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In situ measurement of denitrification (N_2 and N_2O) and greenhouse gas emissions (CO_2, N_2O, CH_4) in conservation agriculture

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Over the last 80 years, intensive agriculture has had numerous consequences globally. In particular, it has led to a loss of soil organic carbon (SOC) and a decline in soil fertility, resulting in higher nitrogen (N) fertilizer application. Excess of fertilizer has driven the emissions of N_2O, a greenhouse gas (GHG) 298 times more potent in inducing global warming than CO_2. Under the UK target of net zero emissions by 2050 and considering the recent increase in fertilizer price, conservation agriculture appears a viable solution to sustain food production whilst reducing global warming. Along with species diversification and reduction (or absence) of tillage, a permanent soil organic cover is the third pillar of conservation agriculture. In particular, "leys" consist in temporary pastures planted in between crops or to restore exhausted soils. These leys are planted with a mix of N fixing plants, which have a unique symbiotic relationship with soil bacteria collectively called "Rhizobia" that transform atmospheric N_2 into organic nitrogen. The mineralization of this organic nitrogen is expected to reduce dependence on N fertilizer. In contrast with the traditional **grass/clover** mix, **herbal leys** have recently gained popularity amongst UK farmers. They consist in a more complex mixture of grasses, legumes and herbs, bringing a range of benefits to forage, livestock health and soil fertility.

Here we report a year's worth of measurement of soil mineral N and SOC contents, N mineralization potential, *in situ* measurement of denitrification (which transforms N fertilizer into N_2O and N_2) and total GHG emissions (CO_2, N_2O, CH_4) from a 4-year-old herbal ley in comparison with an arable field. We measured denitrification with our newly developed method (see Micucci et al., 2022) and GHG with conventional GHG chambers. First results show that during the early growing season (April to June), total N_2O emissions measured from GHG chambers were 10 to 60 times higher in the arable field than in the herbal ley, due to N fertilizer application. Similarly, a high loss of this N fertilizer was observed during April in the form of denitrified N_2.

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