, at the cost of environmental integrity. Nitrogen pollution derived from inefficient use of fertilizers by agricultural crops is ranked as a foremost global concern. Synchronizing soil N supply and crop N demand addresses this problem, but assessing how much and in which form N arrives at the root surfaces remains a major challenge. Microdialysis can be used to accurately quantify in situ N fluxes, but is of limited suitability for studying field-scale N dynamics due to its miniature design. The objective of this study was to test the possibility of upscaling results from small-scale microdialysis sampling by using soil N concentrations estimated by soil water extractions. We estimated diffusive fluxes and concentrations of ammonium, nitrate and amino acids in an agricultural field used for corn production. Results from soil extraction and microdialysis differed significantly regarding the relative contribution of each N form to total N. Nitrate was the dominant N form (∼80%) in water extracts while diffusive fluxes of nitrate, ammonium and amino acids were similar (38, 34 and 28%, respectively). Surprisingly, diffusive N fluxes were decoupled from N concentrations, i.e. no clear correlation between these two parameters could be found. We propose that other soil physical and biological factors have a stronger influence on diffusive N fluxes than N concentrations alone. Future efforts should be directed into including such factors in more complex modelling approaches in order to assess soil N supply at field-scales.