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REGULAR ARTICLE

Non-additive responses of soil C and N to rice straw and hairy vetch (*Vicia villosa Roth L.*) mixtures in a paddy soil

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Abstract

Aims We studied the effects of mixing rice straw and hairy vetch plant residues in a subtropical paddy soil, on subsequent carbon (C) and nitrogen (N) dynamics.

Methods Using a theoretical framework, we designed two groups of experiments (involving equal amounts of residual C or N addition, referred to as either C or N treatments). Each experiment included mixed residues of rice straw and hairy vetch at different mixing ratios. Soils together with residues were incubated at 25 °C under waterlogged conditions for 100 days. Greenhouse gas (GHG) emissions and soil C and N fractions were measured continuously.

Results Both C and N treatments affected soil C and N dynamics, and these dynamics were quantitatively dependent on residue C/N ratios. The effect of residue mixtures on C and N dynamics could not be predicted from single residues, since there were non-additive effects of residue mixtures. Synergistic effects were generally more frequent than antagonistic effects. Residue mixtures tended to enhance CO_2 and CH_4 emissions in both C and N treatments but decreased N_2O emissions in the N treatment. In the N treatment, dissolved organic C (DOC), dissolved organic N (DON), and microbial biomass C (MBC) concentrations increased. DOC and DON concentrations decreased in the C treatment. Residue mixtures enhanced the global warming potentials (GWP) of greenhouse gases (GHG) emitted from soil by non-additive synergistic effects. The C/N ratio of residue mixtures affected the non-additive responses of soil C and N dynamics, for example mixtures with a C/N ratio of 25 had higher CO_2 emissions and DOC concentrations than those with a C/N ratio of 35 as a consequence of non-additive effects, however, CH_4 emissions and MBC concentrations were higher in mixtures with a C/N ratio of 35 than in mixtures with a C/N ration of 25.

Conclusions These results indicated that non-additive effects can impact soil C and N dynamics and that

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