NITROGEN LOSSES FROM ORGANIC AND MINERAL FERTILIZERS IN MODEL SOIL SYSTEM

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Introduction

Diffuse pollution of surface and ground waters water is a major environmental issue in the European Union. Groundwater is rather polluted (Rutkoviene et al., 2005; Muchovej et al., 1995) and pollution with different nutritional matters increases (Kumazawa K., 2002.; Lundin et al., 2000; Mitchell et al, 2003). Agriculture and the agrochemical measures applied by it are an important factor determining dissipated regional pollution and affecting the chemical composition of groundwater. Water for drinking and agriculture use, high in nitrogen compounds is potentially harmful to human and animal health. Therefore, when fertilising fields it is necessary to take into account the rations of fertilisers since the amount of fertilisers used decides the washing out of nutrients (NO_2^-, NO_3^-, NH_4^+) and the quality of groundwater (Rutkoviene et al, 2006). Investigations showed that nitrogen pollution from agricultural sources is characterised by remarkable spatial variability, depending on the interplay of the effects of human driving forces (land use, agricultural demands and activities) with environmental variables (climate, soil and topography) (Filintas et al., 2006). The high fertilization rates and irrigation lead to increased hazards of groundwater pollution. Temporal fluctuation of nitrate concentrations in the groundwater was attributed to seasonal fluctuations in recharge and plant growth too (Costa et al., 2002). Applying the Best Management Practice in fertilizer calculation – based on the environmental circumstances, soil conditions and the plant nitrogen demand – only limited amounts of surplus nitrogen can be detected in the soil-water system after the growing season (Nemeth, 2006).

Material and methods

The investigations were performed in an established site of eight lysimeters. The lysimeters are dug into the ground and their width is 1 m^2. Each lysimeter is connected to the tube and goes to the well, where containers for washed away water. They are filled with monoliths of equal soil. Every lysimeter has shell walls and bottom of waterproof metal, which makes water exchange between lysimeter and surrounding soil or deeper layers of groundwater impossible. The top of lysimeters protrudes 2-3 cm from the surface, which protects their contents from spilling or flowing in of surface water. On the 30th of July 2003 plants growing in lysimeters were fertilized with the following amounts of the ammonium saltpetre (NH_4NO_3): lysimeter No.1 was fertilized with 50 $g(m^2)^{-1}$, lysimeter No.2 was fertilized with 100 $g(m^2)^{-1}$, lysimeter No.3 was fertilized with 150 $g(m^2)^{-1}$, lysimeter No.4 was fertilized with 200 $g(m^2)^{-1}$, lysimeter No.5 was fertilized with 300 $g(m^2)^{-1}$ of sewage, lysimeter No.6 was fertilized with 442 $g(m^2)^{-1}$. No fertilizers were used in lysimeters No.7 and 8 and therefore they were held as control lysimeters. On 13 May 2005 plants growing in lysimeters were fertilized with various amounts of different organic fertilizers: lysimeter No.1 was fertilized with 1 liter of sewage, lysimeter No.2 was fertilized with 2 liters of sewage, lysimeter No.3 was fertilized with 3

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liters of sewage, lysimeter No.4 was fertilized with 4 liters of sewage, lysimeter No.5 was fertilized with 4 liters of sewage, lysimeter No.6 was fertilized with 6 liters of sewage. No fertilizers were used in lysimeters No.7 and 8 and therefore they were held as control lysimeters. The lysimeters were left to irrigate naturally. Samples of water from the lysimeters were taken every two weeks from July to October. They were analyzed at the laboratory of Environment Institute, where water quality parameters NO_2^-, NO_3^- and NH_4^+ values were determined. Assessing significance of differences of parameters washed away from different lysimeters, *Student's t-criterion* was used *(statistical programme STATISTICA)*. If $p > 0{,}05$ the difference was held significant. To define correlation between parameters of water quality and fertilizers used correlation coefficient r were calculated. Statistical significance of correlation was assessed with a coefficient p. If $p>0{,}05$ the difference was held.

Results and discussions

Concentration of ammonium ions in the water of lysimeters is shown in picture 1.

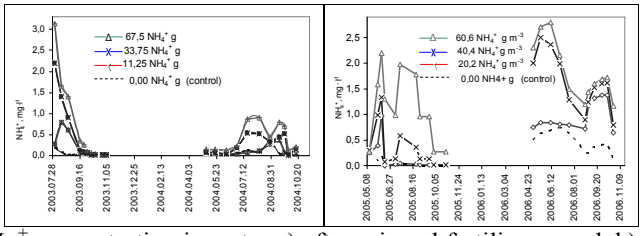

Figure 1. NH_4^+ concentration in water a) after mineral fertilizers used, b) after organic fertilizers used

a b

As it can be seen from data shown in picture 1, concentration of ammonium ions altered depending on the amount of fertilizers applied. The larger amounts of either organic or mineral fertilizers were used, the larger amount of washed away ammonium ions (correlation coefficients $r = 0{,}9465$, $p = 0.000$; $r = 0{,}9839$, $p = 0.000$ respectively). When mineral fertilizers were applied (20 07 2003) maximum quantities of ammonium ions washed away after a week. In one month time, however, the concentration of ammonium nitrogen in lisimetric water decreased significantly ($p < 0{,}05$). The reason for decrease of amount of ammonium ions might be nitrification process, during which ammonium ions transform into nitrites and nitrates. Besides, concentration of ammonium ions was decreasing because during the period of their vegetation plants growing in lysimeters were using it. Maximum concentration values of ammonium ions were observed in July and in the second year of research (2004). In 2004 the amounts of ammonium ions in the lisimetric water were significantly smaller ($p = 0.001$) than in 2003. When organic fertilizers have been used maximum concentration of ammonium ions significantly decreased in June and July of both 2005 and 2006 ($p < 0{,}05$) and increased again in August. Unlikely the situation when mineral fertilizers had been applied, in the second year (2006) after application of organic fertilizers, amounts of ammonium ions in the water of lysimeters was significantly larger than in 2005 ($p = 0{,}000$).

Concentrations of nitrites in the water of lysimeters are shown in picture 2.