LIZIMETRIC RESEARCH OF MIGRATION NITROGEN COMPOUNDS AFTER USE OF ORGANIC FERTILIZERS

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Abstract

Ground water is underground water that has accumulated in watery rocks over the first water-resistant rock layer which is shy this water is less protected from surface pollution especially by fertilizers used in agriculture. Unbalanced application of fertilizers encourages washing nutritional matters out from soil and threatening environmental well-being. The aim of research is to determine regularities of nitrogen compounds migrating into ground water when organic fertilizers are used. For this purpose an eight-lysimeter site was established on educational farm at Lithuanian University of Agriculture. In 2010 organic fertilizers 'Ragų geluonių miltai', 'Ragų drožlės', 'Provita were used in lysimeters. Concentrations of ammonium, nitrates, nitrites and phosphates in lysimetric water were measured. It was found that during the first month of research maximum concentrations of ammonium ions washed away after Provita N90 and Provita N180 had been applied. Concentration of nitrates was the greatest in lysimetric water after Ragų geluonių miltai N180 had been applied. After application of fertilizers Ragų geluonių miltai, a strong negative connection was determined between concentrations of nitrates and total nitrogen. After organic fertilizers Ragų drožlės N270 were applied, a strong positive connection between total nitrogen and pH, as well as concentration of ammonium After fertilizers Provita were applied, strong negative connection was determined between nitrites and pH concentration, as well as a strong positive connection between total nitrogen and ammonium, nitrites.

Key words: *organic fertilizers lysimeter water, nitrogen, nitrates*

INTRODUCTION

Fresh groundwater is a mineral product, which is used in the majority of countries for public supply of portable water (Arustienė et al., 2007). 71 % of the earth surface area is covered with water, 97.2 % of water is not suitable for people, only 2.8 % of all water is fresh – snow and ice, and only 0.6 % of total water amount is portable (Schitz, 1991). Groundwater is the main source of portable water in Lithuania (Arustienė, 2003). The country uses over 1200 public water supply watering places, from which about 3.2 mln. m^3 water is taken per day (Ground..., 2007). Groundwater, gravity groundwater, accumulated in the first aquifer over the first aquitard from the ground surface (Mokrik, 2005). Vadose zone binds the environment with groundwater. This zone filters precipitation by supplementing the groundwater resources. Moreover, the pollutants from the ground surface enter the ground aquifer (Pocienė et al., 2005). In Lithuania the thickness of black-soil layer reaches up to 1.5 m, and groundwater usually occurs at the depth of 1-3 m, its level averagely varies from 0.2 to 5 m, depending on the season (Leonavičiūtė, 1997). Groundwater pollution is predetermined by its shallow resources, so this water is less protected against surface pollution and is especially sensitive to micro-biological and chemical pollution (Panevėžys..., 2004).

Nitrogen leaching depends on black-soil granulometric composition, farming nature, fertilization frequency, type of plants, nitrogen content in black-soil (Adomaitis ir kt., 2004). Intensive farming system is tightly related with the use of mineral fertilizers and other chemical agents. Heavy fertilizing, especially rapidly migrating nitrogen fertilizers, constitutes hazard of groundwater pollution. According to lysimetry research data, 38-43% of groundwater permeates through the loam on the moraine clay. Notwithstanding great harvest loss, it is possible to propagate field plants rationally without using mineral fertilizers. Biological nitrogen, easily released from organic fertilizers, regularly feed s the plants during the whole development period, in contrast with mineral,

which major part is leached (Maikštienė et al., 2001). In order to reduce water pollution, it is necessary to balance nitrogen and apply such fertilization system, which would provide the plants with sufficient plant nutrients and would not pollute nature. The plant nutrients, entered imbalanced fertilized soil, will accumulate in plants and leached from black-soil, so constituting hazard to the environment welfare (Mažvila et al., 2006).

The research objective is to evaluate the regularity of nitrogen compound migration to groundwater after the use of ecological fertilizers.

RESEARCH METHOD (METHODS)

Research object – lysimetric water. The Territory of Aleksandras Stulginskis University training farm is equipped with a site of eight lysimeters, where the tests were carried out. Lysimeters are fixed in the ground; their width makes $1m^2$. They are filled with uniform black-soil monoliths (about 70% of black-soil consists of sand clay, 30% - of light loam). Each lysimeter is connected with a pipe, leading to the well, equipped with eight leached water collection tanks. Lysimeter body walls and bottom are made of metal, so they do not permeate water, and surrounding black-soil and bottom groundwater layers do not have contact. Metal lysimeter body outstands from the black-soil surface by 2-3 cm, so protecting against surface water inflow. In June 2010 the lysimeters were fertilized – 1 lysimeter – the norm of active nitrogenous material in Horn core powder N180, 2 lysimeter – the rate of active nitrogenous material in horn core powder N90, 3 lysimeter – The rate of active nitrogenous material in Horn powder N270, 4 lysimeter– the rate of active nitrogenous material in horn powder N90, 5 lysimeter – the rate of active nitrogenous material in horn powder N180, 6 lysimeter – the rate of active nitrogenous material in Provita N180, 7 lysimeter – the rate of active nitrogenous material in Provita N90, 8 lysimeter – control.

