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A multi-method approach to characterise and quantify pyrogenic carbon in tropical urban agroecosystems.

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Pyrogenic carbon (PyC) is produced by the incomplete combustion of biomass. It is chemically inert and nutrient-deficient, making it relatively stable in soils. PyC can thus form an important pool of total soil organic carbon (TOC) for C preservation in soils. Despite its significance, data on the nature, level, and relative contribution of PyC to TOC in tropical urban agroecosystems is largely non-existent. In this study, we aim to determine the content and chemical composition of PyC in urban arable soils of Kumasi, a rapidly expanding city in Ghana, West Africa. PyC is likely enriched in these soils, mainly due to soot deposition from traffic, combined with widespread burning of household waste and use of charcoal for cooking.

We sampled topsoils (0–10 cm) from arable fields under four levels of urbanisation intensity (UI), from low to high UI. We employed a range of analytical techniques including visual, chemothermal, thermogravimetric, and biomarker analysis, as well as fourier transformed infrared (FTIR) and nuclear magnetic resonance (NMR) spectroscopy. Visual assessment indicated that ≥80% of all bulk soil samples contained charred macro particles, pointing to PyC enrichment in the urban arable soils. Separating TOC into particulate organic C (POC, ≥63 µm particle size) and mineral-associated organic C (MAOC, <63 µm), chemothermal assessment revealed that PyC contributed less than 0.1% to each fraction under all urban intensity conditions. These PyC levels increased notably along with increasing UI in both TOC fractions. Thereby, median PyC levels in the MAOC fraction (7.8–20.4 mg kg^{-1}) were markedly higher compared to those of the POC fraction (0.1–0.3 mg kg^{-1}). This finding highlight a noticeable PyC contribution to TOC preservations in Kumasi's tropical urban arable soils, although overall contribution is low. Ongoing thermogravimetric, FTIR spectroscopy, NMR spectroscopy, and biomarker analysis will further detail the amount and chemical composition of PyC in these soils. For instance, we will integrate diagnostic ratios of polycyclic aromatic hydrocarbons with masoccharide anhydrides in order to decouple the relative amount of PyC from biomass and that of fossil fuel.

By characterising the chemical nature of PyC with this wide range of analytical techniques, insights into the source and transformation of PyC in a tropical urban agricultural context can be provided. This will lead to better understanding of the role of PyC in the urban soil carbon cycle and its

implications for urban sustainability and global C sequestration efforts.