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Greenhouse gas emissions from worm-compost-biochar combinations from farm to production to fork

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Studies on worm-composting or vermicomposting, the addition and use of worms to recycle food and other organic wastes into a nutrient-rich product called vermicast, have shown that when used as soil amendment or activator, they have numerous positive effects on soil physico-chemical properties including: soil aeration, water-holding capacity, nutrient supply and they could be valuable peat substitutes in nursery production. Furthermore, vermicompost is an interesting proposition in the circular economy, particularly with food wastes in peri-urban areas. Despite these advantages, some studies have indicated that worm produce potent greenhouse gases (GHG), notably nitrous oxide (N_2O). It has been suggested that the addition of biochar (BC) to the systems worm-compost-soils could substantially reduce the N_2O emissions. The use of Biochar (BC), a biomass pyrolysis by-product, as soil amendment has been proposed essentially for its vast carbon sequestration potential as a “nature based solution” to combat anthropogenic induced climate change.

In this study, in addition to quantifying the GHG emissions from the entire worm-composting process and assessing the impact of BC addition on the vermicomposting process, particularly the nitrous oxide emissions (N_2O), we determined the potential influence of the timing of the BC addition, whether biochar added before (BC-Compost-worms) or after (Compost-BC-worms) in the initial hot composting process had an influence on overall GHG emission; targeting essentially how biochar (BC) reduces the GHG emissions from the wormication process. We followed right through to the crop production stage using spinach as a test crop, to both determine and compare the N_2O emissions from conventionally grown and organically produced products in a greenhouse experiment. To fully assess and compare these emissions from compost, compost-worms and biochar (BC) additions, we also added a treatment with equivalent inorganic fertilizer using nitrogen stable isotope (^{15}N) labelling with the aim to see the pathway of the fertilizer, matching the nitrogen uptake with observed emissions.

In all seven treatments were established: compost only, compost worms, BC-Compost worms, Compost-BC worms, equivalent inorganic ^{15}N fertilizer, soil only, and soil only no plants. Using a novel experimental set-up and cavity ring down laser based flow through system for analysis we explored the impacts of treatments on both GHG emissions and plant production. Our central hypothesis is that biochar will reduce N_2O emissions from the worm treatments and that, this will lead to greater reductions in worm emissions when BC is added after (Compost-BC-worms) the initial hot composting process than compared to when added before (BC-compost-worms). The results and conclusions of this study will be presented.