# THE EFFECT OF AGROTECHNICAL INTERVENTIONS ON SEASONAL CHANGES OF INORGANIC NITROGEN CONTENT IN THE SOIL

# VPLYV AGROTECHNICKÝCH ZÁSAHOV NA SEZÓNNE ZMENY OBSAHU ANORGANICKÉHO DUSÍKA V PÔDE

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## ABSTRACT

We researched the influence of soil cultivation and fertilization on changes of nitrate, ammonium and inorganic nitrogen content in soil during the monitored vegetation periods (2004/2005 – 2005/2006). This experiment was realized on experimental bases of Slovak University of Agriculture in Nitra – Dolná Malanta on the winter/summer wheat (Triticum aestivum), variety Bonita, with red clover as its before-crop.

In the field trial we used two types of tillage, B1 – conventional tillage up to the depth of 0,25 m and B2 – disc ploughing up to 0,15 m, with three variants of fertilization, 0 – unfertilized control, PH – fertilization according to its content in soil and PZ – fertilization according to its content in soil + plough down of post harvest residues. Samples of the soil were taken from the two soil depth (0,0-0,3 m and 0,3-0,6 m) and in each vegetation period there were 8 takings of soil samples in four repetitions.

During monitored vegetation period this dynamics was changeable. The content of nitrate nitrogen in the soil in autumn was about 40 % higher than content of ammonium nitrate. This tendency changed in spring, when the average content of ammonium nitrogen was higher than the content of nitrate nitrogen on average about 60 %.

The cultivation had significant influence on dynamics of inorganic nitrogen. The average content of inorganic nitrogen in conventional tillage up to the depth of 0,25 m was 8,43 $mg.kg^{-1}$ and in disc ploughing it was 7,60 $mg.kg^{-1}$.

The influence of fertilization on changes of inorganic nitrogen was significantly important. Monitored ways of fertilization within the content of nitrates in the soil had the following averages: in unfertilized soil 7,48 $mg.kg^{-1}$, in fertilized soil NPK 8,20 $mg.kg^{-1}$ and in the soil fertilized with plough down of post harvest residues 8,37 $mg.kg^{-1}$. In the first and second variety of soil cultivation we found out a low increase of average concentration of nitrates in the fertilized soil in comparison with unfertilized one.

High significant influence on dynamics of nitrate nitrogen in the soil had date of sample takings and also depth. In the first depth (0,0-0,3 m) the level of nitrate nitrogen was 9,18 $mg.kg^{-1}$ and in the second depth (0,3-0,6 m) it was 6,85 $mg.kg^{-1}$.

Key words: inorganic nitrogen, nitrate nitrogen, ammonium nitrogen, cultivation, fertilization

## ABSTRACT

V práci bola sledovaná dynamika obsahu anorganických foriem dusíka v pôde pod pšenicou letnou f. ozimnou, v priebehu dvoch po sebe nasledujúcich vegetačných období (2004/2005 a 2005/2006), na výskumno-experimentálnej báze Slovenskej poľnohospodárskej univerzity v Nitre – Dolná Malanta.

V pokuse boli použité dva spôsoby obrábania pôdy ( B1 - stredne hlboká orba do 0,25 m, B2 – tanierovanie), tri varianty hnojenia (0 – bez hnojenia, kontrolný variant, PH – priemyselné hnojivá a PH + ZV – priemyselné hnojivá so zapracovaním pozberových zvyškov predplodiny). Vzorky pôdy boli odoberané z dvoch hĺbok pôdy (0,0-0,3 m a 0,3-0,6 m), pričom v každom vegetačnom období bolo realizovaných 8 odberov pôdnych vzoriek v štyroch opakovaniach.

Počas nášho sledovaného vegetačného obdobia bola táto dynamika premenlivá. Dusičnanová forma dusíka v pôde v jesenných mesiacoch tvorila vyšší obsah v priemere o 40 % viac ako amónna forma. Tento trend sa však zmenil v jarných a letných mesiacoch, kedy priemerný obsah amónneho dusíka bol vyšší ako dusičnanový dusík v priemere o 60%.

