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Soil pH Influences on Microbial Functional Responses to Crop Rotational Management and Field Translocation

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Background

This experiment took place in the Woodland's Field pH Cropping Experiment that is based at SRUC Craibstone, Aberdeen (Top). However, the land had been sold to Aberdeen City Council and there were plans to develop the area into a housing estate. To conserve the experiment, over 450 tonnes of topsoil were transported to a new location; Ashdown Phoenix (Bottom).

Both sites were characterised by Entic Humic Podzols, with a Sandy Loam texture. In Woodland's Field, the pH had been adjusted over the entire duration of the 60 year experiment between the ranges of pH 4.5 to 7.5, in intervals of 0.5, in a linear gradient from North to South. This has since been amended in Ashdown Phoenix, where the pH distribution has now been randomised to minimise field based influences on the experiment. Lime and Ferric Sulphate were used to achieve the target pH for the experiments duration.

Historically, Woodland's Field has generated significant research. Primarily, it was home to some of the first field studies that characterised Ammonia Oxidising Archaea (AOA) that exhibited the amoA and amoB genes (Prosser and Embley, 2002).

Methods

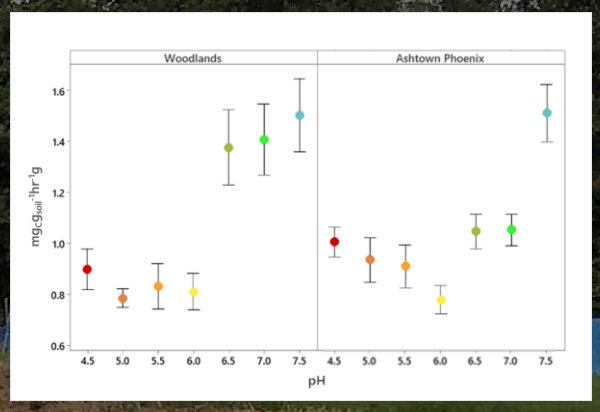
One hundred and sixty eight cores (336 in total) were taken from each treatments and replicate, alongside bulk samples. Additionally, a further 63 cores were taken from Woodland's Field, and a further 56 cores from Ashdown Phoenix were taken to measure the physical properties of the soil.

The bulk samples were utilised to determine the water holding capacity (WHC) of each treatment and replicate. This was then subsequently used to homogenise the 336 cores to 40% of the WHC before they were incubated for 7 days at 25°C.

Following this, samples in batches of 19 were placed inside a BioScientific EGA61 IR Gas Analyser, where the CO_2 emissions were monitored in cycles of 100 minutes over a period of 25 hours.

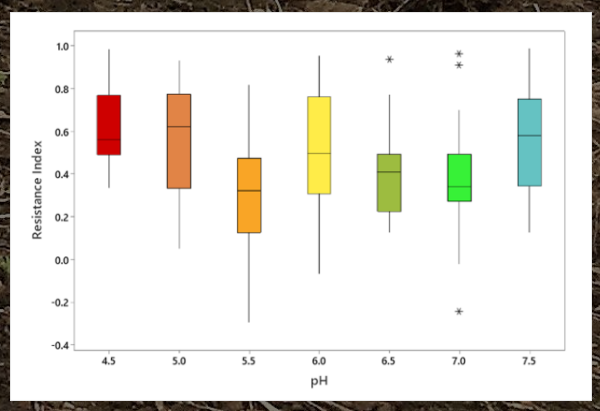
Further to this analysis, the following physical properties were analysed: Bulk density, macroporosity, penetration resistance (to 80cm depth), water stable aggregates, and hydraulic conductivity.

Results



Soil pH had a demonstrable effect on the soil microbial activity, where pH 6.5-7.5 showed the largest volumes of CO_2 efflux compared to other treatments. However, this was not a linear relationship, where the pH 4.5-5.5 showed an increase in comparison to pH 6. Additionally, this pattern was conserved throughout the translocation, which gave a strong indication that the pH was responsible for this relationship.

This inflection is due to a change in the microbial respiration pathways, as the microbes switch from an anaerobic and aerobic respiration mechanism at pH 6.2 (Malik et al., 2018).



Additionally, the microbes in weakly alkaline and acidic soils showed the most resistance to major physical disturbance. This is due to the priming effect of acid stress in the lower pH treatments (Blagodatskaya and Kuzyakov, 2008) and improved soil conditions in the weakly alkaline treatments (Zeng et al., 2021).

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