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The role of hedgerows and field margins in agricultural soil functioning

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We compared a range of soil functions between typical hedgerows, field margins and fields in a lowland arable setting in northern England. The fields were either continuously cropped mainly with winter wheat or under permanent grassland for 6 to >50 years. During the growing season (March-August) mean volumetric water content was 3 to 11% less under hedges than the fields (p <0.05), indicative of higher evapotranspiration from hedges. Infiltration rates and soil permeability were also higher (p <0.05) under hedgerows (mean saturated hydraulic conductivity in the top 20 cm of the soil was 170 to 410 times higher under hedges than fields), and on average the hedge soils took 2 hours longer than adjacent arable soils to reach maximum soil moisture content following rainfall. While macropore flow played a significantly greater role in infiltration for the field margin soils, compared to the arable fields, macropore flow was more limited under hedges. Thus hedgerow soils are less likely to suffer from bypass flow or rapid loss of pollutants to groundwater or surface water zones. Average bulk density in the top 20 cm of soil was significantly (p <0.05) lower under the hedgerows (1.20 g cm^{-3}) than in the grassland fields (1.29 g cm^{-3}), margins (1.30 g cm^{-3}) and arable fields (1.35 g cm^{-3}). The organic matter content of soils under hedgerows was significantly (1.51 times) greater than that in arable fields. Dissolved organic carbon concentrations were 2.4 to 6.2 times higher in porewater under hedges than in the fields at depths of 5 cm and 40 cm. Despite fertiliser applications within the arable fields both phosphate and nitrate concentrations between March 2016 and February 2017 were significantly lower within the arable (PO_4-P 0.07 mg L^{-1}, NO_3-N11.0 mg L^{-1}) and grassland fields (PO_4-P 0.19 mg L^{-1}, NO_3-N12.7 mg L^{-1}) than under the hedges (PO_4-P 0.55 mg L^{-1}, NO_3-N28.3 mg L^{-1}). Earthworm abundance was 3 times greater (p <0.05) in grassland fields compared to hedge, margin and arable soils. Earthworm diversity was higher in hedge, margin and grassland soils compared to arable soils, which consisted mainly of juvenile endogeic species. Earthworms under hedgerows tended to be dominated by epigeic litter-feeding species, and the overall low hedgerow abundance was probably due to drier hedgerow soil moisture conditions. Hedgerow soils contain arbuscular mycorrhizal (AM) communities that are distinct from those in arable fields, and the field margins are intermediate, revealing a gradient in composition from hedge to the centre of arable fields. Permanent grassland AM communities were distinct from arable fields suggesting a significant impact of management history on development of soil microbial communities. Our findings demonstrate that soils under typical hedges can provide important functions on farmland storing organic carbon, intercepting rainfall and runoff, and storing water. Their high permeability and low potential for bypass flow means they are likely to be important in trapping sediments and other mobile chemicals that currently contribute significantly to the costs of soil degradation and water pollution in the UK.