Obrábanie malo na dynamiku $N_{an}$ vysoko preukazný vplyv. Pri obrábaní pôdy stredne hlbokou orbou do 0,25 m (variant B1) bola priemerná koncentrácia anorganického dusíka 8,43 $mg.kg^{-1}$ a pri tanierovaní (variant B2) 7,60 $mg.kg^{-1}$.

Vplyv hnojenia na zmeny koncentrácie $N_{an}$ bol štatisticky vysoko preukazný. Sledované spôsoby hnojenia v rámci obsahu dusičnanov v pôde zaznamenali nasledovné priemery: v nehnojenej pôde 7,48 $mg.kg^{-1}$, hnojenie NPK 8,20 $mg.kg^{-1}$ a v pôde hnojenej so zaoraním pozberových zvyškov 8,37 $mg.kg^{-1}$. V prvom aj v druhom variante obrábania pôdy sme zaznamenali mierny nárast priemerných koncentrácií $N_{an}$ v hnojenej pôde proti nehnojenej kontrole. Vysoko preukazný vplyv na dynamiku dusičnanového dusíka v pôde mali aj termíny odberov pôdnych vzoriek ako aj hĺbka.

## DETAILED ABSTRACT

V tejto práci bola sledovaná dynamika obsahu anorganických foriem dusíka v pode pod pšenicou letnou f. ozimnou, v priebehu dvoch po sebe nasledujúcich vegetačných období (2004/2005 a 2005/2006), na výskumno-experimentálnej báze Slovenskej poľnohospodárskej univerzity v Nitre – Dolná Malanta. Experimentálna báza je situovaná v teplej klimatickej oblasti s priemernou teplotou v priebehu vegetačného obdobia 16,4 °C a priemernými ročnými zrážkami 561 mm. Pôdy v skúmanej oblasti sa vyvinuli z pôvodne proluviálnych, poprípade soliflukčných sedimentov.

V pokuse boli použité dva spôsoby obrábania pôdy (B1 – stredne hlboká orba do 0,25 m, B2 – tanierovanie), tri varianty hnojenia (0 – bez hnojenia, kontrolný variant, PH – priemyselné hnojivá a PH + ZV – priemyselné hnojivá so zapracovaním celých pozberových zvyškov predplodiny). Vzorky pôdy boli odoberané z dvoch hĺbok pôdy (0,0-0,3 m a 0,3-0,6 m), pričom v každom vegetačnom období bolo realizovaných 8 odberov pôdnych vzoriek v štyroch opakovaniach.

Počas sledovaného vegetačného obdobia bola dynamika jednotlivých foriem anorganického dusíka premenlivá. Zistili sme, že dusičnanová forma dusíka v pôde v jesenných mesiacoch tvorila vyšší obsah v priemere o 40 % viac ako amónna forma. Tento trend sa však zmenil v nasledujúcich mesiacoch, kedy priemerný obsah amónneho dusíka bol vyšší ako dusičnanový dusík v priemere o 60 %.

Obrábanie malo na dynamiku $N_{an}$ vysoko preukazný vplyv. Pri obrábaní pôdy stredne hlbokou orbou do 0,25 m (variant B1) bola priemerná koncentrácia anorganického dusíka 8,43 mg.kg$^{-1}$ a pri tanierovaní (variant B2) 7,60 mg.kg$^{-1}$.

Vplyv hnojenia na zmeny koncentrácie $N_{an}$ bol štatisticky vysoko preukazný. Sledované spôsoby hnojenia v rámci obsahu dusičnanov v pôde zaznamenali nasledovné priemery: v nehnojenej pôde 7,48 mg.kg$^{-1}$, hnojenie NPK 8,20 mg.kg$^{-1}$ a v pôde hnojenej so zaoraním pozberových zvyškov 8,37 mg.kg$^{-1}$. V prvom aj druhom variante obrábania pôdy sme zaznamenali mierny nárast priemerných koncentrácií $N_{an}$ v hnojenej pôde proti nehnojenej kontrole.

