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Dynamics of bioavailable nitrogen and phosphorus under elevated CO_2 at a temperate mature forest

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Anthropogenic CO_2 emissions have resulted in elevated CO_2 in our atmosphere, and this rise is predicted to continue1. Increases in CO_2 have fertilised forest ecosystems and led to an uptake of anthropogenic CO_2 into plant and soil biomass, offsetting the concentration of CO_2 in the atmosphere. There is, however, growing evidence that this fertilisation effect may be limited by soil nutrient availability2., Without the buffering effect of carbon uptake by forests, there is potential for further CO_2 rises to continue unchecked. This study assesses the impact of elevated CO_2 on soil bioavailable nitrogen and phosphorus at the BIFoR FACE (Free-Air Carbon Dioxide Enrichment) research facility.

BIFoR FACE is a second generation FACE experiment, and is the first experiment globally set in a mature, unmanaged, temperate woodland in the Northern Hemisphere. The site comprises three replicate control (ambient air) and experiment (ambient +150 ppm elevated CO_2) rings, with CO_2 fumigation raising CO_2 to 150 ppm above ambient levels in the experiment rings, to match the 2050 future atmospheric CO_2 scenario. Changes in soil fertility are monitored using ion exchange membranes3. Anion and cation membranes have been deployed monthly from May 2016 (1 year before CO_2 fumigation) to November 2018. Results are reported for nitrogen (as ammonium and nitrate) and phosphorus (as phosphate).

NH4+, NO_3- and PO43- show strong seasonal trends across the BIFoR FACE site. A comparison of nutrient concentration pre- and post- fumigation shows no significant variation in bioavailable nitrate, ammonium and phosphate concentrations in both control (n=3) and experiment rings (n=3). Post fumigation (April 2017), nitrate was significantly lower in the high CO_2 experiment rings, when compared with the controls. However, there was no difference in soil ammonium and phosphate between control and fumigated rings. These data suggest either an increase in nitrate forest ecosystem demand and/or a decrease in nitrate production under elevated CO_2.

References

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