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The interdependence of mineral nitrogen content in different soil layers of Lithuanian agricultural lands

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Abstract

The aim of this work was to investigate the interdependence of mineral nitrogen (N_{min}) content in 0–60 and 0–90 cm soil layers and in 0–30 cm soil layer in order to see whether it would be possible to predict the N_{min} content in the deeper soil layers based on the N_{min} content determined in 0–30 cm soil layer and thus to get a possibility to skip the soil sampling from the deeper layers of soil.

The experiment was carried out in 2009–2012 in 156 monitoring plots of 20 × 20 m size located in 63 regions of Lithuania characterized by the different prevailing soil types and the different soil texture: Eastern Lithuania – *Arenosols* (*AR*) and *Planosols* (*PL*) – sand, *Luvisols* (*LV*) and *Albeluvisols* (*AB*) – sandy loam and light loam; Central Lithuania – *Cambisols* (*CM*) and *Luvisols* – light loam, loam, medium loam, clay loam and clay; Western Lithuania – *Albeluvisols* and *Luvisols* – sandy loam and light loam. The data obtained from the long-term fertilisation experiment conducted in Central Lithuania on the light loam *Cambisol* were used in this study as well. Soil samples for the determination of N_{min} content were taken from 0–30, 30–60 and 60–90 cm soil layers.

Higher levels of N_{min} were found in the soils of heavier texture as well as in the soils of plots treated once with N_{min} fertiliser at the rates not lower than 90 kg ha^{-1}. Significant correlations were determined between the N_{min} content in 0–60 or 0–90 cm soil layers and in 0–30 cm soil layer: in spring $r^2 = 0.837$, $P < 0.01$ and $r^2 = 0.687$, $P < 0.01$, respectively, in autumn $r^2 = 0.833$, $P < 0.01$ and $r^2 = 0.723$, $P < 0.01$, respectively. The ratios of N_{min} content (as dependent on the N_{min} content in 0–30 cm soil layer) in the 0–60 and 0–90 cm soil layers were calculated; when the content of N_{min} in 0–30 cm soil layer increased from 6 to 12 mg kg^{-1}, the 0–60 and 0–30 cm soil layer N_{min} content ratio decreased from 0.85 ± 0.25 to 0.75 ± 0.13 in spring and from 0.87 ± 0.21 to 0.82 ± 0.17 in autumn. These ratios or regression equations can be used for the calculation of N_{min} content in the deeper soil layers based on the available data on the N_{min} content in 0–30 cm soil layer. Strong correlations were determined between the nitrate N and N_{min} contents in 0–60 and 0–90 cm soil layers in spring and in autumn; the corresponding ratios were calculated. The content of nitrates in soil increases as the N_{min} level in soil rises.

Key words: fertilisation, N_{min}, $N\text{-}NO_3$, sampling depth, soil.

Introduction

The optimal nitrogen fertilisation rates for agricultural crops, calculated based on the N_{min} ($N\text{-}NO_3$ + $N\text{-}NH_4$) content in soil, are recommended in many countries aiming to ensure the efficient use of nitrogen fertiliser as well as to decrease the environmental pollution with nitrogen compounds (Chen et al., 2006; Eriksen et al., 2008; Rutkowska, Fotyma, 2009). Harrison (1995) noted that soil nitrogen and fertiliser nitrogen are equally important for the plant nutrition; other researchers indicate that soil nitrogen is taken up by the plants more efficiently than the fertiliser-supplied nitrogen – soil nitrogen is more evenly distributed through the soil layers, while the major part of fertiliser nitrogen stays in 0–30 cm soil layer where the concentration of soil microorganisms is the highest. These microorganisms fix or denitrify the nitrogen compounds supplied by fertiliser. Concentrations of microorganisms in the deeper soil layers are lower; therefore the intensity of nitrogen transformation is lower as well (Stokes et al., 1998).

