Faculty of Agricultural and Nutritional Sciences
Institute of Crop Science and Plant Breeding
Grass and Forage Science/Organic Agriculture

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Christian-Albrechts-Universität zu Kiel

Nitrous Oxide Emission from high productive grassland as a function of soil compaction and nitrogen fertilization

Schmeer M., Dittert K., Loges R., Senbayram M. and Taube, F.

1. Introduction

- **Soil compaction induces a reduction of macropores → increasing N_2O emission (Sitaula & Hansen, 2000; Yamulki & Jarvis, 2002)**
- **High nitrogen fertilization → increasing N_2O emission (Breitenbeck & Blackmer, 1980; Velthof et al, 1997)**
- **Lack of studies dealing with the simultaneous analysis of soil compaction and high fertilizer input on grassland**
- **Aim of this study: Calculation emissions of CO_2equivalents for a grassland site in Northern Germany with regard to N_2O emission induced by soil compaction and N fertilization**

2. Method:

Experimental site: experimental station „Hohenschulen" (University of Kiel) in Northern Germany; mean annual temperature 8.3°C, mean annual precipitation 777mm
Soil texture: sandy loam – loamy sand
Uniform multispecies grassland with three cuts per year
Experimental design:
split-plot factorial design
Experimental years 2006, 2007 and 2008
3 replicates
Treatments:

- **controlled soil compaction: a. control = zero soil compaction**
  b. soil compaction (= contact area pressure 228 kPa) in early April
- **N fertilization a. 0 vs b. 360 kg N ha^{-1} as calcium ammonium nitrate**
- **Year of initial controlled soil compaction (2006, 2007 & 2008)**

N_2O emissions were measured using the Close-Chamber-method (Hutchinson & Mosier, 1981); daily / weekly measurement

Cumulative N_2O measurements were calculated by linear interpolation between daily/ weekly data

3. Results:

- **2007: dry spring → no increase of daily N_2O emissions caused by soil compaction in spring (fig. 1, left); humid weather in summer → increase of daily N_2O emission in all treatments.**
- **2008 and 2006: humid spring → soil compaction causes a considerable reaction of the daily N_2O emissions in the high fertilized treatments (fig. 1, right; 2006 data not shown, similar to 2008).**
- **In every experimental year N-fertilization in combination with soil compaction causes high cumulative N_2O emissions (fig. 2). Due to the combination of dry spring and humid summer in 2007 high N_2O emission where caused by the N-fertilization.**
- **Due to a high proportion of alfalfa the DM-yields of the not fertilized plots were not statistically different from those of the fertilized treatments (data not shown).**

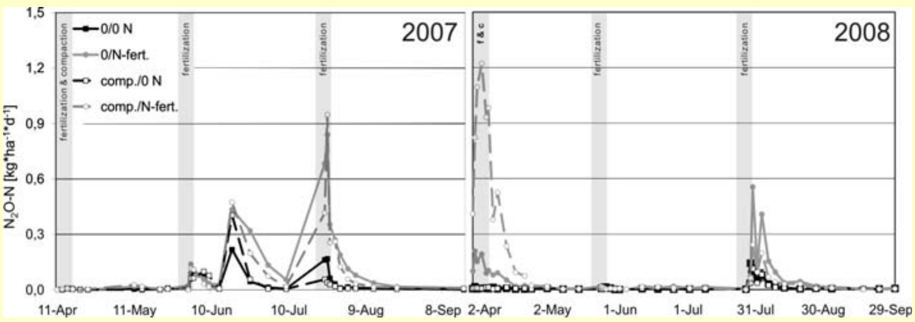


Figure 1: N_2O-flux [kg N_2O-N ha^{-1} d^{-1}] during the measuring period (Apr. to Sept.); the vertical bars represent the combined treatments of soil compaction and N fertilization

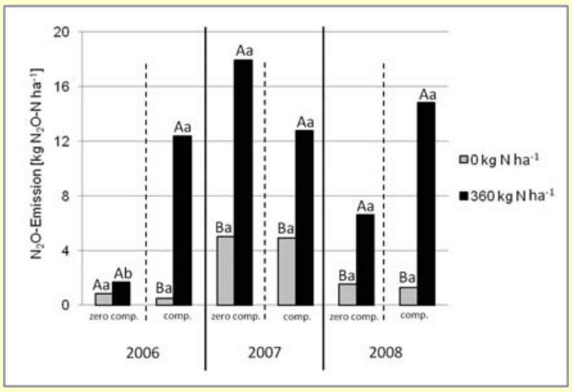
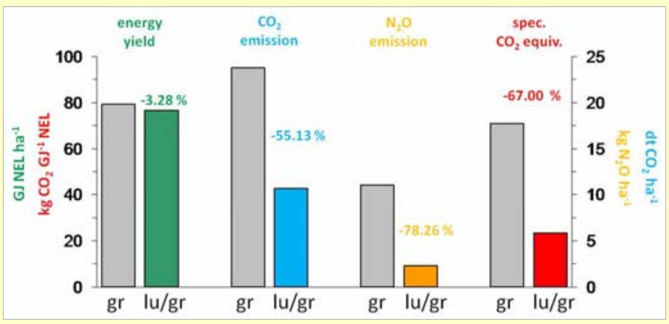


Figure 2: Cumulative nitrous oxide emissions [kg N_2O-N ha^{-1}] for soil compaction and N-fertilization treatments in 2006-2008; Capital letters indicate a significant difference due to the fertilization, lower cases indicate a significant difference due to the soil compaction

4. Conclusion

- **With respect to N_2O emissions on grassland soil compaction has to be avoided especially under wet soil conditions and simultaneous high N-application**



- **Fig. 3 shows the calculation of specific CO_2 equivalents based on energy yield, CO_2- and N_2O- emissions: the nitrogen fertilized treatment emits 67% more CO_2 equiv. per unit harvested net energy than the unfertilized treatment.**

Figure 3: Calculation of CO_2equivalents per unit net energy for the different N fertilization treatments; gr = high N fertilized grassland, lu/gr = zero N fertilized, lucerne dominated grassland; N_2O emission calculated under the assumption of soil compaction of 50 % of the area.

Contact: Msc. agr. Maria Schmeer, 0431/880-7419,mschmeer@email.uni-kiel.de Dr. R. Loges, rloges@email.uni-kiel.de