

EGU2020-17848

<https://doi.org/10.5194/egusphere-egu2020-17848>

EGU General Assembly 2020

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Biochar combined with manure application can decrease organic matter decomposition compared to manure alone in the dry tropical cropland of south India

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Soils in the dry tropical croplands of south India are inherently low in soil carbon (C) stock, and it is essential to accumulate the soil C for sustainable soil management. Biochar is generally considered to be a useful material that enhance the soil C stock, though its real effect on soil C dynamics is still unclear especially in the dry tropical croplands such as south India. Thus, our objective was to evaluate the effect of biochar application on soil C dynamics for optimal soil management in south India. Field experiment was conducted in Tamil Nadu state (Inceptisols) from Sep. 2017 to Apr. 2019 (1.5 years), which include two times sorghum cultivation (each 4 months) with six treatment plots (control (C), biochar (B) (8.2 Mg C ha⁻¹), farmyard manure (FYM) (F) (1.1 Mg C ha⁻¹), chemical fertilizer (CF) (100 kg N; 40 kg P ha⁻¹), biochar and FYM (B+F), and biochar and chemical fertilizer (B+CF)). We applied biochar once at the beginning of the experiment to evaluate the effective duration of biochar in soil after application, while we applied FYM every year before crop cultivation. We periodically measured the CO₂ efflux rate (29 times totally) with continuous environmental data including soil moisture (0-15 cm) and soil temperature (5 cm), and estimated the total CO₂ flux as C output, based on the relationship between the CO₂ efflux rate and environmental data. We found that the CO₂ efflux rate in the B+F plot tended to be lower than the F plot throughout the experimental period, though the significant difference between the B+F plot and F plot was only in the cultivation period of the 1st year, in case of using the analysis of variance for each cultivation period separately. We found that cumulative CO₂ flux in the B+F plot (2.2 Mg C ha⁻¹ 1.5 year⁻¹) was also lower than the F plot (2.5 Mg C ha⁻¹ 1.5 year⁻¹), and that biochar and FYM application decreased ca. 0.3 Mg C ha⁻¹ 1.5 year⁻¹ decomposition compared to the application of FYM alone. This might be because combined application of biochar and FYM decreased the soil microbial activity, resulting in the lower FYM decomposition in the B+F plot. Our results indicate that biochar combined with FYM application would effective for soil C sequestration, and hence for sustainable soil management in the dry tropical cropland.