Since N_{min} compounds migrate into the lower layers of soil, the soil samples for N_{min} tests are usually taken from 0–60 or 0–90 cm soil layers (Mengel et al., 2006; Rutkowska, Fotyma, 2009). The data obtained from the scientific fertilisation experiments carried out on different soil types (containing different levels of N_{min}) prevailing in Lithuania suggested that soil samples for N_{min} tests should be taken before the spring fertilisation from 0–60 cm soil layer for cereal crops and from 0–90 cm – for hilled crops (Pliupelyte et al., 1986; Staugaitis et al., 2007; 2008; Mažvila et al., 2009). Yet Kuhlman et al. (1989) found out that winter wheat plants consumed the major part of required nitrogen from the arable layer of soil, 25% – from 30–90 cm and only 8% – from 90–150 cm soil layer. According to the results obtained by the United Kingdom researchers, 50% of total N_{min} available in 0–90 cm soil layer was accumulated in 0–30 cm layer (Stokes et al., 1998). Similar results were obtained in Lithuania:

48–49% of total N_{min} available in 0–90 cm soil layer was accumulated in 0–30 cm layer (Staugaitis et al., 2008).

Soil sampling from the deeper layers is quite labour-intensive, thus the interdependence of N_{min} content in 0–60 or 0–90 cm soil layers and in 0–30 cm soil layer was sought after in order to see whether it would be possible to calculate and adjust the N fertilisation rates based on the N_{min} content determined in the top layer of soil (Knight, 2006).

Changes in mineral nitrogen (NO_3 and NH_4) content in Lithuanian soils amounts in early spring and late autumn, 0–30, 30–60 and 60–90 cm soil layers were monitored since 1984 in the long-term scientific fertilisation experiment and since 2005 – in the selected monitoring plots located in the representative soil regions of the Eastern, Central and Western Lithuania. Based on the results obtained, the agricultural producers were provided with the appropriately adjusted and environmentally-responsible nitrogen fertilisation recommendations. During all these years the need to decrease the labour-intensiveness of soil sampling activities became quite obvious.

The aim of our study was to process the accumulated scientific data and to calculate the interdependence of mineral nitrogen (N_{min}) content in 0–60 or 0–90 cm soil layers and the N_{min} content in 0–30 cm soil layer.

Materials and methods

Mineral nitrogen (N_{min}) tests were carried out in 2009–2012 in 156 plots of 20 × 20 m size located in 63 regions of Lithuania, representing the main soils of different texture: Eastern Lithuania – *Arenosols* (*AR*) and *Planosols* (*PL*) – sand, *Luvisols* (*LV*) and *Albeluvisols* (*AB*) – sandy loam and light loam; Central Lithuania – *Cambisols* (*CM*) and *Luvisols* – light loam, loam, medium loam, clay loam and clay; Western Lithuania – *Albeluvisols* and *Luvisols* – sandy loam and light loam (Fig. 1). Annual precipitation during the experimental years slightly (5–11%) exceeded the multiannual average.

The data obtained from the long-term fertilisation experiment conducted in Central Lithuania on the light loam *Cambisol* were used for the purposes of this study as well. The plots were occupied with winter wheat, spring rape, spring barley and annual grasses (vetch-oat mixture). Plots were fertilised with 0, 30, 60, 90 and 180 kg ha^{-1} N rates on the different backgrounds of phosphorus

Figure 1. Locations of soil sampling for mineral nitrogen (N_{min}) tests

and potassium fertiliser rates. Soil sampling for N_{min} tests was carried out in spring and in autumn from 0–30, 30–60 and 60–90 cm layers of soil. Grouping of the taken soil samples according to the soil texture was the following: in spring – 306 from the sandy soils, 1347 from the sandy loam and light loam soils, 207 from the medium loam, clay loam and clay soils; in autumn – 288, 1317 and 207 samples, respectively. Soil N_{min} was expressed as the total nitrogen of N-NH_4 and N-NO_3 determined in the 1 M KCl extraction. The ratios of N_{min} content in different layers of soil were calculated by dividing the amount of N_{min} determined in 0–60 and 0–90 cm soil layers by the N_{min} amount determined in 0–30 cm soil layer. The arithmetical means were calculated for each of the groups (grouping was based on the N_{min} content in 0–30 cm soil layer).

