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Effect of New Urease Inhibitors on Gaseous N Emissions (NH_3, NO_x, N_2O) Following Surface Application to Arable Soil

Weber A., Gutser R., Schmidhalter U. [a]

[a] Technical University Munich, Chair of Plant Nutrition,
Am Hochanger 2, D-85350 Freising-Weihenstephan

1 Introduction

The potential for gaseous N losses from urea fertiliser following surface application has been recognized for many years. Research on strategies to reduce N emissions after fertiliser application become important with the increasing use of urea and international efforts for air pollution abatement. The release of NH_3 by hydrolysis of urea and subsequently the risk of NH_3 emissions is affected by soil properties (pH, soil texture) and environmental factors (temperature, rainfall). The most important processes related to the production of NO_x and N_2O are nitrification and denitrification. Until now no urease inhibitors (UI), which are easy to handle in practice as granule fertilisers, are available to control urea hydrolysis catalysed by the urease enzyme.

The objective of this study was to determine the reduction of NH_3, NO_x and N_2O emissions in fields after urea application to soil surface by the new developed urease inhibitor P 204/98 compared to the standard NBTPT (N-(n-butyl)-thiophosphoric-triamide). Field experiments were performed in 2002 and 2003 in Weihenstephan, South Bavaria, (800 mm annual precipitation, 7,4 °C temperature) on a silty loam derived from loess. Granules of urea with and without UI were surface applied to winter wheat in several successive applications of 80 kg N ha^{-1} respectively. NH_3 and NO_x emissions were measured continuously during two weeks after each fertiliser dressing by a dynamic chamber method. N_2O emission measurements were done by a closed chamber technique in separate plots up to three times a week (dependent on actual weather conditions) during the vegetation period from tillering to maturity.

2 Results and discussion

The experimental site conditions imply a small risk for NH_3 losses due to the soil characteristics, rather frequent rainfalls and temperate climatic conditions. Nevertheless in both years and all measurement periods, significant differences in the NH_3 emissions were found between UI treatments (Table 1). Urea led to NH_3 losses up to 2,7 kg NH_3-N ha^{-1} representing ~3 % of the applied N. Maximum losses were found in warm and dry periods within 3-6 days following fertilisation. Lower temperature

and rainfall significantly decreased NH_3 losses. The use of UI led to a reduction in NH_3 volatilisation up to 50 %. P 204/98 showed reduction effects comparable to NBTPT.

Table 1: NH_3 and NO_x emissions within two weeks after fertiliser application

Year	Date of Appl.	NH_3 Urea	NH_3 P 204/98	NH_3 NBTPT	NO_x Urea	NO_x P 204/98	NO_x NBTPT	Temp.	Rainfall (day 1-5)
		g NH_3-N ha^{-1}			g NO_x-N ha^{-1}			°C	mm
2002	12 April	522	50	276	58	94	36	8,1	0,9
	26 April	230	191	44	258	208	154	10,7	6,5
	8 May	113	104	165	273	264	295	15,0	21,1
	23 May	139	162	111	45	36	39	13,2	20,3
	av.	251	127	149	159	151	131		
	%	100	50	59	100	95	83		
2003	27 March	190	0	37	141	192	196	5,2	1,7
	8 May	109	110	73	113	234	201	11,9	33,1
	26 May	2730	1454	1899	117	62	148	18,9	0,3
	11 June	587	404	520	265	337	146	19,6	16,6
	av.	904	492	632	159	206	173		
	%	100	54	70	100	129	108		

NO_x emissions varied in the different periods between 36 and 337 g NO_x-N ha^{-1}. Compared to NH_3 the amount of volatilised NO_x was low. NO_x losses were mostly affected by soil conditions (soil temperature, soil moisture). Both UI tended to reduce NO_x volatilisation particularly in periods with high NH_3 losses.

N_2O emissions occurred directly after fertiliser application. The peaks increased marginally when urea stabilised with UI was applied. No differences between the two UI were found. Besides these peaks, losses of N_2O remained at similar low levels within all treatments. There was a weak relation between the levels of NH_3 and N_2O emissions. Reduced NH_3 losses by UI were sometimes accompanied by slightly increased N_2O emissions.

3 Summary

The results of this study suggest that the risk of NH_3 volatilisation is dependent on site conditions in the first days after fertilisation. Under the climatic conditions of South Bavaria the ammonia loss potential is generally small, nevertheless the reducing effect of UI on actual NH_3 emissions was clearly demonstrated. The results show, that promising new substances are available, which effectively inhibit urease activity to abate NH_3 emissions. It is expected, that a combination of UI and nitrification inhibitors may further increase the nitrogen efficiency and environmental compatibility of urea fertilisers.

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