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Carbon Dioxide Emissions from Model Soil Aggregates Incorporated with Organic Amendments: Effects of Organic Matter and Water Repellency

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Model soil aggregates incorporated with organic amendments (OAs) can serve as nutrient-rich potting media. The OAs can induce water repellency (WR) in model soil aggregates restricting moisture availability for the organic matter (OM) decomposition. Decomposition of OM can reduce carbon dioxide (CO_2) emissions temporally due to limited substrate availability to the microorganisms. On the other hand, the decomposition loss of OM can reduce WR, which in turn increases CO_2 emissions. However, the net effects of these OM and WR variations on CO_2 emissions are still unclear. This study explored CO_2 emissions from OAs-incorporated model soil aggregates considering the effects of OM and WR. Surface Ultisol soil from Mapalana, Sri Lanka, was amended with 5 types of air-dried and/or ground OAs (mahogany and casuarina litter at an early decomposition stage, goat and cattle manure less than one week old, compost) at 15% (w/w) rate. Using these samples, uniform model aggregates (1×1×0.5 cm) were prepared and kept under laboratory conditions for over 15 weeks, maintaining initial air-dried moisture contents. Weekly, CO_2 emissions (trapping by NaOH), WR at the same initial moisture contents (persistence; water drop penetration time, degree; sessile drop contact angles), and OM% (Walkley-Black and Loss on Ignition methods) were measured. Both OM% and WR decreased temporally due to decomposition. The CO_2 emissions consistently decreased within the first three weeks (initial stage) and then (later stage) showed emission pulses on certain days. According to ANOVA, the effects of OM% on CO_2 emissions were statistically significant ($p<0.05$) during the initial stage. In the later stage, the statistically significant ($p<0.05$), non-linear, negative correlation between CO_2 emission pulses and the corresponding contact angles indicated that decreasing WR improved water penetration and microbial access, thereby increasing CO_2 emissions. The interaction effects between the OM% and the degree of WR on CO_2 emission pulses were significant ($p<0.05$) in addition to their individual effects in this stage. Overall, the initial CO_2 emissions from OAs-incorporated model soil aggregates were regulated by OM%, while the latter were influenced by both OM% and WR.

Keywords: Carbon dioxide, Decomposition, Model aggregates, Organic amendments, Water repellency