The obtained data were evaluated statistically by calculating the standard deviations and the correlative – regressive relations expressed in the coefficients of determination r^2; the significance was evaluated using *t* test – *P* with the help of software *STATISTICA 7* (Clewer, Scarisbric, 2001).

Results and discussion

Mineral nitrogen (N_{min}) content in soil is closely related to the N balance and its transformation processes depending on the C:N ratio, concentration and activity of the microorganisms, soil properties as well as weather conditions (Koos, Nemeth, 2006; Marchetti, Castelli, 2011). Major part of the N is supplied to the soil with organic and mineral fertilisers; the rest of it comes from the atmosphere and is fixed biologically (Staugaitis et al., 2007; McConnell et al., 2011; Wang et al., 2012). Mineral nitrogen content in soil increases substantially when crops are treated with 180–200 kg ha^{-1} and higher rates of N (Bergstrëm, Brink, 1986; Mažvila et al., 2009).

The data obtained from our experiments suggest that N_{min} content in 0–60 cm soil layer was low: 6.37 ± 3.13 mg kg^{-1} in spring and 6.63 ± 4.12 mg kg^{-1} in autumn (Table 1). The lowest levels of N_{min} were determined in sandy soils, average – in loamy sand and sandy loam soils, high – in medium loam, clay loam and clay soils. Chen et al. (2007) noted that higher content of clay particles slows down the migration of nitrates in soil. Bednarek and Reszka (2008) and Rutkowska and Fotyma (2009) have also found that heavier-textured soils contain larger N_{min} amounts. The data obtained from our experiments suggest that the highest N_{min} concentration is in 0–30 cm soil layer, followed by the lower levels in 30–60 cm soil layer and the lowest – in 60–90 cm soil layer. The ratios were calculated aiming to determine the interdependence of N_{min} content in 0–60 and 0–90 cm and 0–30 cm soil layers. It was found that these ratios did not depend significantly enough on the soil texture with only one exception: in autumn the relatively higher levels of N_{min} are accumulated in the lower soil layers of light-textured soils, and in spring – in the lower soil layers of heavy-textured soils.

According to the results obtained from the long-term experiment, the N_{min} content in 0–60 cm soil layer in autumn depended on the applied N fertilisation rates and was within the range of 5.18 ± 2.86–11.5 ± 4.75 mg kg^{-1}. Content of N increased substantially when the plants were treated with onetime 90 kg ha^{-1} and higher N rates (Table 2). When plants were treated with the N rates below 90 kg ha^{-1}, the highest N_{min} concentration was

Table 1. Mineral nitrogen (N_{min}) content in the soils of different texture and the ratios of N_{min} content between the deeper soil layers and the upper soil layer, 2009–2012

