The utilisation of aminomethyl phosphonic acid (AMPA) by soil micro-organisms as a phosphorus nutrient source

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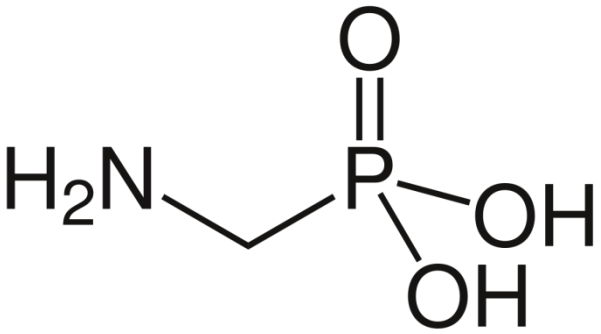
Aminomethyl phosphonic acid (AMPA)

AMPA is a phosphonate compound, which is C-P bonded and exists in soil systems as a result of environmental breakdown processes, reducing conditions and direct industrial inputs.

- Breakdown product of commonly used herbicides
- Contains a covalent C-P bond with high bond energy, therefore phosphorus (P) is difficult to access as a nutrient source
- A reduced P compound (+3 oxidation state)



Why should we investigate AMPA as a P source?

IPCC predicts increased rainfall events causing widespread saturated soils

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Saturated soil environments encourage reducing conditions

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Reducing conditions increase the concentration of reduced P compounds in soil

- Phosphonates are successfully utilised in the marine environment, yet these mechanisms are not widely investigated in the soil environment
- Through understanding the strategies that micro-organisms use to access P in soil systems, it can elucidate the importance of reduced P compounds in the global redox cycle.

The objectives are to determine if soil micro-organisms are capable of utilising P from AMPA and to determine variation in microbial species between aerobic and anaerobic environments.

Methods

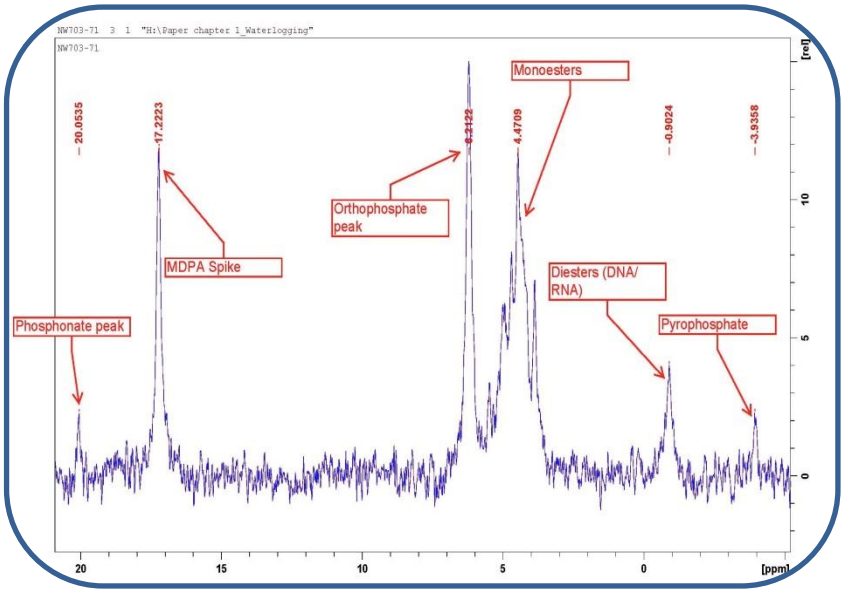
- Samples were collected from Rothamsted long-term experiments across a range of P gradients and soils were characterized using ^{31}P-NMR to identify quantity of phosphonates.
- Soil inoculum grown on media containing AMPA as the only source of P and run alongside controls containing no P.
- Micro-organisms capable of utilising AMPA for growth will be identified using gene amplification and PCR.

Joseph's Carr wetland (Rothamsted Research NW)

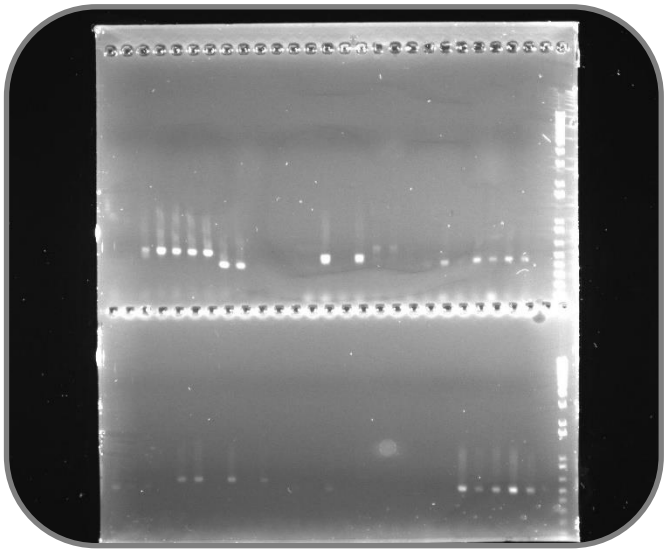
Park grass site (Rothamsted Research)

Highfield wheat site (Rothamsted Research)

Preliminary results



^{31}P-NMR spectra from Joseph's Carr site confirming phosphonate presence



ITS PCR gel electrophoresis run confirming DNA extraction and amplification

- 5 out of 16 sites contained phosphonate compounds within soil samples, with seasonal differences in phosphonate concentration present in certain sites
- Using PCR methods, DNA from 19 bacterial samples was extracted and amplified using 16S primers and 36 fungal samples using ITS primers.

Next steps

- Bacterial and fungal samples to be identified
- Comparisons to be made between soil phosphonate concentration/presence and species abundance
- Species identified in control samples (P free) to be compared to AMPA utilising species
- P management strategies to be discussed in relation to data

further work

- ^{31}P-NMR analysis of all microbial samples
- Determination if certain species are capable of producing phosphonates or simply utilising them

Thank you for viewing this work!

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