Vysoko preukazný vplyv na dynamiku dusičnanového dusíka v pôde mali aj termíny odberov pôdnych vzoriek ako aj hĺbka. V prvej hĺbke (0,0-0,3 m) bola hladina dusičnanového dusíka 9,18 mg.kg$^{-1}$ a v hĺbke 0,3-0,6 m 6,85 mg.kg$^{-1}$.

Redukované obrábanie pôdy a optimalizácia hnojenia dusíkom je veľmi významným opatrením v systéme trvalo udržateľného poľnohospodárstva. Umožňuje znižovať spotrebu energie pri dosahovaní dostačujúcich úrod pestovaných plodín..


## INTRODUCTION

The content and quality of nitrogen in the soil are the result of soil historic development formed by natural soil-forming factors and more or less by human´s activity.

Therefore every present content of nitrogen in the soil corresponds with the present development stage of the soil and its previous commercial utilization.

Soil cultivation intensively affects the activity of microorganisms which share in nitrogen transformations in the soil [2, 3, 12]. More intense and deeper soil cultivation forms much more nitrates in the soil than in rough or shallow cultivated soil [17, 20].

Effect of soil cultivation and fertilizing come into relations with weather conditions which can more or less gloze over or even eliminate agricultural effects on ammonization and nitrification [6, 14].

The aim of this article was to consider the effect of different forms of soil cultivation or fertilization on changes of ammonization intensity and nitrification in the soil.

## MATERIAL AND METHODS

Changes of content inorganic nitrogen forms in the soil profile were monitored in two growing seasons (2004/2005 and 2005/2006). This experiment was realized on research-experimental bases of Slovak University of Agriculture in Nitra – Dolná Malanta. It is situated in a warm climatic area, the soil type is the brown soil on loess loam. Average monthly temperatures and monthly precipitation in the vegetation of winter wheat during monitored growing season are listed in table 1

In the field trial two tillage systems were used:

B1 –conventional tillage up to depth of 0,25 m

B2 – disc ploughing up to 0,15m.

Three variants of fertilization were used:

0 – unfertilized control

PH – fertilization with commercial fertilizers – fertilization on the basis of content $N_{in}$ in the soil and requirements of the winter wheat for the yield of 6 t,

PZ – fertilization with commercial fertilizers + post harvest residues of preceding crop – fertilization on the basis of $N_{in}$ content in the soil and requirements of the winter wheat for the yield of 6t with parallel ploughing down of post harvest residues of preceding crop.

On variants with post harvest residues the whole mass of preceding crop was ploughed down, while on the

**Table 1** Average climatic conditions during the vegetation period of winter wheat
**Tabuľka 1** Priemerné klimatické podmienky v priebehu vegetačných období pšenice letnej f. ozimnej (1) mesiac, (2) priemerné mesačné teploty v ºC, (3) suma zrážok (4) priemer

| Month (1) | Average month temperatures in Celsius degree (2) | | | | Sum of month precipitation in mm (3) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1951-1980 | 2004 | 2005 | 2006 | 1951-1980 | 2004 | 2005 | 2006 |
| I. | -1.7 | 32.0 | -0.1 | -4,1 | 31.0 | 55.9 | 31.0 | 57,4 |
| II. | 0.5 | 33.0 | -2.7 | -1,6 | 32.0 | 31.1 | 53.0 | 39,0 |
| III. | 4.7 | 43.0 | 2.7 | 3,5 | 33.0 | 52.8 | 3.4 | 35,2 |
| IV. | 10.1 | 55.0 | 11.0 | 11,4 | 43.0 | 36.3 | 78.7 | 48,1 |
| V. | 14.8 | 70.0 | 15.2 | 14,0 | 55.0 | 36.9 | 60.9 | 95,6 |
| VI. | 18.3 | 64.0 | 18.0 | 19,2 | 70.0 | 93.8 | 31.5 | 63,9 |
| VII. | 19.7 | 58.0 | 20.5 | 22,6 | 64.0 | 33.8 | 59.0 | 23,7 |
| VIII. | 19.2 | 37.0 | 19.1 | 16,7 | 58.0 | 19.4 | 94.5 | 84,0 |
| IX. | 15.4 | 41,0 | 16.3 | 16,6 | 37.0 | 35.4 | 47.1 | 12,7 |
| X. | 10.1 | 54.0 | 10.7 | 12,2 | 41,0 | 45.3 | 12.1 | 15,3 |
| XI. | 4.9 | 43.0 | 4.2 | 7,5 | 54.0 | 45.7 | 43.2 | 24,4 |
| XII. | 0.5 | 561.0 | 0.4 | 3,2 | 43.0 | 26.8 | 113.2 | 7,8 |
| **Average (4)** | **9.7** | **9.9** | **9.6** | **10,1** | **561.0** | **513.2** | **633.0** | **507,1** |

