Geophysical Research Abstracts
Vol. 19, EGU2017-16773, 2017
EGU General Assembly 2017

Carbon dynamics under a maize-Faidherbia albida agroforestry system in Zambia

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Continued crop residue removal for other competing uses such as livestock or household has exacerbated the decline of soil organic matter. Foliar litter from indigenous agroforestry trees such as Faidherbia albida (F. albida) can be a source of organic matter input in resource constrained farmers' fields to mitigate the declining fertility status of many Zambian soils. A controlled incubation study was conducted to evaluate the short term degradability of F. albida litter and maize plant residue. Further, we assessed the effect of F. albida litter and maize residue amendments on microbial biomass carbon (MBC) and enzyme activity. Soils were collected from outside and under the canopies of F. albida trees from six sites with 8, 9, 11, 15, and two sites with > 35-year old trees. Soils from under the canopies were amended with F. albida+maize residue (FMU), F. albida litter (FU), maize residue (MU) and controls were not amended (CTRU). The soils from outside the canopy were amended with maize residue (MO) and controls were not amended (CTRO). These were adjusted to 50% WFPS and incubated for twelve weeks at 27°C to assess C mineralization, microbial biomass carbon (MBC) and enzyme activity (Dehydrogenase, β-glucosidase and β-glucosaminidase activity). The material used as amendment in the incubation experiment had two pools of carbon: a labile and a recalcitrant pool. The mixed amendment FMU had a significantly ($p<0.05$) higher C mineralization compared to the other amendments for all incubated soils. The treatment MU had a higher net C mineralized than FU. However, C mineralization from FU treatment was generally higher in the first 20 days of the incubation period but declined thereafter for all the soils. The net C mineralized from MU did not significantly differ with MO in all except soil from 11-year old trees. Enzyme activity and MBC consistently increased due to amendments for all soils. Enzyme activity was significantly ($p<0.05$) positively correlated with MBC in amended soils. Net C mineralized and microbial activity were high in FMU because of large C substrate added. Indicating a high C mineralization potential, MBC and enzyme activity for soils under the canopy compared with soils outside the canopy. F. albida trees therefore could be a source of labile C in F. albida-Maize systems nevertheless, in the long term, input from other crop residue such as maize and savanna grasses which have a large recalcitrant pool of C are important in sustaining SOC on these fields.