Soil sampling		Sand	Sandy loam, light loam	Medium loam, clay loam, clay	Mean
soil layer cm	season	Soil N_{min} ± SD mg kg^{-1}			
0–30	spring	6.66 ± 3.39	8.13 ± 4.18	8.72 ± 5.84	7.96 ± 4.31
	autumn	6.74 ± 3.36	8.21 ± 5.12	9.73 ± 6.14	8.18 ± 5.09
30–60	spring	4.21 ± 2.51	4.76 ± 2.86	5.89 ± 3.72	4.80 ± 2.94
	autumn	4.58 ± 3.68	4.99 ± 3.73	6.25 ± 4.44	5.08 ± 3.83
60–90	spring	3.92 ± 2.70	4.26 ± 2.78	4.88 ± 3.37	4.27 ± 2.85
	autumn	3.81 ± 3.30	3.63 ± 2.46	4.10 ± 2.54	3.71 ± 2.61
0–60	spring	5.44 ± 2.57	6.45 ± 2.97	7.31 ± 4.42	6.37 ± 3.13
	autumn	5.65 ± 3.16	6.60 ± 4.06	7.99 ± 5.05	6.63 ± 4.12
0–90	spring	4.93 ± 2.38	5.72 ± 2.62	6.50 ± 3.84	5.68 ± 2.77
	autumn	5.04 ± 3.04	5.61 ± 3.34	6.69 ± 3.98	5.66 ± 3.41
Ratios between the N_{min} available in deeper soil layers and the 0–30 cm soil layer ± SD					
0–60	spring	0.82 ± 0.17	0.82 ± 0.17	0.84 ± 0.22	0.82 ± 0.18
	autumn	0.86 ± 0.16	0.84 ± 0.16	0.83 ± 0.11	0.85 ± 0.15
0–90	spring	0.72 ± 0.22	0.73 ± 0.22	0.75 ± 0.24	0.73 ± 0.23
	autumn	0.78 ± 0.20	0.71 ± 0.18	0.71 ± 0.12	0.73 ± 0.18

SD – standard deviation

Table 2. Mineral nitrogen (N_{min}) content in soil as affected by the nitrogen fertilisation rates
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Nitrogen fertilisation rate kg ha^{-1}	Soil sampling time	Soil sampling depth cm				
		0–30	30–60	60–90	0–60	0–90
		N_{min} content in soil ± SD mg kg^{-1}				
0	spring	6.62 ± 3.73	3.72 ± 2.44	2.55 ± 1.53	5.18 ± 2.86	4.30 ± 2.25
	autumn	5.21 ± 1.93	2.80 ± 1.12	2.26 ± 1.04	4.01 ± 1.47	3.42 ± 1.29
30	spring	6.60 ± 0.54	4.19 ± 0.35	3.01 ± 0.91	5.40 ± 0.36	4.60 ± 0.53
	autumn	5.83 ± 0.77	3.66 ± 0.29	3.00 ± 0.64	4.74 ± 0.38	4.16 ± 0.27
60	spring	6.60 ± 1.27	4.52 ± 1.17	2.72 ± 0.95	5.56 ± 1.13	4.62 ± 0.97
	autumn	5.85 ± 1.17	3.84 ± 0.72	2.81 ± 0.59	4.84 ± 0.89	4.16 ± 0.75
90	spring	9.03 ± 5.25	7.83 ± 4.30	4.28 ± 1.93	8.35 ± 4.48	6.46 ± 2.34
	autumn	6.25 ± 2.34	4.68 ± 2.68	3.71 ± 1.64	5.46 ± 2.39	4.88 ± 1.97
180	spring	9.81 ± 4.12	13.2 ± 7.17	8.52 ± 4.30	11.5 ± 4.75	10.5 ± 4.13
	autumn	8.49 ± 3.16	7.30 ± 3.55	7.17 ± 3.14	7.89 ± 2.98	7.66 ± 2.53

SD – standard deviation

determined in 0–30 cm soil layer, followed by the lower levels in 30–60 cm soil layer and the lowest – in 60–90 cm soil layer. When plants were treated with 180 kg ha^{-1} N rate, the highest levels (13.2 ± 7.17 mg kg^{-1}) of N_{min} were determined in 30–60 cm soil layer due to the nitrate migration. According to the findings of Lopez-Bellindo et al. (2013), when plants are treated with high N rates (150 kg ha^{-1}), the nitrates migrate from the arable layer of soil, which causes an increase of nitrate concentration in 30–60 cm soil layer.

According to the results of the experiments conducted on sandy loams in United Kingdom, the application of high N rates resulted in high losses of N_{min} in spring compared to the N_{min} amounts left in soil in autumn (Bhogal et al., 2000). The data obtained from our long-term experiment on the N_{min} content in 0–60 cm soil layer in spring and autumn revealed the decrease of N_{min} content in spring as well; the degree of this decrease depended on the nitrogen fertilisation rate applied in spring and was from 4.74 ± 0.38 to 7.89 ± 2.98 mg kg^{-1} (Table 2). Higher losses of N_{min} were determined in the plots where N_{min} levels in autumn were high. Both in spring and autumn higher levels of N_{min} were determined in 0–30 cm soil layer except for the plots treated with 180 kg ha^{-1} N rates – here high levels of N_{min} were determined in 60–90 cm soil layer as well.