**Table 2** Applied nitrogen rates (in kg of pure nutrients.ha$^{-1}$)
**Tabuľka 2** Aplikované dávky dusíka (kg čistých živín/ha)

| Fertilization (1) | Year (2) | B1- conventional tillage | | B2- reduced tillage | |
|---|---|---|---|---|---|
| | | PH | PZ | PH | PZ |
| Basic fertilization (3) | 2004 | 0 | 0 | 0 | 0 |
| | 2005 | 0 | 0 | 0 | 0 |
| Recovery fertilization (4) | 2004 | 0 | 0 | 0 | 0 |
| | 2005 | 20 | 30 | 20 | 30 |
| Productive fertilization (5) | 2004 | 0 | 0 | 20 | 20 |
| | 2005 | 30 | 30 | 30 | 30 |
| Qualitative fertilization (6) | 2004 | 0 | 10 | 0 | 10 |
| | 2005 | 15 | 15 | 15 | 15 |

(1) Hnojenie, (2) Rok, PH – priemyselné hnojenie (Industrial fertilization) PZ - priemyselné hnojenie + pozberové zvyšky (Industrial fertilization + plough down postharvest residues), (3) základné hnojenie, (4) regeneračné hnojenie, (5) produkčné hnojenie, (6) kvalitatívne hnojenie
B1 – stredne hlboká orba, B2 – plytká orba

variant without postharvest residues plough down was only stubble and clover was removed from experimental field.

Ammonium nitrate with limestone was used as fertilizations and the doses of applied nitrogen are listed in table 2. Nitrogen doses were determined on the basis of inorganic nitrogen forms content after the first soil sampling, which at the same time indicated the initial situation of soil supply by nitrogen in every monitored growing season.

The grown crop was winter wheat (Triticum aestitivum, Samantha species), its preceding crop was red clover. The

**Table 3** Mean contents of inorganic nitrogen forms for whole research period in $mg.kg^{-1}$
**Tabuľka 3** Priemerné obsahy anorganických foriem dusíka za celé sledované obdobie v $mg.kg^{-1}$

| Observed parameters (1) | | Mean contents, $mg . kg^{-1}$ (2) | | |
|---|---|---|---|---|
| | | $N-NO_3^-$ | $N-NH_4^+$ | $N_{an}$ |
| **Cultivation (3)** | **B1** | 4,20 | 4,24 | 8,43 |
| | **B2** | 3,36 | 4,27 | 7,60 |
| **Fertilization (4)** | **0** | 3,44 | 4,05 | 7,48 |
| | **PH** | 3,86 | 4,37 | 8,20 |
| | **PZ** | 4,04 | 4,34 | 8,37 |
| **Depth of sampling (5)** | **0,0-0,3m** | 4,91 | 4,27 | 9,18 |
| | **0,3-0,6 m** | 2,64 | 4,23 | 6,85 |
| **Sampling (6)** | **September** | 3,75 | 4,51 | 8,26 |
| | **October** | 5,44 | 4,39 | 9,83 |
| | **November** | 8,10 | 4,76 | 12,86 |
| | **March** | 4,45 | 5,45 | 9,81 |
| | **April** | 2,33 | 4,08 | 6,41 |
| | **Mai** | 1,38 | 3,54 | 4,92 |
| | **June** | 1,87 | ,57 | 5,42 |
| | **July** | 2,91 | 3,71 | 6,62 |
| **Vegetation period (7)** | **2004/2005** | 3,28 | 4,24 | 7,52 |
| | **2005/2006** | 4,28 | 4,26 | 8,52 |

