**Impacts of extreme weather events on soil health and greenhouse gas emissions from agricultural land.**

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The frequency and severity of extreme weather (flooding, drought and extreme heat) events have increased globally in recent decades[1], all of which impact on soil substrate availability (C and N) and the abiotic (e.g., pH, aeration status) and biotic (e.g., microbial activity) factors responsible for greenhouse gas (GHG) emissions. In particular, these extreme conditions effect the resistance and resilience of soil microbial communities and their enzymatic ‘readiness’ responsible for reduction reactions, e.g., via nitrate reductase and nitrous oxide reductase. ***Flooding*** not only increases the risk of CH4 generation, but also results in the accumulation of NH4+ within the soil profile (as mineralization of organic matter continues, but nitrification is inhibited)[2, 3] with factors such as temperature and the presence of organic amendments influencing this. As flood waters recede and O2 diffuses into the anaerobic soil, nitrification of this large pool of accumulated NH4+ results in a prolonged period of enhanced N2O emission[2, 3], which can be greater than fluxes following fertilizer N application under typical soil conditions[3]. Under contrasting conditions, where a period of ***drought*** is followed by intense rainfall, large N2O fluxes have also been observed, e.g., under typical Mediterranean climates [4]. This ‘Birch’ effect, and subsequent N2O pulse, is known to be controlled by mineralization rates and the release of osmolytes[5], with the bioavailability and utilization of substrates by the microbial community primed by the drought and important in overall N2O production and emission. Rewetting from a drier soil state results in larger N2O emissions if soil is sufficiently rewetted, where drought duration and subsequent size of N2O “hot moments” are negatively correlated and non-linear[6]. ***Extreme heat-stress events*** (and fire) also impact soil microbial activity, with a critical thermotolerance threshold identified between 40 and 50 oC, beyond which a sharp decline in microbial carbon use efficiency and nutrient availability is observed and, under laboratory conditions, the microbial community recovers extremely slowly. The frequency of combined extreme events is also increasing in some regions[1], and these combinations could increase GHG emissions further. As such, extreme weather events have significant implications for developing climate-resilient GHG emission inventories and for national environmental targets such as meeting Net Zero. This presentation provides evidence of the impacts of extreme weather events on soil biogeochemistry and GHG emissions.

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