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Effects of N and P fertilisation on greenhouse gas (GHG) production in floodplain fen peat: A microcosm fertilisation experiment.

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Biogeochemical and hydrological cycles are being significantly perturbed by anthropic activities altering atmospheric mole fractions of greenhouse gases (GHG) and increasing global temperatures. With the intensification of the hydrological cycle, lowland areas, such as floodplain fens, may be inundated more frequently. Rivers in agricultural catchments have the potential to pollute floodplain fens with significant amounts of nitrogen (N) and phosphorus (P); however, the effects of short-term (< 15 days) N and P fertilisation via fluvial inundation on GHG emissions from floodplain fens are poorly understood. The aim of this research was to determine how N (51 mg L-1 NO_3-N) and P (1.4 mg L-1 PO43–P) additions may alter GHG (CO_2, CH4, and N2O) production in floodplain fens of contrasting nutrient status under anaerobic conditions. A five-level (control, glucose (G), N+G, P+G, and N+P+G), fully-factorial microcosm experiment was designed and undertaken in Spring 2013 with peat from two floodplain fens under conservation management with similar vegetation (from Norfolk, United Kingdom). One site receives a higher nutrient load than the other and has a historical legacy of higher N and P contents within the peat.

Results from the experiment showed no significant difference in CO_2 production between the control and fertilised treatments from 0 to 96 hours, but a significant difference between treatments (ANCOVA, between factors: treatment and site; covariate: time; F4,419 = 11.844, p < 0.001) and site (F1,149 = 5.721, p = 0.017) from 96 hours to in the end of the experiment due to fermentation. N2O production only occurred in samples fertilised with N (N+G and N+P+G) due to denitrification. Rates of N2O production were significantly greater in samples from the lower-nutrient site in comparison to the nutrient-rich site (t12= 6.539, p < 0.001 and t12= 7.273, p < 0.001 for N+G and N+P+G fertilised samples, respectively). Fertilisation with N and P had different effects on CH4 production. Samples fertilised with P+G had the highest CH4 production (ANCOVA, between factors: treatment and site; covariate: time; F4,120= 15.026, p < 0.001). Samples fertilised with N (N+G and N+P+G) showed CH4 inhibition in comparison to G and P+G additions. CH4 production was significantly greater from the nutrient-rich peat than from the lower-nutrient peat (ANCOVA, between factors: treatment and site; covariate: time; F1,120= 38.646, p < 0.01). However, a decline in CH4 concentration in the microcosms suggests that CH4 oxidation occurred after 150 hours at the lower-nutrient site. Owing to the anaerobic conditions within the microcosms, aerobic methanotrophy cannot occur, suggesting anaerobic CH4 oxidation occurred along with denitrification. However, NO and N2 concentrations were not measured in this study, so this suggestion requires examination in future work.