([1]) sledované parametre, ([2]) priemerné obsahy, ([3]) obrábanie, ([4]) hnojenie, ([5]) hĺbka, ([6]) odber, ([7]) vegetačné obdobie
Cultivation B1 – conventional tillage (do 0,25 m) (stredne hlboká orba)
B2 – reduced tillage (do 0,20 m) (plytká orba)
Fertilization 0 – without fertilization (bez hnojenia)
PH – Industrial fertilization (priemyselné hnojenie)
PZ – Industrial fertilization + plough down postharvest residues (priemyselné hnojenie + pozberové zvyšky)

soil samples were taken from the depth of soil profile of 0,0 – 0,3 m and 0,3 – 0,6 m In taken soil samples the contents of inorganic nitrogen forms (in 1 % leachate of $K_2SO_4$) were determined by color method with acid phenoldihydrosulphate, and in the samples of nitrate nitrogen by the color method with Nessler test solution for ammonium nitrogen. $N_{in}$ content was calculated as the sum of $N-NH_4^+$ and $N-NO_3^-$.

The soil samples were taken in monthly intervals during the entire growing season of winter wheat. There was four time repetition of variants. Results are evaluated by tables and by statistics (Statgraphic plus 5.0).

## RESULTS AND DISCUSSION

The average concentration of $N-NO_3^-$ in the soil during the monitored vegetation periods was 3,78 $mg.kg^{-1}$, what is 47 % from total inorganic nitrogen. Bielek [3] presents that nitrates represent on average about 40-50 % of overall mineral nitrogen in quality soils (not fertilized with nitrogen). In less fertile soils is this part only about 10-20%.

Levels of $N-NO_3^-$ during two monitored vegetation periods ranged between 0,95 to 20,85 $mg.kg^{-1}$ (Tab 4.), what proves intensive dynamics of nitrate nitrogen. This confirms also a high value of variation coefficient – 90, 98 %.

The effect of agrotechnical cultivation according to the results was statistically significant, what is in accord with the opinion of Sotáková [22] and Malhiho et al. [10], who say that a deep tillage in comparison with a shallow one increases the biological activity of soil. On one hand it increases soil aeration and, on the other hand, in the non-cultivated soil the post harvest residues are cumulated on the surface where their mineralization is highly limited.

The highest avergare concentration of nitrate nitrogen (table 3) was recorded in the variant PZ (4,04 $mg.kg^{-1}$) and the lowest value was in the variant without the fertilizers application (3,44 $mg.kg^{-1}$). However, the differences were not statistically significant. Bielek [3] shows that practically every result confirmed the relationship between the nitrogen rate and its content in the soil. Reddy et al. [18] also recorded that application of organic and inorganic fertilizers increased the content of nitrate nitrogen in the soil.

According to the statistical evaluation the effect of sampling periods was highly significant. In the whole trial period the highest average content of nitrate nitrogen was in the third (autumn) taking - 8,10 $mg.kg^{-1}$. Minimal average concentration was 1,38 $mg.kg^{-1}$, measured in

**Table 4** Basic statistical characteristics of measured data ($N\text{-}NO_3^-$, $N\text{-}NH_4^+$, $N_{in}$)
**Tabuľka 4** Základné štatistické parametre sledovaných ukazovateľov ($N\text{-}NO_3^-$, $N\text{-}NH_4^+$, $N_{an}$)

| Statistical characteristic (1) | Form of nitrogen (2) | | |
|---|---|---|---|
| | $N\text{-}NO_3^-$ | $N\text{-}NH_4^+$ | $N_{an}$ |
| **Number of observations (3)** | 192 | 192 | 192 |
| **Average, mg.kg$^{-1}$ (4)** | 3,78 | 4,25 | 8,02 |
| **Standard deviation (5)** | 3,4382 | 0,9767 | 3,9227 |
| **Standard error (6)** | 0,2481 | 0,0705 | 0,2831 |
| **Minimum, mg.kg$^{-1}$** | 0,95 | 2,31 | 3,43 |
| **Maximum, mg.kg$^{-1}$** | 20,85 | 8,49 | 25,55 |
| **Coefficient of variation, % (7)** | 90,98 | 22,98 | 48,94 |

