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Source-process partitioning of soil N2O and CO2 production: nitrogen and simulated exudate additions

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Understanding the source partitioning of carbon dioxide (CO_2) and nitrous oxide (N_2O) fluxes from soil is integral for the characterization of total fluxes and the quantification of potential soil organic matter priming effects. Additionally, we utilized ^{15}N-N_2O site preference data to analyze the process priming of microbial nitrification and denitrification on subsequent N_2O fluxes. A 32-day laboratory incubation was designed to examine the effects of artificial exudate, nitrogen fertilizer and their potential interactive effects on CO_2 and N_2O fluxes, soil organic matter source-priming and N_2O process-priming. Artificial root exudate (ARE) consisting of a mixture of 99 atom% ^{13}C labelled compounds at three addition rates (0, 6.2, 12.5 mg C kg^{-1} soil day^{-1}) was applied daily for 21 days to microcosms with or without urea fertilizer, a subset of which was labelled with 5 atom % ^{15}N. Measurements of CO_2 and N_2O fluxes, isotopic composition and N_2O site preference were frequent throughout the duration of the experiment. Source partitioning of CO_2 fluxes showed that soil organic carbon (SOM-C) positive priming was significantly altered by additions of artificial exudate and urea ($p < 0.001$ and 0.001, respectively). When applied concurrently, urea addition had an antagonistic interactive effect on SOM-C sourced CO_2 fluxes ($p < 0.001$). Source partitioning of N_2O flux data revealed that soil organic matter nitrogen (SOM-N) was positively primed for N_2O flux by the addition of urea fertilizer ($p < 0.001$), but positive SOM-N priming was reduced by an antagonistic interaction with artificial exudate application ($p < 0.001$). Further, examination of ^{15}N-N_2O site preference found that the main processes by which N_2O is formed (nitrification and denitrification) were differentially process-primed by the addition or absence of ARE. Cumulative denitrification and nitrification contributions to total N_2O flux were both positively primed in the soils receiving both ARE and urea inputs relative to a control (50.0 ± 10.1 and 28.2± 8.0 µg N_2O-N kg^{-1}, respectively). In soils receiving only ARE application, denitrification-derived N_2O was negatively primed relative to a control and thus contributed less to overall N_2O flux (-9.5 ± 12.4 µg N_2O-N kg^{-1}) but nitrification-derived N_2O was positively primed (17.2 ± 9.0 µg N_2O-N kg^{-1}).