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How do Metals Affect N_2O Emission from Upland Soil Supporting for Maize?

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Annual nitrous oxide (N_2O) emissions from arable soil have gradually increased due to intensive nitrogen (N) during fertilization. N_2O is emitted during the reduction process from ammonium (NH_4^+) to dinitrogen (N_2). Metals are related with this process and play important role to produce N_2O as cofactor. Therefore, this study was conducted to examine the effect of the metals on N_2O emission in a maize field soil. In an upland soil, maize was transplanted on may 22nd in 2018 and harvested on Oct 4th in 2018. Urea as N fertilizer was applied soon after transplanting of maize. The zero-valent metals including copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) were added at the rate of 187 kg ha$^-$ on may 22nd in 2018. To examine N_2O emissions from the soil gas samples periodically were collected using a closed chamber method. The N_2O flux with metals increased sharply soon after urea application. The peak of N_2O flux appeared with all metal treatment during growing season of maize when water filled pore space (WFPS) was high enough (> 60%) to boost both nitrification and denitrification. N_2O emission might be mainly governed by nitrification process in this study, because WFPS was ranged from 30% to 60% during growing season of maize. This WFPS range is favorable aerobic condition for nitrification. Cumulative N_2O emissions for one year were 28.8, 17.3, 26.0, and 34.4 kg N_2O ha$^-$ with Cu, Fe, Mn and Zn, respectively. Fe was the most effective to reduce cumulative N_2O emission from soil among zero-valent metals. NH_4^+ concentration in soil with metals was significantly higher from that with control at harvest time but, NO_3^- concentration in soil with metals was lower than that with control implying that nitrification process might be prohibited by metals. The order of cumulative N_2O emission from lowest to highest was Fe > Cu > Mn > Zn. This was similar to the order of NH_4^+ and NO_3^- concentrations in soil with metals. In conclusion, metals including Cu, Fe, and Mn were effective to reduce cumulative N_2O emission from upland soil. Further research on elucidating reason why N_2O emission was suppressed by metals should be conducted in the future.

Keywords: Nitrous oxide (N_2O), Metal, Nitrification, water filled pore space (WFPS)
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