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Carbon dynamics of contrasting agricultural practices

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Application of organic amendments can improve soil quality and provide crop nutrients. To optimise these agricultural benefits from organic applications, the capacity of microbe-driven nutrient and carbon cycling must be understood and exploited. Consideration is therefore required of the complex interactions between the rhizosphere, microbial biomass and organic amendment. We hypothesise that the labile C present in root exudates of plants increases the mineralisation of organic matter in soil, constituting a mechanism to promote nutrient acquisition. This mechanism is known as the 'priming effect', but is poorly understood in the context of agricultural carbon and nutrient management.

Field data from the Centre of Sustainable Cropping (CSC) research platform (Dundee, Scotland, UK) are utilised to build an understanding of soil C and N fluxes between contrasting agricultural practices. The field site uses a split-plot design to compare (i) compost amended soils with reduced tillage and chemical inputs and (ii) conventionally managed soils, reflective of current UK commercial arable practice. Significant differences ($p = <0.001$) were identified between compost amended and conventionally managed soils at field-scale with respect to soil microbial biomass (SMB), total organic carbon (TOC) and mineral nitrogen. Investigation into the priming effect within compost amended soils was subsequently undertaken under laboratory conditions. Stable isotope analysis and measurements of soil biotic parameters were used to quantify priming resulting from Spring Barley (Hordeum vulgare cv. Optic) cultivation for (i) unamended and (ii) municipal compost incorporated soils. Compost treatments comprised amendments of 25, 50 and 150 t/Ha and planted soils were compared with unplanted controls. Soil mesocosms were maintained under controlled environmental conditions within labelling chambers supplied continuously with 13C-depleted CO_2. Throughout a 41-day incubation period, soil CO_2 efflux and dissolved organic carbon (DOC) was collected for quantification and 13C analysis. Following the incubation period, soils and plant material were harvested for nitrogen, carbon and δ13C analyses. Isotopic analyses allowed partitioning of the contributions of plant- and soil-derived organic matter sources to SMB, DOC and soil respiration. The results demonstrate a strong influence of plant-microbe interactions in mediating the mobilisation and mineralisation of stabilised organic fractions in soil, constituting a significant feedback to crop productivity through increased nutrient cycling.