Relationships of Nitrous Oxide Emissions to Fertilizer Nitrogen Recovery Efficiencies in Rain-fed Corn Systems: Research Foundation Building

USA-4RN28

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2016 Annual Interpretive Summary

Little is known about relationships between nitrous oxide (N_2O) loss and crop nitrogen use efficiency (NUE) metrics, despite years of past research. It is commonly assumed that higher nitrogen recovery efficiency (NRE) by corn, following nitrogen (N) fertilizer application, will lead to lower N_2O emissions but there has been little direct evidence. Three separate experiments were conducted in 2015 and 2016 with the primary objective to determine the relationships between seasonal N_2O emissions, whole-plant N uptake, and NRE in rain-fed corn under different management systems.

Experiment #1 compared ecological intensification (EI: increased population; 92,000 plants/ha and N application rates: 0, 180, 250 kg N/ha with and without nitrapyrin, a nitrification inhibitor) relative to a more traditional farmers' practice (FP: 75,000 plants/ha and N rates: 0, 110, 180 kg N/ha). Experiment #2 compared long-term tillage (no-till, NT; strip, ST; chisel plow, CP; and moldboard plow, MP) where a single UAN rate was applied with and without nitrapyrin and experiment #3 involved a range of total N rates where intentional late-split N applications at V12-14 growth stages were compared to a single sidedress application. Nitrous oxide emissions were measured two times a week for six to eight weeks following early sidedress UAN application, and then weekly thereafter till maturity. Cumulative seasonal N_2O emissions were calculated. After maturity, corn was harvested (grain and above-ground stover), and both N uptake and NRE were calculated.

Preliminary results indicate that seasonal N_2O emission and its relationship to NRE vary by year and fertilizer management. For experiment # 1, the average seasonal N_2O emission was not higher for EI (2.19 kg N/ha) than for FP (2.12 kg N/ha) despite higher N rates in EI. Across management systems, a negative linear relationship ($p=0.017$) existed between N_2O and NRE and N_2O emissions decreased by 5 g N/ha for every 1% increase of NRE. In experiment #2, across the years, N_2O emissions due to long-term tillage increased in the order of: CP >MP>ST>NT. As found in Experiment 1, the relationship between N_2O and NRE was negatively linear in 2015 and emissions decreased by 14 g N/ha for every 1% increase of NRE in 2015. Nitrogen uptake data for 2016 are forthcoming. The N_2O and N uptake data are still being processed and will be used to assess N rate and timing impacts on these relationships for experiment #3.