The lysimieters are left for natural moistening. The samples were tested in the Environmental Laboratory of the Environmental Institute; the following indices were determined: NH_4^+ ; NO_2^- ; NO_3^- ; N total and pH.

The data were processed using "STATISTICA" software, and so the lysimeter water quality was evaluated. Student's t-criterion was used for checking the importance of differences in alteration of the determined water quality rates. If $p > 0.05$ – the difference is significant.

RESULTS

Concentration of ammonium ions in lysimetric water shown in Figure 1

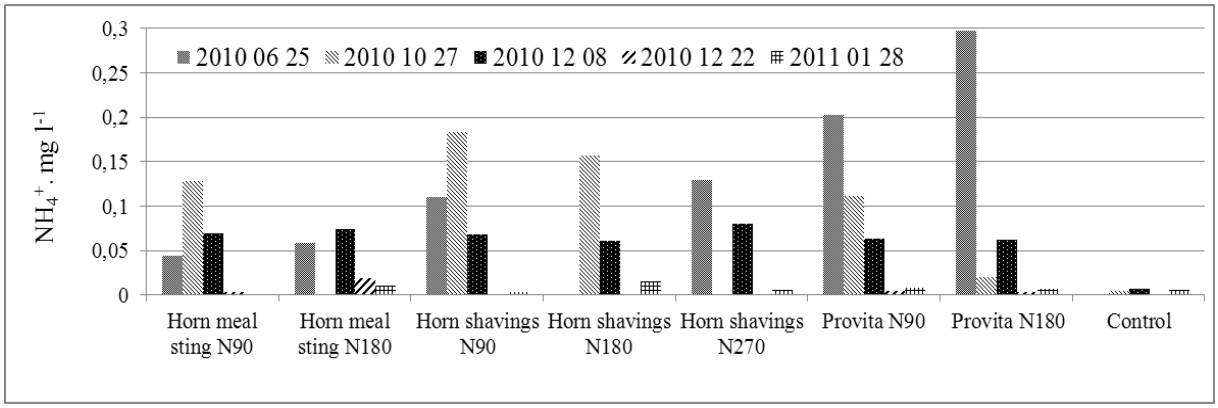


Fig 1. Concentration of ammonium ions in washed away water June 2010- January 2011

It can be seen from the data provided on figure 1 that the content of ammonium ions in lysimetric water was different in different seasons of the year. While using ecological fertilizers during the first research month maximum ammonium ion content were obtained in lysimetric water, which lysimeters were fertilized with Provita N90 and Provita N180. In four months of research maximum ammonium ion content were established in the lysimetric water after the use of horn powder fertilizers. Ammonium ion content, established during the research period, were great, comparing with the control lysimeter (fertilizers were not used) after the use of all ecological fertilizers.

