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Effects of pyroligneous acid on greenhouse gas emissions in rice paddy soil

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Pyroligneous acid (PA) is known to inhibit urea hydrolysis, which delays the release of ammonium (NH_4^+) from urea. Nitrogen fertilizers such as urea contribute to nitrous oxide (N_2O) emissions from agricultural soils. Therefore, PA may enhance the nitrogen use efficiency of crops and reduce greenhouse gas emissions. The objective of this study was to evaluate the effect of PA on greenhouse gas emissions in rice (*Oryza sativa* L.) paddy soil. Urea (U) and slow-release fertilizer (SRF) was used as nitrogen fertilizer to compare the effect of PA with SRF. Soils were treated with no fertilization (Control), conventional urea (U 100%), half amount of conventional urea (U 50%), half amount of conventional urea with PA (U 50%+PA 100), half amount of conventional urea with half amount of PA (U 50%+PA 50%) and half amount of conventional SRF (SRF 50%). Greenhouse gases including methane (CH_4) and N_2O were collected once a week and analyzed using GC-FID and GC-ECD, respectively. The U 50%+PA 50% treatment showed significantly higher CH_4 emissions (56.9 kg ha^{-1}) compared to U 100% treatment (11.4 kg ha^{-1}). Total CH_4 emissions were significantly increased as the amount of nitrogen fertilizer decreased, which might be attributed to reduction in electron acceptor. The U 50%+PA 100% treatment effectively reduced N_2O emissions by 39.7% and 66.2% compared to U 100% (1.21 kg ha^{-1}) and U 50% (2.16 kg ha^{-1}), respectively. Global warming potential (GWP) including CH_4 and N_2O was lowest in the U 50%+PA 100% (584.8 kg CO_2-eq. ha^{-1}). The dry weight of grains showed no significant difference among the treatments except for the Control. Therefore, the half amount of conventional urea application with PA could be an effective way to reduce greenhouse gas emissions while maintaining productivity by increasing nitrogen use efficiency of rice.