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Trace gas emissions from organic fertilisers

A comparison between cattle and pigs slurry

The Hohenheim University research group „Climate relevant gases" has conducted a field trial since 1999 on the measuring of trace gases from field surfaces. In an investigation on the influence of Nr. forms on N_2O emissions two different types of slurry – from cattle and pigs – were studied. It was thus demonstrated that the N_2O-N emissions correlated only very slightly with the distributed NH_4^+ in the slurry. The amount of water brought out with the slurry had a substantially larger influence in this trial.

The greenhouse effect represents a large problem for the environment, and thus also for agriculture. The proportion of N_2O from agriculture is estimated [1] at 47% of total N_2O emissions. Possibilities for reducing this have been investigated in many institutes. Since 1995 at Hohenheim University, a research group has been financed by the German Research Society to investigate trace gas emissions from agriculture and demonstrate ways in which they can be reduced.

Since 1999 a long-term field experiment has been conducted near Hohenheim University on the measurement of trace gases (CO_2, N_2O and CH_4) from field surfaces with inversion and non-inversion cultivations and rotations featuring high and low amounts of legumes. Parallel to this on neighbouring areas, additional trials were carried out to quantify the influences of fertilising and cultivations. One of these trials, in autumn 1999, measured nitrous oxide emissions after distribution of cattle and pig slurry. In this case the influences of different Nr. forms on the emission rates were especially investigated.

Table 1: Chemical composition of brought-out slurry

	HN_4^+ [%]	N_{total} [%]	DM [%]	pH
Cattle slurry	1.45	3.30	7.29	7.5
Pig slurry	3.00	4.93	7.12	6.8

Materials and methods

Emissions were quantified with the Hohenheim measurement system, a so-called „closed chamber" method. The samples were automatically collected from the measurement chamber over an area of 1 m^2 and analysed via gas chromatography. Five samples were taken per closed period. The closed periods represented 20 minutes for the first four closings and one hour for all the following ones. The three variants were cattle slurry, pig slurry (NH_4^+) and pig slurry (N_{total}). The chemical composition is presented in *table 1*. The amount of pig slurry was calculated according to the ammonia content and the total nitrogen content from 2 l/m^2 cattle slurry ($\hat{=}$20 m^3/ha). Thus, the amount brought out for pig slurry (NH_4^+) was 1.34 l/m^2 and for pig slurry (N_{total}) 0.96l/m^2. The three variants were repeated in each case four times. The slurry was brought out with a tanker with

Fig. 1: Hohenheim chamber

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Keywords

N_2O, greenhouse effect, slurry, NH_4, arable land

	cattle-slurry	Pig-slurry N_{total}	Pig-slurry NH_4^+	Coefficient of-correlation r^2
Accumulated N_2O-N-emission after ten days [µg/m²]	233796	135697	97576	
Distributed NH_4 [g/m²]	29.00	40.17	28.78	0.0529
Amount of brought-out slurry [l/m²]	2.00	1.34	0.96	0.9911

Table 2: Emission rates and their correlation with NH_4^+-content and amount of applied slurry

impact plate and worked-in about 5 cm deep by hand with a cultivator.

Results

The N_2O-N emissions of the three variants are – with the exception of the first sampling – not statistically significantly different ($\alpha = 0.05$) which above all was because of the high standard deviation. This phenomenon can be attributed to the area variability of nitrous oxide. The emissions and the standard deviations of one variant (pig NH_4^+) of the N_2O-N during the first 24 hours and the following day (*fig. 2*) confirmed this.

The percentage proportion of emitted N_2O-N of total Nr. was 0.4% (cattle slurry), 0.2% (pig slurry (N_{total})) and 0.3% (pig slurry (NH_4^+)). According to this, the proportion of emitted N_2O-N was relatively small.

The emissions correlated with some chemical characteristics (*table 2*). The results of these calculations showed that the emissions of N_2O-N correlated very slightly with the NH_4^+ content of the slurry. This, however, matched very well with the behaviour of the NH_3 in that NH_3 emissions according to [3] correlate positively with the NH_4+ content and in that NH_3 as a rule shows behaviour contrary to N_2O [4].

The N_2O-N is, on the other hand, positively correlated with the content of the organically linked N. From this it may be assumed that N_2O is mainly produced from the degradation of organic substance and not, as NH_3 is, out of NH_4^+-N.

Additionally, the relatively small amounts of distributed slurry – and, with that, water too – led more to aerobic conditions in the soil. This was also confirmed through the high correlation of emission rate and amount of slurry brought-out, i.e. amount of water distributed. This led to the conclusion that the higher the amount of N_2O produced, the more anaerobic the conditions are, and this matched the generally accepted scientific opinion.

Key conclusions

From these results one can conclude that N_2O emission rates in this trial was more influenced by the amount of water brought-out than from the NH_4^+ content. From this point of view it would appear to be recommendable not to dilute the slurry too much. On the other hand this confirmed the characteristic of N_2O often observed in the past – a tendency to react contrary to NH_3 [4]. There are also trial results in which the N_2O emissions do not correlate with the amount of water brought-out [2]. With this trial, however, the soil moisture was already very high before the beginning of the procedure and this can explain this result – as can the author's own results.

Whether the actual emission of N_2O-N or NH_3-N is higher should now be investigated through further trials.

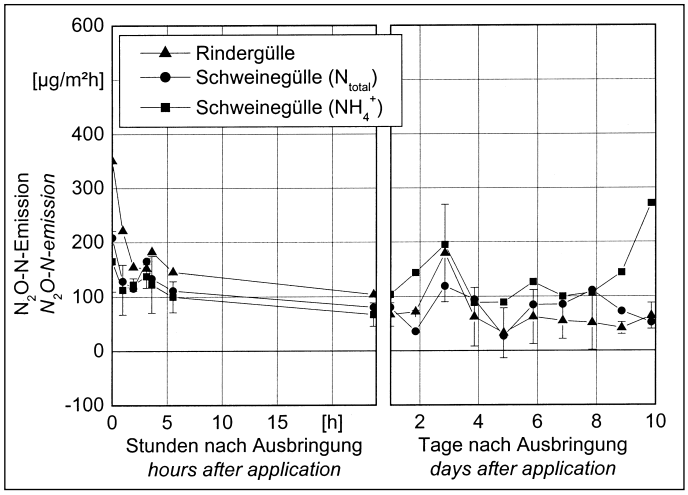

Fig. 2: N_2O-N-emissions during the first 24 h and during the following days after slurry application

Literature

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