

Interactive effects of EC and pH on nitrous oxide emissions and denitrification

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Long-term fertilizer applications and saline water irrigation lead to the accumulation of salts and changes in soil pH. These changes may in turn affect N₂O emissions from soil. Interactive effects of EC and pH on N₂O emissions were studied by using paddy soil in Ushimado, Okayama Prefecture, Japan. Closed incubation experiments were conducted in 100-mL glass bottles for 72 h at 25°C. Each bottle contained 5 g of air-dried soil and 25 mL of solution, which includes KNO₃ (10 mg NO₃-N L⁻¹) and NaCl (0 M, 0.005 M, 0.01 M, 0.05 M, 0.1 M, 0.2 M) for adjusting different electric conductivity (EC) levels under different pH: acid (HCl 0.005 M), neutral (no adjustment), and alkaline (NaHCO₃ 0.005 M). Nitrous oxide concentration in the headspace of the bottle was measured 3 h, 24 h, 48 h, and 72 h after incubation with gas chromatograph (GC-8A, Shimadzu, Kyoto, Japan). After gas collection, the solution was taken out for measuring pH, EC and concentrations of NH₄⁺ and NO₃⁻. Results indicated that pH was a significant factor controlling N₂O emissions ($P < 0.05$). Nitrous oxide emissions were greater in higher EC treatments under the acid treatment. Nitrous oxide emissions peaked at 24 h of incubation and fell sharply afterwards due to further denitrification process. At 24 h, the highest N₂O emissions was measured in 0.2 M NaCl (7.5 mg kg soil⁻¹), followed by in 0.1 M, 0.05 M, 0.01 M, 0.005 M and 0 M treatments, which were 6.7, 5.1, 3.8, 2.0, and 1.2 mg N kg soil⁻¹, respectively. Nitrous oxide reductase was sensitive to both high EC and low pH condition. In neutral and alkaline treatments, there was no significant effect of EC on N₂O emissions during 72 h incubation ($P > 0.05$). The N₂O emissions were 0 mg kg soil⁻¹ at 3 h after incubation then ranged from 0.02 to 0.11 mg N kg soil⁻¹. Ammonium concentration increased over the incubation periods. Higher EC promote NH₄⁺ release. There was no significant difference in NO₃⁻ removal among treatments at different EC levels ($P > 0.05$). We conclude that low pH increased N₂O emissions and higher EC under acid conditions promoted N₂O emissions.

Keywords: Denitrification, EC, nitrous oxide, paddy soil, pH