EGU22-5489
https://doi.org/10.5194/egusphere-egu22-5489
EGU General Assembly 2022

Glacial Rock Flour as soil fertility amendment increases N fixation activity in red clover and enhances soil N_2O reduction.

Fotis Sgouridis, Harry Forrester, Sarah Tingey, and Jemma Wadham
University of Bristol, School of Geographical Sciences, Bristol, United Kingdom of Great Britain – England, Scotland, Wales (f.sgouridis@bristol.ac.uk)

The current climate trajectory in conjunction with agricultural intensification and the reliance on synthetic fertilisers, present further threat to the resilience of future food production through their contributions to soil degradation and consequent climatic feedback. Innovative sustainable agricultural technologies are needed to produce nutritious and equitable food products in line with the UN's goal for Zero Hunger and sustainable development. Glacial Rock Flour (GRF) is a fine mineral rock dust, made available through the glacial abrasion of bedrock, and is often enriched in nutrients (e.g. Potassium, Phosphorous, Silicon, trace elements) but low in Nitrogen. It would therefore be a suitable soil fertility amendment for legume crops grown in acidic, nutrient poor soils often found in many mountainous regions (e.g. Hindu Kush Himalaya), where GRF is considered an alluvial 'waste' silting up dams and reservoirs. We have investigated the effect of GRF soil amendments in soil-plant mesocosms using a typical UK silt loam arable soil (pH~7) for cultivating red clover (*Trifolium pratense*) inoculated with *Rhizobium*. GRF from the Chhota Shigri (India) and Sólheimajökull (Iceland) glaciers were applied at 2 and 20 T/ha, while no GRF treatments included synthetic fertilizer applications of phosphorus (P), potassium (K) and P+K, and they were all compared against control red clover plants grown with no soil amendments. The nitrogen fixation capacity of red clover was estimated via ^{15}N natural abundance against a rye grass control (*Lolium perenne*) in two harvests on weeks 14 and 19. Both 20 T/ha GRF treatments appeared to stimulate fixed nitrogen yield compared to synthetic fertilizer treatments and control red clover plants, while the stimulation was more pronounced in the 2nd harvest as the soil nutrients were progressively depleted. Soil greenhouse gas fluxes over the growth period (weeks 4-14) were monitored by enclosing pots in sealed chambers. While no difference was observed in carbon dioxide fluxes between treatments, nitrous oxide (N_2O) flux was negative for all red clover mesocosms with the N_2O reduction being more prominent in both 20 T/ha GRF treatments towards the end of the first growth period (week 14). Gross N mineralization and nitrification were estimated in post-harvest soils from all the mesocosms using the isotope dilution method, while ^{15}N-N_2O and ^{15}N-N_2 production were also measured after amending the soils with 98 at% ^{15}N-NH_4^+ and ^{15}N-NO_3^-. Gross N mineralization was not different between treatments, while nitrification was non-detectable, indicating a very tightly coupled N cycle between *Rhizobium* and red clover. However, when excess nitrate was applied, bacterial denitrification was active but the amendment of the soils with GRF appeared to reduce the production of N_2O and promote complete denitrification to N_2. Our novel study on the properties and application of GRF as a sustainable soil

fertility amendment under a low nitrogen cropping system, holds promise that it can promote leguminous nitrogen fixation and a tightly-coupled N cycle that maximises N-use efficiency while mitigating N_2O emissions by promoting complete denitrification.