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НОВЫЕ МЕТОДЫ И РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЙ ЛАНДШАФТОВ В ЕВРОПЕ, ЦЕНТРАЛЬНОЙ АЗИИ И СИБИРИ

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This monograph shall inform you about up to date methodologies and recent results in landscape research. It is intended as a guide for researchers, teachers, students, decision makers, stakeholders interested in the topic of landscape science and related disciplines. It provides information basis for decision makers at various levels, from local up to international decision bodies, representing the top level of landscape science in a very short form.

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Глава III/10: Минеральный азот в почвах различных сельскохозяйственных культур Литвы

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ABSTRACT. The concentration of mineral nitrogen in the main root zone of crops is very important for plant growth, development and yield, therefore our study set out to explore the regularities of mineral nitrogen distribution in the soils of various origin as influenced by different terrain and soil texture. The study was carried out in three soil regions where mineral nitrogen concentrations were comprehensively estimated in relation to the terrain, moisture regime, soil group, soil texture. It was determined by research, that higher mineral concentrations will accumulate in the terrain of plains, on footslopes of hills, in gleic and in heavy-textured soils with higher humus status. Lower mineral nitrogen concentration is expected to accumulate in acid, erosion-affected soils.

Резюме. Концентрация минерального азота в основной корневой зоне сельскохозяйственных культур очень важна для роста, развития и урожайности растений, поэтому наше исследование посвящено изучению закономерностей распределения минерального азота в почвах различного происхождения под влиянием различных ландшафтных условий и гранулометрического состава почвы. Исследования проводили в трех почвенных регионах, где концентрация минерального азота были всесторонние изучены в зависимости от ландшафта, водного режима, типа и гранулометрического состава почвы. Было установлено, что более высокие концентрации минерального азота накапливаются на раввинных территориях, склонах холмов, в глеевых и в сильноструктурных почвах с более высоким уровнем гумуса. Предполагается, что более низкая концентрация минерального азота будет характерна для кислых и эродированных почв.
**INTRODUCTION**

The optimisation of nitrogen fertilization is one of the most important tasks in agriculture aiming to prevent nitrate pollution of the environment and to achieve high crop yields [1]. Mineral nitrogen content in the soil is usually measured in early spring and based on the obtained results, nitrogen fertilization rates are calculated. Soil mineral nitrogen content is also measured in the autumn in order to know the amount of mineral nitrogen or only nitrates left after the cropping season - before winter [2, 3]. Soil N\textsubscript{min} is very mobile due to the fact that a large part of it is in the nitrate form; therefore it is difficult to precisely forecast the amount of it in the soil as well as to foresee its content fluxes in the long term [4]. N\textsubscript{min} content in the soil is affected by a range of factors: precipitation levels influencing the leaching of nitrates into the deeper soil layers, soil and air temperature influencing the rate of organic matter mineralization, soil texture and typology, amount of organic matter in the soil, crop grown, amount of plant residues left in the field after harvesting, organic and mineral fertilization rates and other factors [5, 6, 7]. Heavy-textured soils, containing more clay and silt particles, tend to accumulate higher concentrations of mineral nitrogen than light-textured soils, from which nitrogen migration is the most intensive [8, 9, 10]. The high concentration of N\textsubscript{min} in the soil measured in the autumn often markedly decreases by spring, therefore moderate nitrogen fertilization and cultivation of catch crops during the autumn-winter period reduce nitrate leaching losses [11, 12, 13].

**Research objective** – the study set out to explore the regularities of mineral nitrogen distribution in the soils of various origin as influenced by different terrain and soil texture.

**MATERIAL AND METHODS**

For mineral nitrogen investigation in a soil region, in different soil groups we selected three objects present in different zones of the country in the soil region characteristic of that zone. Research was done during 2011–2014 in the fields situated: 1) in Western Lithuania Zone, in the western part of the soil region of Middle Žemaičiai Upland and Western Kuršas Upland (x 409428; y 6158486); 2) in Middle Lithuania Zone, in the soil region of Lower Nemunas Plain (x 435370; y 6062869); 3) in Eastern Lithuania Zone, in the soil region of Baltic Upland’s Western Plateau (x 574244; y 6158473).

In Western Lithuania Zone, in the western part of the soil region of Middle Žemaičiai Upland and Western Kuršas Upland, seven test plots were chosen in the fields differing in soil type and soil cover: 1 plot – Eutric Gleysols (GLE), soil texture – L/L/LS, 2 plot – Hapli-Endohypogleyic Luvisols (LVg-n-w-ha) – L/L/SL, 3 plot – Endohypogley-Eutric Planosols (PLE-gl-n-w) – SL/LS/L, 4 plot – Hapli-Endohypogleyic Luvisols (LVg-n-w-ha) – L/LS, 5 plot – Fluv-Eutric Cambisols (CMe-fv) – L/L, 6 plot – Haplic Luvisols (moderately eroded) (LVh-em) – C/CL/L, 7 plot – Haplic-Albic Luvisols (LVa-ha) – C/CL/L [14, 15, 16].

