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Soil C stock is controlled by forest understories in the African tropical forest of eastern Cameroon: a 13C analysis

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African tropical forest is one of the most important conservation areas in the world, both in terms of C pool and biodiversity. Local farmers generally use the forests for slash-and-burn agriculture (3–5 years cultivation and 20–50 years fallow period). To evaluate the effect of agricultural activity on soil C dynamics in African tropical forest, it is necessary to quantify the variation of soil C stocks among croplands, fallow and mature forest, with reference to the contribution of forest understories (mainly C4 grass plants in this region). In this study, we collected soil samples from four pits (100 cm depth) within each of four sites: cropland (Crop), fallow forest (4–7 years: Fallow), young forest (20–30 years: YF) and old forest (>50 years: OF) in eastern Cameroon. We evaluated the soil organic C (SOC) content using the physical fractionation method (0.25–2.0 mm as M-POM, 0.053–0.25 mm as m-POM, and <0.053 mm as Clay+silt). To reveal the C source of each fraction, such as from C4 grass plants and C3 plants (forest), we also measured the δ13C for each fraction, and calculated its contribution to the total soil C stock. We found a significant difference of δ13C values in the Clay+silt fraction (OF & Crop < Fallow < YF), though no such difference was found in M-POM and m-POM. This indicates the rapid decomposition of applied litter and immediate transfer of decomposed OM into the Clay+silt fraction in this region. The SOC stock in 0–40 cm depth decreased as follows: Fallow (86.9 Mg C ha^{-1}) > Crop (76.1 Mg C ha^{-1}) & YF (74.2 Mg C ha^{-1}) > OF (60.0 Mg C ha^{-1}). The C4-plant-derived C decreased in the order YF (36.0 Mg C ha^{-1}) & Fallow (35.5 Mg C ha^{-1}) > Crop (23.9 Mg C ha^{-1}) & OF (18.6 Mg C ha^{-1}) ($P < 0.05$). These results indicate that (1) SOC stock increased from Crop to Fallow as a result of the increase in C4-plant-derived C, suggesting the large contribution of understories to SOC increase in Fallow, and (2) SOC stock decreased from YF to OF under the depletion of C4-plant-derived C, which resulted from the crown closure in OF. Therefore, variation in forest understories (i.e. C4 grass plants) strongly controlled the SOC stock during the fallow period in this area. Moreover, SOC stock was lowest in the OF site because of the low understory biomass.