(1) štatistické charakteristiky, (2) forma dusíka, (3) počet pozorovaní, (4) priemer, (5) štandardná odchýlka, (6) štandardná chyba, (7) variačný koeficient

**Table 5** Analyses of variance of $N\text{-}NO_3^-$, $N\text{-}NH_4^+$ and $N_{in}$
**Tabuľka 5** Analýza variancie $N\text{-}NO_3^-$, $N\text{-}NH_4^+$ a $N_{an}$

| Parameter (1) | Source of variability (2) | Test statistics (3) | Significant level (4) |
|---|---|---|---|
| | **Cultivation (5)** | 5,63 | 0,0188 |
| | **Fertilization (6)** | 0,99 | 0,3741 |
| **$N\text{-}NO_3^-$** | **Depth of sampling (7)** | 40,17 | 0,0000 |
| | **Sampling date (8)** | 19,08 | 0,0000 |
| | **Vegetation period (9)** | 7,85 | 0,0056 |
| | **Cultivation (5)** | 0,06 | 0,8004 |
| | **Fertilization (6)** | 3,49 | 0,0325 |
| **$N\text{-}NH_4^+$** | **Depth of sampling (7)** | 0,17 | 0,6850 |
| | **Sampling date (8)** | 18,01 | 0,0000 |
| | **Vegetation period (9)** | 0,03 | 0,8740 |
| | **Cultivation (5)** | 4,44 | 0,0365 |
| | **Fertilization (6)** | 1,91 | 0,1508 |
| **$N_{an}$** | **Depth of sampling (7)** | 34,73 | 0,0000 |
| | **Sampling date (8)** | 23,18 | 0,0000 |
| | **Vegetation period (9)** | 6,40 | 0,0123 |

> 0,05 -; < 0,05 > 0,01 +; < 0,01 ++
(1) parameter, (2) zdroj variability, (3) hodnota testovacej štatistiky, (4) signifikantná hladina, (5) spôsob obrábania, (6) variant hnojenia, (7) hĺbka odberu, (8) dátum odberu, (9) vegetačné obdobie

sixth (summer) taking before harvest.

Bielek [3] explains the high content of $N\text{-}NO_3^-$ in the soil from March to April as a result of increased activity of mineralization and nitrification and also insufficient income through the plants. He explains the depression from May to July with the high intake by the plants and deficiency of humidity for nitrification processes, and raising of $N\text{-}NO_3^-$ content in August – October he explains as the effect of improved humidity conditions, mineralization of post harvest residues and inferior or no nitrogen take-off by plants.

The effect of climatic conditions during the vegetation period has shown different values of nitrate nitrogen in monitoring depths of soil samples takings. The average content of $N\text{-}NO_3^-$ in first depth (0-0,3 m) was 4,91 mg.kg$^{-1}$ and in the second depth (0,3-0,6 m) 2,65 mg.kg$^{-1}$. From our previous works [13, 15] under the same soil-ecological conditions we came to opposite conclusions because we did not confirm the effect of depth of soil samples taking on the contents of nitrate nitrogen in the soil profile.

These different conclusions are probably the result of different rainfall conditions during the vegetation period. In our experiment more intensive autumn and winter rainfalls increased the movement of nitrates in the soil profile, what is demonstrated also by their values in individual depths in autumn or more precisely in the first spring takings. By reduction of rainfalls in the following months the migration of nitrate nitrogen into the deeper layers of soil profile significantly decreased. The similar conclusions declare also some other authors [9, 16, 19].