The data obtained from our experiments suggest that nitrogen migration in soil depends on the season and N fertilisation intensity; nitrogen compounds distribute in the soil layers unevenly. In order to determine the regularities of N_{min} distribution in different soil layers in spring and autumn, the correlations and interrelations between the N_{min} contents in 0–60 and 0–90 cm soil layers and 0–30 cm soil layer were calculated. Significant correlation was determined between the N_{min} content in 0–60 and 0–30 cm soil layers in spring – r^2 = 0.837, $P < 0.01$ (Fig. 2) and somewhat less significant – between the N_{min} content in 0–90 and 0–30 cm soil layers – r^2 = 0.687, $P < 0.01$. The corresponding calculations for autumn were r^2 = 0.833, $P < 0.01$ and r^2 = 0.723, $P < 0.01$, respectively.

The data on N_{min} content in soil were grouped according to the evaluation scale used in Lithuania at present (Pliupelyte et al., 1986; Staugaitis et al., 2007). It was found that the comparative values of N_{min} content in 0–60 and 0–90 cm (as compared to the N_{min} content in 0–30 cm soil layer) in spring as well as in autumn were higher when the soils were richer in N_{min} (Table 3). Autumn values were higher than the spring values.

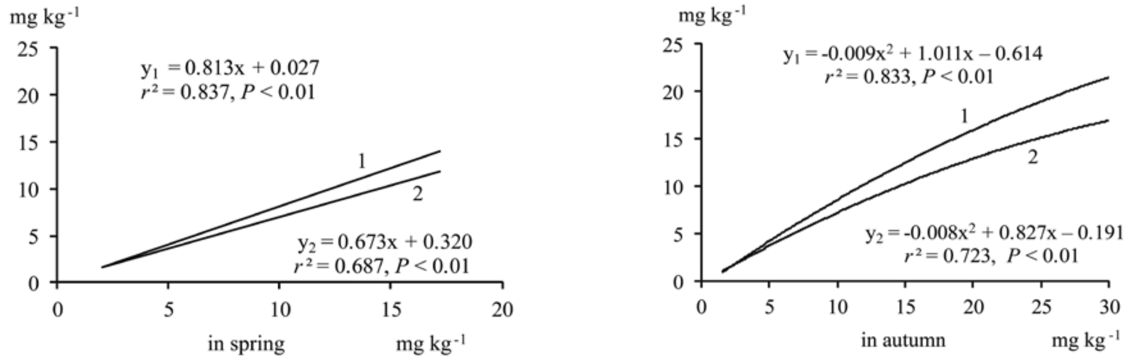

Figure 2. Correlation between the mineral nitrogen contents in 0–60 (y_1) and 0–90 (y_2) cm soil layers and in 0–30 cm soil layer (x)

Table 3. Comparative values of mineral nitrogen (N_{min}) content in different soil layers as affected by the N_{min} content in 0–60 cm layer of soil

Season	N_{min} content mg kg^{-1} in 0–60 cm soil layer			Mean
	<5	5–10	>10	
Comparative values of N_{min} content in 0–60 and 0–30 cm soil layers ± SD				
Spring	0.78 ± 0.13	0.83 ± 0.18	0.86 ± 0.15	0.82 ± 0.20
Autumn	0.79 ± 0.14	0.85 ± 0.21	0.92 ± 0.22	0.86 ± 0.24
Comparative values of N_{min} content in 0–90 and 0–30 cm soil layers ± SD				
Spring	0.70 ± 0.21	0.75 ± 0.24	0.76 ± 0.17	0.73 ± 0.23
Autumn	0.69 ± 0.20	0.74 ± 0.28	0.76 ± 0.24	0.73 ± 0.26