Nitrate concentrations in lysimetric water shown in Figure 2

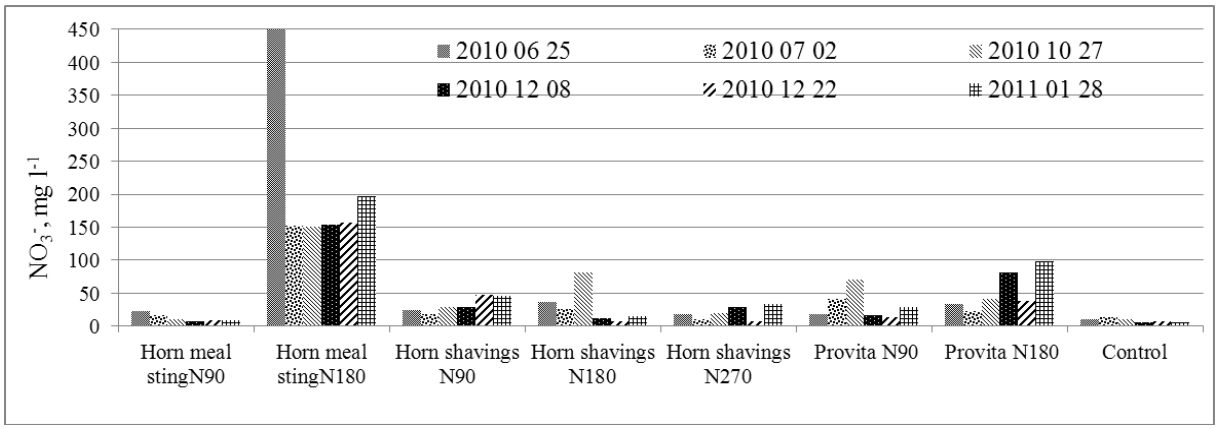


Fig 2. Nitrate concentrations in lysimetric water in June 2010- January 2011

It can be seen from the data provided on figure 2 that the major nitrate content in the water is from the lysimeter, fertilized with horn core powder N180. It was especially high during the first month after the use of fertilizers. Other fertilizers, used at the same time, migrated to the water similarly (differences were insignificant, $p > 0.005$), but nitrate content in the lysimetric water was greater, comparing with the control lysimeter.

Correlation of the water quality indices were evaluated as correlation coefficients, provided on table 1.

Table 1. Water quality indicators correlation matrix

	$N_{(total)}$		**pH**	***NO_3^- mg l^{-1}***
Horn meal sting N90				
NO_3^- mg l^{-1}	r= -0,739; p= 0,049		r= 0,745; p=0,049	
Horn meal sting N180				
pH	r= 0,850;p= 0,032			
Horn shavings N90				
NH_4^+ mg l^{-1}				r= -0,792;p= 0,065
NO_3^- mg l^{-1}	r= -0,812; p= 0,049			
Horn shavings N180				
NH_4^+ mg l^{-1}				r= 0,797; p= 0,048
Horn shavings N270				

pH	r= 0,787; p= 0,043			
NH_4^+ mg l^{-1}	r= 0,751; p= 0,045			
Provita N90				
NH_4^+ mg l^{-1}	r= 0,882; p= 0,020			
NO_3^-mg l^{-1}			r= -0,808; p= 0,045	
Provita N180				
NH_4^+ mg l^{-1}	r= 0,877; p= 0,022			
NO_3^-mg l^{-1}			r= -0,924; p= 0,008	
pH	r= 0,823; p= 0,044			

Values of correlation coefficients : 0.8 – 1.0 – very good correlation; 0.6 – 0.8 - good correlation; 0.4 – 0.6 – average correlation; 0.2 – 0.4 – weak correlation; 0.0 – 0.2 – no correlation; Correlation statistically significant when $p< 0.05$.

After the use of horn powder N90 ecological fertilizers strong negative relation was established between nitrates and total nitrogen content (r= -0.7399, p= 0.049), strong positive relation between pH and nitrate content (r= 0.7452; p=0.049).

After the use of horn core powder N180 ecological fertilizers strong negative relation was established between nitrites and total nitrogen, pH content (r= -0.9467, p= 0.004; r= -0.9505, p= 0.004), strong positive relation between total nitrogen and pH (r= 0.8502, p= 0.032).

After the use of horn powder N90 ecological fertilizers strong negative relation was established between ammonia, nitrate and total nitrogen content (r= -0.792, p= 0.0649; r= -0.8117, p= 0.049).

After the use of horn core powder N180 ecological fertilizers strong negative relation was established between nitrites and ammonia ion content (r= 0.7968, p= 0.048).

After the use of horn powder N270 ecological fertilizers strong negative relation was established between total nitrogen and pH, ammonia (r= 0.787, p= 0.043; r= 0.7512, p= 0.045).

After the use of Provita N90 and N180 ecological fertilizers pH value had impact on nitrate oxides. The less the value is the more nitrate content in lysimetric water.

After the use of Provita N90 ecological fertilizers strong negative relation was established between nitrates and pH content (r= -0.8079, p= 0.0449), strong positive relation between total nitrogen and ammonia (r= 0.882, p= 0.020).

After the use of Provita N180 ecological fertilizers strong negative relation was established between nitrates and pH content (r= -0.9238, p= 0.008), strong positive relation between total nitrogen and ammonia, pH (r= 0.877, p= 0.022; r= 0.8234, p= 0.044).

After use of various ecological fertilizers mineralization and migration of nitrogen compounds in lysimetric water passes differently.

CONCLUSIONS

Maximum ammonia ion content in lysimetric water was established during the first months after the use of Provita N90 and Provita N180 fertilizers.

Maximum nitrite content in lysimetric water was established after the use of horn core powder N180 fertilizers.

After use of various ecological fertilizers mineralization and migration of nitrogen compounds in lysimetric water passes differently. After the use of horn core powder strong negative relation was established between nitrate and total nitrogen content; after the use of horn powder N270 strong positive relation was established between total nitrogen, pH and ammonia ion content; after the use of Provita fertilizers strong negative relation was established between nitrate and pH content, and strong positive relation between total nitrogen and ammonia ions.

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