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Soil N_2O and CO_2 emission drivers in vineyard (*Vitis vinifera*) under different soil management systems and amendments

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Greenhouse gases emitted from agricultural soils entering the atmosphere must be reduced to lessen negative impacts on the environment. Thus, the effects of different soil management systems and enhancer materials on CO_2 and N_2O emissions were investigated in a long-term vineyard study site. Five treatments were considered in the present study, i) no till management with no fertilizer addition (C), ii) shallow tilled (with rotation hoe) soil with no fertilizer (T), iii) shallow tilled soil with no fertilizer and 2.5% (by weight) biochar applications (T+BC), iv) shallow tilled soil with organic manure addition (T+N), and v) shallow tilled soil with organic manure addition and 2.5% (bw) biochar application (T+N+BC). Soil water and temperature sensors (5TM, Decagon instruments) were placed at 15 and 40 cm below surface. Air samples of CO_2 and N_2O were taken weekly from March to October, 2017 using closed chamber system and analyzed using GC-FID and GC-ECD (respectively).
Tilled soil with no fertilizer nor biochar (T) amendment showed the highest N_2O values, while the lowest were observed in the case of T+N+BC, which was 27.7% less compared to control (C) and 31.9% less than T+N treatments. In overall, CO_2 emissions were the highest in the case of T and T+BC treatments (26.7 and 30.0% higher CO_2 compared to C, respectively) and the lowest in the control and T+N+BC. During the investigated time the total amount of precipitation was 453.8 mm. The lowest average volumetric water content (VWC) were observed in the case of T+BC treatments, while we found the highest water contents in the shallow tilled soil (T) for the upper 15 cm with no significant differences between the different treatments' water content ($p = 0.214$). When analyzing the soil water content in the lower 40 cm, we found that the changes were more pronounced between treatments where between T+BC and T or T+N+BC treatments had significantly different soil moisture values ($p < 0.008$).
We investigated the relationships between soil physical parameters such as soil and air temperature or water content and soil CO_2 and N_2O emissions. In our study, we did not find good correlations between air temperatures or soil water content and N_2O emissions, while in terms of CO_2 emissions weak to moderately strong correlations were observed. Soil disturbance of shallow tillage alone significantly influenced greenhouse gas productions in the present experiment. We also found that biochar amendments can decrease both N_2O and CO_2 emission values from soils.