SD – standard deviation

The qualified groups of soil richness in mineral nitrogen based on the N_{min} content determined in 0–30 cm soil layer were made using the comparative values of N_{min} content in 0–60 and 0–30 cm soil layers. In this case, as the levels of N_{min} in 0–30 cm soil layer increased, the comparative values of N_{min} levels in 0–60 and 0–90 cm soil layers decreased. The comparative values between 0–90 and 0–30 cm soil layers were lower than those between 0–60 and 0–30 cm soil layers (Table 4).

Table 4. Comparative values of mineral nitrogen (N_{min}) content in different soil layers as affected by the N_{min} content in 0–30 cm layer of soil

Season	N_{min} content mg kg^{-1} in 0–30 cm soil layer			Mean
	<6	6–12	>12	
Comparative values of N_{min} content in 0–60 and 0–30 cm soil layers ± SD				
Spring	0.85 ± 0.25	0.83 ± 0.17	0.75 ± 0.13	0.82 ± 0.20
Autumn	0.87 ± 0.21	0.87 ± 0.25	0.82 ± 0.17	0.86 ± 0.23
Comparative values of N_{min} content in 0–90 and 0–30 cm soil layers ± SD				
Spring	0.78 ± 0.26	0.75 ± 0.20	0.64 ± 0.16	0.73 ± 0.23
Autumn	0.78 ± 0.27	0.75 ± 0.26	0.66 ± 0.18	0.73 ± 0.26

SD – standard deviation

In the cases of significant correlations between the N_{min} contents in 0–60 or 0–90 cm and 0–30 cm soil layers the regression equations presented in Figure 2 or the comparative values presented in Table 4 can be used for the calculation of N_{min} content in 0–60 or 0–90 cm soil layers based on the available data on N_{min} content in 0–30 soil layer. According to the results of research conducted in Argentina, the correlation between the N_{min} contents in 0–60 and 0–30 cm soil layers was significant; the researchers came to the conclusion that it is possible to calculate the N_{min} content in 0–60 cm soil layer based on the available data on N_{min} content in 0–30 soil layer (Alvarez et al., 2001). The major part of N_{min} consists of nitrate anions which are more mobile than ammonium cations; therefore it is important to determine the content of them in autumn and to evaluate the possible leaching during the autumn–winter season. The calculations of correlations between the nitrate N and the N_{min} content in soil conducted in Lithuania revealed that these correlations were very strong in autumn (0–60 and 0–90 cm soil layers – $r^2 = 0.954$, $P < 0.01$ and $r^2 = 0.937$, $P < 0.01$, respectively) and less strong in spring ($r^2 = 0.934$, $P < 0.01$ and $r^2 = 0.920$, $P < 0.01$, respectively) (Fig. 3).

The soils were grouped according to the N_{min} content in 0–30 cm soil layer and the nitrate N and N_{min} comparative values were calculated. These values increased both in spring and autumn as the content of in 0–30 cm soil layer increased (Table 5). Spring values were lower than the autumn values. During the autumn–spring season larger amounts of nitrates were leached from the soils containing more than 6 mg kg^{-1} of N_{min} in 0–30 cm soil layer, thus the high content of N_{min} in the upper soil layer in autumn indicates the higher amounts of the nitrates as well – there is high possibility of nitrate leaching during the autumn–spring season.

