Management Effects in Organically Grown Clover-Grass on Nitrous Oxide Emissions: Comparison of Mulching and Cutting

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1 Introduction

Organic farming mainly depends on the input of nitrogen by symbiotic N_2-fixation. Clover-grass is one of the most important sources of nitrogen fixation for both organic farm types, those with and without livestock. With stockless farming clover-grass needs to be mulched regularly. This results in N-input and N-recycling already within the growing clover-grass. Due to the limited N-input, it is crucial for organic farmers to prevent N-losses. Therefore the question arises, whether mulching of clover-grass changes N-fluxes as compared to the cutting of clover-grass. The underlying hypotheses of this investigation was that nitrous oxide (N_2O) emissions could be an indicator for such a change.

2 Materials and Methods

The effects of mulching on N_2O-emissions were studied in a field trial of the Bavarian State Research Centre of Agriculture at Viehhausen (30 km north of Munich), which was established in 1997 on an eutric Cambisol. The average temperature and precipitation are 7.5°C and 795 mm per year. During the vegetation period of 2003 N_2O-emissions were measured in clover-grass of two contrasting crop rotations, managed with and without livestock. The closed-chamber method with eight repeated 1.7 L-chambers per plot was used for N_2O-measurements. Samples were retrieved at time zero and after 20 and 40 minutes. Analysis was done with a gas chromatograph (Star 3400, VARIAN, Darmstadt, Germany).

3 Results and Discussion

During the vegetation period of 2003 N_2O-emissions of clover-grass were very high within 1-3 weeks after mulching compared to cutting (Fig 1). Furthermore from mid May until mid October the emission from mulched clover-grass seem continuously elevated compared to cut clover-grass. The total N-losses through N_2O-emission – averaged for the measurement period – amounted to 980 g and 4270 g in cut and mulched clover-grass.

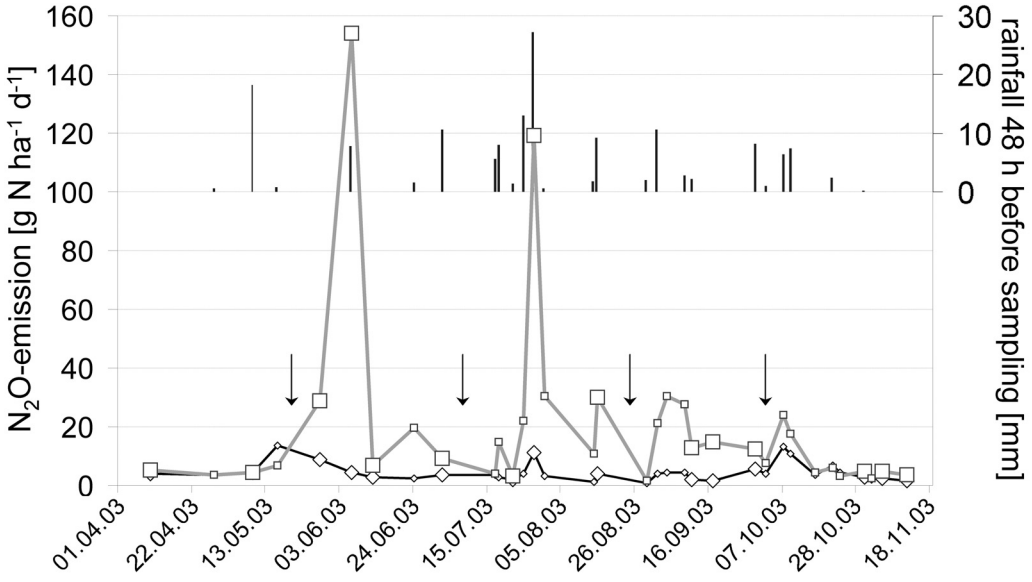

Fig. 1: N_2O-emissions from cut (—◇—) and mulched (—□—) clover-grass. Large symbols indicate that three replicates were measured and small symbols indicate that one replicate was measured. Each replicate consisted of 8 measurements from different chambers. Precipitation data (ıı) is the sum of rainfall within 48h before sampling. Arrows indicate cutting and mulching dates.

The elevated N_2O-emission from the stockless system may have been induced by high microbial activity within the mulch material after rainfall interrupted periods of drought. Mineralisation of light-fractioned organic compounds is likely to occur first in such wetted material, followed by nitrification. This is possibly one of the N_2O-sources. The occurrence of these processes at the high temperatures of in 2003 would have consumed large amounts of oxygen in exchange for carbon dioxide. Densely packed mulch may have reached oxygen-deficient conditions, favouring denitrification processes, which consume the just nitrified nitrate and favour N_2O-production. Taking into account that the dominating product of denitrification is N_2, the additional N-loss induced by mulching might reach more than 10 kg/ha during the measurement period. The relevance of N_2O as an harmful gas makes it imperative for organic farming systems to minimize such losses. Stockless organic farms should therefore be advised to optimise the utilization of the plant material from clover-grass instead of mulching.