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Using ^{31}P-NMR to investigate dynamics of soil phosphorus compounds in the Rothamsted Long Term Experiments

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The technique of ^{31}P-NMR spectroscopy has done more to advance the knowledge of phosphorus forms (especially organic phosphorus) in environmental samples than any other method. The technique has advanced such that specific compounds can be identified where previously only broad categories such as orthophosphate monoesters and diesters were distinguishable. The Soil Archive and Long Term Experiments at Rothamsted Research, UK, potentially provides an unequalled opportunity to use this technique to observe changes in soil phosphorus compounds with time and under different treatments, thereby enhancing our understanding of phosphorus cycling and use by plants. Some of the earliest work using this technique on soils was carried out by Hawkes et al. in 1984 and this used soils from two of the oldest Rothamsted Long Term Experiments, namely Highfield and Park Grass. Here we revisit the samples studied in this early work and reanalyse them using current methodology to demonstrate how the ^{31}P-NMR technique has advanced. We also present results from a study on the phosphorus chemistry in soils along the Hoosfield acid strip (Rothamsted, UK), where a pH gradient from 3.7 to 7.8 occurs in a single soil with little variation in total phosphorus (mean $\pm$ standard deviation 399 $\pm$ 27 mg P kg^{-1}). Soil pH was found to be an important factor in determining the proportion of phosphomonoesters and phosphodiesters in the soil organic phosphorus, although total organic phosphorus concentrations were a relatively consistent proportion of the total soil phosphorus (36 $\pm$ 2%) irrespective of soil pH.

Key words.

^{31}P-NMR, soil organic phosphorus, long term experiments, Hoosfield acid strip