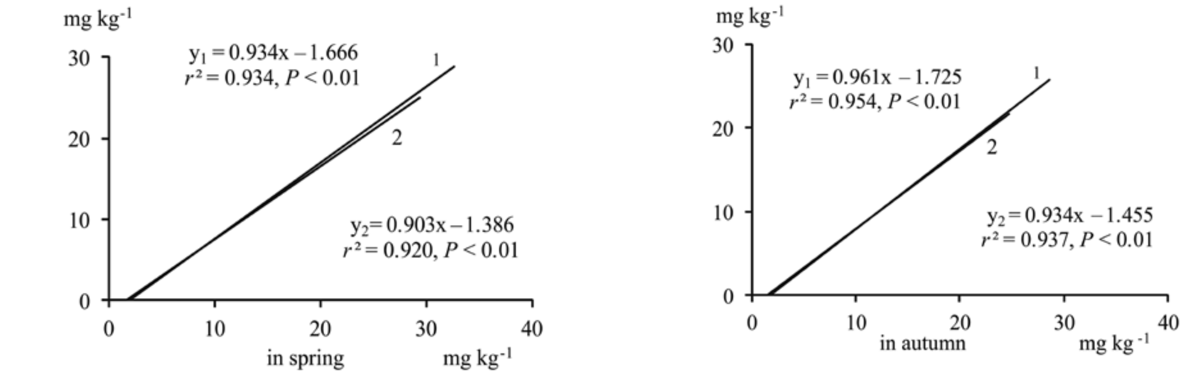

Figure 3. Correlation between nitrate nitrogen content in 0–60 (y_1) and 0–90 (y_2) cm soil layers and the mineral nitrogen content

Table 5. Comparative values of nitrate nitrogen and mineral nitrogen (N_{min}) content in soil as affected by the N_{min} content in 0–30 cm layer of soil

Season	N_{min} content mg kg^{-1} in 0–30 cm soil layer			Mean
	<6	6–12	>12	
Comparative values of nitrate nitrogen and N_{min} content in 0–60 cm soil layer ± SD				
Autumn	0.49 ± 0.22	0.71 ± 0.21	0.83 ±0.12	0.68 ± 0.25
Spring	0.46 ± 0.21	0.66 ± 0.22	0.79 ± 0.14	0.64 ± 0.24
Comparative values of nitrate nitrogen and N_{min} content in 0–90 cm soil layer ± SD				
Autumn	0.47 ± 0.23	0.67 ± 0.23	0.79 ± 0.19	0.64 ± 0.25
Spring	0.45 ± 0.22	0.63 ± 0.21	0.75 ± 0.20	0.61 ± 0.24

SD – standard deviation

The calculated correlations between the nitrate N content in 0–60 and 0–90 cm soil layers and 0–30 cm soil layer were strong both in spring ($y = 0.002x^2 + 0.846x – 0.125$, $r^2 = 0.879$, $P < 0.01$ and $y = 0.004x^2 + 0.79x – 0.190$, $r^2 = 0.756$, $P < 0.01$) and autumn ($y = 0.002x^2 + 0.914x – 0.067$, $r^2 = 0.814$, $P < 0.01$ and $y = 0.003x^2 + 0.756x – 0.039$, $r^2 = 0.714$, $P < 0.01$). Nitrate N content in 0–60 or 0–90 cm soil layers can be calculated based on the available data on nitrate N content in 0–30 soil layer using the coefficients of regression equations; in the cases of strong correlation between the nitrate N and N_{min} contents in soil in spring and autumn the nitrate N content in 0–60 or 0–90 cm soil layers can be calculated based on the available data on content in 0–30 soil layer.

Conclusions

1. High correlation was determined between the mineral nitrogen (N_{min}) content in 0–60 and 0–90 cm soil layers and in 0–30 cm soil layer of the prevailing soil types in Lithuania. The regression equations or the calculated comparative values can be used for the calculation of N_{min} content in 0–60 or 0–90 cm soil layers based on the available data on N_{min} content in 0–30 soil layer.

2. Strong correlation was determined between the nitrate N and N_{min} content in soil; the comparative values were calculated. The level of nitrates in soil is higher when soil contains larger amounts of N_{min}. Nitrate N content in 0–60 or 0–90 cm soil layers can be calculated based on the available data on nitrate N content in 0–30 soil layer using the coefficients of regression equations; in the cases of strong correlation between the nitrate N and N_{min} contents in soil in spring and autumn the nitrate N content in 0–60 or 0–90 cm soil layers can be calculated based on the available data on N_{min} content in 0–30 soil layer.

