Management Matters: Testing a Mitigation Strategy for Nitrous Oxide Emissions on Intensively Managed Grassland

Kathrin Fuchs\(^1\), Lukas Hörttnagl\(^1\), Werner Eugster\(^1\), Nina Buchmann\(^1\), Florian Käslin\(^1\), Patrick Koller\(^2\) and Lutz Merbold\(^1,3\)

\(^1\)Department of Environmental Systems Science, ETH Zurich, Switzerland; \(^2\)MeteoSwiss, Zurich, Switzerland; \(^3\)Mazingira Centre, International Livestock Research Institute (ILRI), Nairobi, Kenya

EGU2017-8094

Motivation

- In order to mitigate global warming it is beneficial to reduce GHG emissions, i.e. nitrous oxide (N\(_2\)O) from agricultural soils
- Management practices including fertilization besides climate variables are the most important drivers of N\(_2\)O fluxes and thus the “regulating screws”
- Biological Nitrogen Fixation (BNF) can replace anthropogenic N inputs

Objectives

- Quantification of the net N\(_2\)O exchange of an intensively managed grassland in Switzerland in a field experiment
- Assessment of the consequences of an alternative management practice on N\(_2\)O exchange
- Estimation of side effects on yields and yield quality

Material and Methods

- Experiment-control study at the SwissFluxnet site Chamau in the Swiss lowlands (CH-CHA, Kanton Zug)
- Eddy covariance (EC) flux measurements of CO\(_2\)/CH\(_4\)/N\(_2\)O/H\(_2\)O exchange, meteorological, soil and vegetation measurements (Fig.1.)
- Management information

Results

- Enlarged N\(_2\)O fluxes were observed following organic fertilizer application in the control parcel (Fig.2). N\(_2\)O flux peaks occurring in the non-fertilized parcel, could be attributed to harvest, rain events and periods of moist soil and high temperatures. Net annual N\(_2\)O fluxes were 46% and 35% reduced at the experimental parcel in 2015 and 2016, respectively.

Conclusions

Significantly lower nitrous oxide fluxes at the experimental management compared to the control parcel indicate that nitrous oxide emissions can be effectively reduced at very low costs with a clover-based management. Longer-term effects on the N budget and implications of the experimental management on animal feed need further evaluation.

Fig. 1. Experimental setup at the SwissFluxnet site Chamau (CH-CHA): The clover parcel is the experimental treatment to bind large amounts of N inputs biological nitrogen fixation (BNF), the control parcel remains under conventional management and is characterized by N amendments in form of organic fertilizer (295 kg N ha\(^{-1}\)) and small amounts by BNF (180 kg N ha\(^{-1}\)).

Fig. 2. (A) Daily averaged N\(_2\)O fluxes, (B) daily averaged CO\(_2\) fluxes, and (C) daily averaged CH\(_4\) fluxes from the control (left, red) and the clover treatment (right, blue) parcel in 2015 and 2016. Shaded areas indicate within-day variability (standard deviations of 10 min fluxes, in contrast to SEM, which are very low and not displayed here). Bold downward arrows and dotted lines indicate fertilization events; upward arrows and solid lines indicate mowing and dashed lines indicate the beginning of grazing events.

Fig. 3. (A) Yields and intake by grazing (semi-transparent) of the control (left) and experimental parcel (right) with total clover yields (saturated). (B) Harvested and grazed biomass. Circles represent the whole vegetation sample, crosses are displaying the remaining biomass after harvest. (C) Clover proportion in dry biomass: (D) leaf area index (LAI); (E) C content and (F) N content in biomass where diamonds represent the legumes, triangles represent non-legumes; (G) Vegetation heights derived from webcam images; (H) Total N removal after harvest (semi-transparent) with amount of N derived from the atmosphere (saturated).