In Middle Lithuania Zone, in the western region of Lower Nemunas Plain, seven test plots were chosen in one field differing in soil type: 1 plot – Endocalcaric Gleysols (GLk-n), soil texture – CL/C, 2 plot – Calcari-Endohypogleyic Luvisols (LVg-n-w-ha) – L/CL/L, 3 plot – Bathihypogleyi Calcariic Luvisols (LVk-gld-w) – L/L, 4 plot – Calcarii-Endohypogleyic Luvisols (LVg-n-w-ha) – L/CL, 5 plot – Orthogleyic Planosols (PLE-or) – SL/S/L, 6 plot – Haplic Luvisols (slightly eroded) (LVh-el) – L/L, 7 plot – Fluv-Eutric Fluvisol (FLe-fv) – CL/C [14, 15, 16].

In Eastern Lithuania Zone, in the soil region of Baltic Upland’s Western Plateau, five test plots were chosen in one field differing in soil type: 1 plot – Orthieutric Planosols (PLE-or) soil texture – SL/S/L, 2 plot – Eutric-Haplic Arenosols (ARh-eu) – SL/S, 3 plot – Haplic Luvisol (slightly eroded) (LVh-el) – L/CL, 4 plot – Eutric-Gleyic Fluv Fluvisol (Fly-eu-gl-n(w)-w) – SL/SL/S, 5 plot – Calcarii-Epithogleyic Luvisols (LVg-p-w-cc) – L/CL [14, 15, 16].

Each test plot was replicated three times. The number of replications was chosen taking into account the expected differences between the treatments and the available resources. Soil samples were taken in spring (at the end of March – beginning of April), in summer (at the beginning of June) and in autumn (at the end of October-beginning of November) from 0–60 soil layers, from 10×10 m test plots. One composite soil sample was made of 4–6 subsamples, it was then thoroughly mixed, placed into a plastic box or a plastic bag and put into the specially suited cooled bag. These sample-containing bags were brought to the laboratory, where the collected samples were kept in a refrigerator at 1–3°C. The content of nitrate and ammonia nitrogen in the tested soil sample was measured in accordance with the national standard ISO 14256–2:2005 the soil sample was dried, then the 1:2.5 1 M KCl extraction was...
made. Nitrate and amonia nitrogen content in the obtained filtrate was determined using Fiastar 5000 Analyser.

The relationship between the variables was assessed using the correlation-regression analysis method. The **STATISTICA 7** programme was used for correlation coefficients and ratios and for expression of the relationship between the objects of the research (Čekanavičius, Murauskas, 2002; Sakalauskas, 2003; Hill, Levicki, 2005). The following symbols were used in the work: ***, ** and * – statistically significant differences at 99.9; 99 and 95 % confidence level respectively.

**RESULTS AND DISCUSSION**

During the experimental period (2011–2014), in Western Lithuania Zone, in the soil region of Middle Žemaicių Upland and Western Kuršas Upland, the mineral nitrogen fluxes in various soil groups in different seasons of the year (spring, summer and autumn) were found to vary considerably. Low concentrations of $N_{\text{min}}$ were present in the gley soils prevalent in the lowland terrain (plot 1) and gleyic soils prevalent in plain terrain (plot 2). These concentrations amounted to, on average, 5.6 and 4.5 mg kg$^{-1}$ respectively in 0–60 cm layer during the experimental period (Fig. 1).

Soil texture had a significant effect on mineral nitrogen fluxes. In light-textured sands with deeper lying moderately heavy loam (plot 3), the average $N_{\text{min}}$ concentration over experimental years was 7.2 mg kg$^{-1}$, while in heavy-textured moderately heavy loams (plot 4) $N_{\text{min}}$ concentration was higher – 11.2 mg kg$^{-1}$ (Fig. 1).

The highest $N_{\text{min}}$ concentration (on average 11.5 mg kg$^{-1}$) accumulated in the soils of footslopes of hills (plot 5), markedly lower $N_{\text{min}}$ concentrations (5.7 mg kg$^{-1}$) were found in the eroded soils of hill slopes (plot 6), and in the planes of hilltops in the spots less affected by erosion (plot 7), $N_{\text{min}}$ concentration amounted to 7.9 mg kg$^{-1}$ (Fig. 1).

**Figure 1** - Average mineral nitrogen concentration in 0–60 cm layer of Žemaitija and Kuršas Upland soils in Western Lithuania Zone (2011–2014)

During the experimental period (2011–2014), mineral nitrogen concentration in Middle Lithuania Zone in the soils of Lower Nemunas Plains differed between the seasons (spring, summer and autumn), and compared with that in the soils of other zones, was higher. The lowest average $N_{\text{min}}$ concentration 7.0 mg kg$^{-1}$ in 0–60 cm soil layer was established in alluvial-deluvian soils (plot 7) (Fig. 2).