**Table 6** Limit values of monitoring factors at $F_{0.05}$ and $F_{0.01}$
**Tabuľka 6** Limitné hodnoty sledovaných faktorov na hladine významnosti 0,05 a 0,01

| Observed parameters (1) | Limit values (2) | | | | | |
|---|---|---|---|---|---|---|
| | $N\text{-}NH_4^+$ | | $N\text{-}NO_3^-$ | | $N_{an}$ | |
| | $F_{0.05}$ | $F_{0.01}$ | $F_{0.05}$ | $F_{0.01}$ | $F_{0.05}$ | $F_{0.01}$ |
| **Cultivation (3)** | 0,1107 | 0,1536 | 0,3644 | 0,5057 | 0,4171 | 0,5789 |
| **Fertilization (4)** | 0,1661 | 0,2174 | 0,5466 | 0,7156 | 0,6257 | 0,8191 |
| **Depth of sampling (5)** | 0,1107 | 0,1536 | 0,3644 | 0,5057 | 0,4171 | 0,5789 |
| **Sampling date (6)** | 0,3641 | 0,4575 | 1,1985 | 1,5061 | 1,3718 | 1,7240 |
| **Vegetation period (7)** | 0,1107 | 0,1536 | 0,3644 | 0,5057 | 0,4171 | 0,5789 |

(1) sledované parametre, (2) limitné hodnoty, (3) spôsob obrábania, (4) variant hnojenia, (5) hĺbka odberu, (6) dátum odberu, (7) vegetačné obdobie

Ammonium nitrogen is not the subject of such important dynamics in the soil profile as nitrate nitrogen. Many authors [4, 5, 11,12, 21] confirm this fact.

In monitored period the concentrations of ammonium nitrogen moved in essentially more narrow scope (2,31 – 8,49 mg.kg$^{-1}$) than concentrations of nitrate nitrogen. The average concentration was however higher than the average concentration of $N\text{-}NO_3^-$ (4,25+ 0,98 mg.kg$^{-1}$), what presented 53% out of $N_{in}$ concentration. The confirmation of his low dynamic is value of variation coefficient – 22,98 %.

Rate of ammonium and nitrate nitrogen in the soil is affected by agrotechnical interventions [8, 9], but it is mainly the result of long-term soil-forming in different climatic regions. In Slovakia Bielek [3] deals with this issue. He found out the prevalence of ammonium nitrogen in most soils.

According to the statistic evaluation soil cultivation did not have an evident effect on the content changes of ammonium nitrogen in the soil, what is probably caused by the fact that ammonization is more universal process than nitrification and it is not markedly affected by soil-ecological and climatic conditions [1, 2, 3, 12, 14].

The influence of fertilization on the content of ammonium nitrogen was statistically significant (tab. 5, 6). Fertilized variants had higher content of $N\text{-}NH_4^+$ than unfertilized control, what we can attribute to positive effect of fertilization on mineralization of organic matter in the soil [1].

Concentrations of ammonium nitrogen in monitored depth of soil profile were equal (4,27mg.kg in the depth 0-0,3m, 4,23mg.kg in the depth 0,3-0,6m - tab.3). Therefore we cannot claim or even disprove the statements of Suchorukova et al [23] and Smatana [19, 20], who say it is natural for more soil types that the deeper the soil is the higher ammonium nitrogen content and the lower content of nitrate nitrogen are.

The fertilizer application, resp. ploughdown pre-crop had a positive affect on increasing of inorganic nitrogen content in the soil. The highest average concentration we found in variant PZ (8,37 mg.kg$^{-1}$), whereas the difference between this variant and unfertilized control was statistically high confirmative. Similarly Reddy et al [18] show that the content of inorganic nitrogen in the soil increased by influence of fertilization.

The content of inorganic nitrogen is influenced also by depth of soil samples taking [24]. In first depth the average concentration of $N_{in}$, apart from cultivation or fertilization, was 9,18 mg.kg$^{-1}$ and in second depth decreased at 6,85 mg.kg$^{-1}$.

Reducing tillage and optimizing nitrogen fertilization are important strategies for soil and water conservation and sustainability of agricultural systems. These interacting practices can alter soil water and N availability, and thus affect N uptake, water use efficiency and crop yield. The transition from intensive to conservative tillage systems will require the modification of N use because of the effect on N dynamics in the soil-plant system, on crop productivity, and on N fertilizer use efficiency.

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