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Mineralinio azoto kiekio įvairiuose dirvožemio sluoksniuose sąsajos Lietuvos žemės ūkio naudmenose

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Santrauka

Dirvožemio ėminių paėmimui iš gilesnių sluoksnių reikia daug darbo sąnaudų, todėl, siekiant jas sumažinti, buvo tirtas mineralinio azoto ($N_{min.}$) kiekio dirvožemio 0–60 ir 0–90 cm sluoksniuose priklausomumas nuo jo kiekio 0–30 cm sluoksnyje, kad dirvožemio azotingumą gilesniuose sluoksniuose būtų galima prognozuoti pagal paviršinį sluoksnį.
Tyrimai atlikti 2009–2012 m. šalies 63-jų vietovių 156-iose 20 × 20 m dydžio stebėsenos aikštelėse, parinktose vyraujančiuose skirtingos granuliometrinės sudėties dirvožemiuose: Rytų Lietuvoje – smėlžemiuose (SD) ir palvažemiuose (PL) – smėlio, išplautžemiuose (ID) ir balkšvažemiuose (JI) – priesmėlio ir lengvo priemolio; Vidurio Lietuvoje – rudžemiuose (RD) ir išplautžemiuose (ID) – lengvo, vidutinio sunkumo, sunkaus priemolio ir molio; Vakarų Lietuvoje – priesmėlio ir lengvo priemolio balkšvažemiuose (JI) bei išplautžemiuose (ID). Tuo tikslu buvo panaudoti ir ilgalaikio tręšimo bandymo, vykdomo Vidurio Lietuvos lengvo priemolio rudžemyje, tyrimų duomenys. Mineraliniо azoto kiekiui nustatyti ėminiai buvo imti iš dirvožemio 0–30, 30–60 ir 60–90 cm sluoksnių.
Nustatyta, kad daugiau azoto buvo sunkesnės granuliometrinės sudėties, taip pat 90 kg ha^{-1} ir didesnėmis vienkartinėmis normomis azoto trąšų tręštų laukelių dirvožemyje. Gauti esminiai koreliaciniai ryšiai tarp $N_{min.}$ kiekio dirvožemio 0–60 arba 0–90 cm sluoksniuose su jo kiekiu 0–30 cm sluoksnyje: pavasarį atitinkamai r^2 = 0,837, P < 0,01 ir r^2 = 0,687, P < 0,01, rudenį – r^2 = 0,833, P < 0,01 ir r^2 = 0,723, P < 0,01. Apskaičiuota $N_{min.}$ kiekio sąsajos šiuose dirvožemio sluoksniuose, kurių reikšmės priklausė nuo $N_{min.}$ kiekio 0–30 cm sluoksnyje. Jam padidėjus nuo 6 iki 12 mg kg^{-1}, $N_{min.}$ kiekio dirvožemio 0–60 ir 0–30 cm sluoksniuose santykis pavasarį sumažėjo nuo 0,85 ± 0,25 iki 0,75 ± 0,13, rudenį – nuo 0,87 ± 0,21 iki 0,82 ± 0,17. Taikant regresijos lygtis arba šiuos santykius, $N_{min.}$ kiekius gilesniuose dirvožemio sluoksniuose galima apskaičiuoti pagal jo kiekį 0–30 cm sluoksnyje. Taip pat nustatyti glaudūs koreliaciniai ryšiai tarp nitratinio bei mineralinio azoto kiekio pavasarį ir rudenį dirvožemio 0–60 bei 0–90 cm sluoksniuose ir apskaičiuotos jų santykinės reikšmės. Mineralinio azoto kiekiui dirvožemyje didėjant, jo sudėtyje santykinai daugiau padidėja nitratų kiekis.

Reikšminiai žodžiai: dirvožemis, ėminių gylis, $N_{min.}$, N-NO_3, tręšimas.