Soil texture had a significant effect on mineral nitrogen changes. In light-textured soils (plot 5), average $N_{\text{min}}$ concentration amounted to 7.8 mg kg$^{-1}$ (Fig. 2). In heavy-textured soils (plot 4), $N_{\text{min}}$ concentration was higher – 9.5 mg kg$^{-1}$, i.e. by 1.7 mg kg$^{-1}$ higher compared with that in the light-textured soils.

High $N_{\text{min}}$ concentration was recorded in gley, gleyic and in adjacent not water-logged soils (plots 1, 2 and 3) – 9.6, 8.6 and 8.1 mg kg$^{-1}$, respectively.
Mineral nitrogen fluxes in Eastern Lithuania Zone in the soil region of Baltic Upland’s Western Plateau markedly varied between the seasons of the year (spring, summer and autumn) and depended on soil group and texture. In autumn, higher $N_{\text{min}}$ concentration 5.9 mg kg$^{-1}$ was noted for Eutri-Haplic Arenosols (Fig. 3). During the whole experimental period, higher average $N_{\text{min}}$ concentrations – 5.6 mg kg$^{-1}$ accumulated in Eutric Fluvi Fluvisols (Fig. 3).

In heavy-textured ($p_1/p_2$) soils (plots 3 and 5) $N_{\text{min}}$ concentration was lower – 4.8 and 4.6 mg kg$^{-1}$, respectively. However, during the autumn-winter period mineral nitrogen fluxes were lower compared with those in the soils with light texture.

The relationship between the crop yield and mineral nitrogen concentration ($x_i$; mg kg$^{-1}$) was best reflected by the linear regression equations. In Western Lithuania Region, in the soil region of western part of Middle Žemaičių Upland and Western Kuršas Upland and Eastern Lithuania Zone in the soils of Baltic Upland’s Western Plateau the correlation coefficients indicating the strength of the correlation were moderately strong and strong: $r = 0.69$ (p=0.003), $r = 0.73$ (p=0.005), respectively and significant at 99 % confidence level. The strength of this correlation was lower ($r=0.59$, p=0.163) in Middle Lithuania Zone in the soil region of Lower Nemunas Plain.

**Figure 2** - Average mineral nitrogen concentration in 0–60 cm layer in the soils of Lower Nemunas Plain in Middle Lithuania Zone, 2011–2014

**Figure 3** - Average mineral nitrogen concentration in 0–60 cm layer in the soils of Baltic Upland’s Western Plateau, 2011–2014
CONCLUSIONS
1. Our study revealed typical pattern of mineral nitrogen in the main root zone of crops.
2. Pattern of mineral nitrogen were associated with soil texture and the position of soil types in the landscape.
3. The study provided first data about the magnitude of mineral nitrogen concentration pools in soils resulting from mineralisation and fertilisation processes.
4. In order to provide an optimal use of fertilisers and to protect water resources from pollution, future work should be directed on measurement and modelling of nutrient fluxes and cycles in agricultural landscapes of Lithuania.

REFERENCES
Photos 1,2. Field research plots of the Lithuanian Research Centre for Agriculture and Forestry, and two typical soil profiles within the soil mosaic of the agricultural landscape. Soils are a Haplic Luvisol and an Albic Gleyic Luvisol. Soils are typical for landscapes having a leaching regime. In case of redoximorphic properties in the deeper part of the soil profile temporary stagnant water or, like in the right photo, a sometimes relictic shallow water table may occur. In both cases, this is often associated with a slow lateral movement of water and leachates.

Основная глава 8.3 Мониторинг лесов
Main Chapter 8.3 Forest Monitoring

Chapter III/11: MONITORING PROCESSES IN FOREST SOILS OF THE NORTHEAST GERMAN LOWLANDS
Глава III/11: Мониторинг процессов в почвах под лесом в Северо-Восточной Низменности Германии

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ABSTRACT. The goal of the National Forest Soil Inventory is to provide a periodic overview on the spatial and temporal variation of forest soil condition. With regard to the anthropogenic and natural influencing factors the intensive monitoring sites of the Level II-program serve to gain a better understanding of the relevant cause-effect relationships. By the example of the Northeast German lowlands, the data obtained can be used to record changes in forest soil condition and to interpret them properly in the context of the effective pedogenic processes. An important factor that has shaped the soil condition in the past decades is the atmospheric deposition of nutrients and pollutants. Due to the generally improved air quality, an increasing dependence of the slightly changing soil properties on the natural conditions (e.g. parent material) as well as on the influence of the stand structure can currently be observed.