Geophysical Research Abstracts
Vol. 21, EGU2019-3611, 2019
EGU General Assembly 2019

Fates of fertilizer nitrogen and gaseous N loss in maize fields in China

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Maize (*Zea mays L.*) is one of most important crops in China, and its cultivation increased rapidly in the last decades. High doses of nitrogen (N) fertilizers are widely applied for high grain yield. Quantifying the fates of fertilizer N, especially the use efficiency by aboveground biomass (NUE) and their losses to the environment and the atmosphere, is critical for local agricultural management. However, up to now, it is not clear on fate of N fertilizer and how and how much the applied nitrogen is lost, particularly by the various forms of gaseous N.

We have conducted six new ^{15}N tracer experiments and combined previous results to evaluate the fates of N fertilizer in maize cropping systems across China. In order to accuracy evaluate the gaseous N loss, a fully automated measuring system was built to simultaneously measure soil N_2O and NO emissions in 2017 and 2018 for a typical maize filed in Northeast China; to identify the source (soil N or fertilizer N) of gases of NO, N_2O and NH_3, another field experiment was conducted in the adjacent field using ^{15}N-labeled fertilizer.

We found that, on average, 34%, 35% and 31% of the applied N fertilizer (averagely 222 kg N ha^{-1}, n = 23) was taken up by crop, retained in the soil and lost to the environment, respectively. The results of the automated measuring system showed that the release rates of NO and N_2O were 9.1 and 2.6 kg N ha^{-1} in 2017, 2.6 and 2.2 kg N ha^{-1}in 2018, respectively. Relatively high NO emission rate in 2017 might been caused by relatively low annual precipitation in that year (437 mm in 2017 and 581 mm in 2018). The results of the static chamber system showed that the release rates of NH_3, NO and N_2O during the maize growing period were only 1.6, 1.8 and 1.4 kg N ha^{-1}, respectively, while NO and N_2O emission using this method being much lower compared to the auto system with high resolution. ^{15}N labeling experiment showed that 67%, 52% and 29% of the released NH_3, NO and N_2O came from the applied fertilizer N. Seasonal patterns of soil NO and N_2O emissions were similar, indicating they were controlled by similar factors. Among the factors, soil temperature and moisture were significantly related to the emissions of NO and N_2O, and soil temperature was significantly controlling the NO/N_2O ratio in this study site.

Key words: nitrogenous gases losses, maize crop, nitrogen fertilization, ^{15}N trace, nitrogen use efficiency (NUE)