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EFFECT OF BIO-ORGANIC FERTILIZERS ON SEASONAL CHANGES OF INORGANIC NITROGEN FORMS IN THE SOIL UNDER WINTER WHEAT

VPLYV BIO-ORGANICKÝCH HNOJÍV NA SEZÓNNE ZMENY ANORGANICKÝCH FORIEM DUSÍKA V PÔDE POD PŠENICOU LETNOU F. OZIMNOU

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The experiment was conducted during the growing season 2007/8 and 2008/2009 in an experimental field. The effect of bio-organic fertilizers Condit Mineral and Condit Eco on the dynamics of inorganic nitrogen in the soil under winter wheat was investigated. The soil was sampled monthly from two sampling depths (0.0 – 0.3 m and 0.3 – 0.6 m). In these samples, we determined the contents of inorganic nitrogen forms in 1% solution of K_2SO_4, by using the colour method. Changes in inorganic nitrogen forms were observed in connection with several variables as the sampling depth, sampling date content and others. The higher contents of N-NH_4^+ were determined in the first year (2007/2008), the average content of N-NH_4^+ in this year was 6.657 mg kg^{-1} and the higher contents of nitrate nitrogen were determinate in the second year (2008/2009), the average content of N-NO_3^- in this year was 6.681 mg kg^{-1}, the average content of N-NO_3^- was 5.78 mg kg^{-1}. The results of experiment confirmed that the greater dependence on the dynamics of inorganic nitrogen in the soil had climate conditions during the growing season than the applied fertilizers. Differences between fertilized treatments were statistically no-significant. The higher content of inorganic nitrogen was in the autumn underCondit Mineral fertilizer application.

Key words: nitrogen, ammonium nitrogen, nitrate nitrogen, wheat, tillage, fertilization

Nowadays, more and more discussions are holding about healthy eating, which is dependent on healthy crops. However, each crop takes its nutrients from the soil. Nitrogen is one of the main biogenic elements, and therefore it is important to address the cycle. Increasing crop also requires awareness of input of nutrients and hence nitrogen. Claims to land are becoming higher, reducing the acreage of cultivated land, but in doing so increases the amount of the desired crop (León et al., 2002; Vale, 2007).

The most important plant nutrients include nitrogen, not only for its dominant role in shaping the crop, but also because its application poses many problems for other fertilizers show a much lesser degree. For this reason, nitrogen is still the focus of both farmers and environmentalists (Myrold and Huss-Danell, 2003). Crops according to their biological characteristics and environmental conditions in which they are grown, are able to transform into organic compounds, only a certain amount of nitrogen taken. Surplus of nitrogen, which plants take depending on its content in the soil, they remain “raw“ in the form of nitrate at risk for consumers. To ensure the crop requires a high utilization of soil nitrogen supply. The balance of the relationship between sources of nitrogen in the soil and the needs of the plants is important for the economic success of the breeder (Soon et al., 2007).

Nitrogen withdrawn with harvest is replacement by fertilizers, but which must be applied as appropriate. Effectiveness of these applications depends not only on the type of fertilizer applied, but also from land-use (Peoples, 1995; West et Post, 2002; Spagni, 2009).

Defined doses of fertilizers for agricultural crops, taking into account their demands, which are partly paid by available nutrients from the soil and to the required level of nutrients, are replenished from commercial and organic fertilizers. Information about anticipated supply of nutrients from the soil provides agrochemical soil analysis and the average utilization of specific nutrients for the plants growing season (Zumft, 1997; Malhi et al., 2006).

Toth (2007) defines Condit as bio-organic fertilizer, which combines the properties of soil improvers and mineral fertilizers. Its composition and physico-chemical and biological properties have been tested and tested in several research institutes. Condit not only fertilize the soil, but also has many positive side effects such as. reduce PCBs in the environment of 20 to 60% degraded residues of herbicides, reduces the need for pesticides, increasing soil pH acidic soils, improves production, ensuring long-term soil fertility, improves pH, stops pathogenic organisms, and improves composting of organic materials, increases the number of microorganisms in roots, improves soil structure, increases the concentration of nitrogen, calcium, phosphorus and humus in the soil, improves the better natural aroma and taste of bio-products, improving the natural life of animals, reduces CO_2 in the air under the Kyoto Protocol.

The aim of this study was to review the influence of application biological-organic fertilizers Condit Mineral and Condit Eco on the dynamic of inorganic forms of nitrogen in the soil environment.

Material and method

This experiment was carry out on an experimental basis Slovak University of Agriculture – Dolná Malanta during the growing seasons 2007/2008 and 2008/2009. The experimental base is situated in a warm climatic area, on Orthic – Luvisol, where average temperature during growing season is 16.4 °C and average annual precipitation reach to 561 mm.

The field trial was establish by the method of divided blocks perpendicular (divided into 4 parts) (Ehrenbergerová, 1995). Dimensions of plot: the experimental area size: 35.1 m × 66 m experimental plots size: 2.7 m × 6 m.

In the experiment the following treatments of fertilization were:

A – Condit E, spring application dose 0.5 t ha^{-1}

B – Condit M, spring application dose 0.5 t ha^{-1}

C – Condit E, autumn application dose 1.0 t ha^{-1}

D – Condit M, autumn application dose 1.0 t ha^{-1}

E – Without fertilization

Contents of inorganic forms (N-NO_3^- and N-NH_4^+) were determined in the soil samples. The soil was sampled monthly from two sampling depths (0.0 – 0.3 m and 0.3 – 0.6 m). In these samples we determined the contents of inorganic nitrogen forms in 1% solution of potassium sulphate (K_2SO_4), using the following methods:

N-NO_3^- – colour method by acid phenoldihydrosulphide,

N-NH_4^+ – colour method by Nessler test solution.

The contents of inorganic nitrogen forms were evaluated in tables, figures and statistically. Because the set of values had not normal distribution, we used Kruskal-Wallis Test and Pearson´s correlation coefficient to determinate the correlation between the chosen evaluated factors (Program Statgraphics Plus 5.0.1).

Results and discussion

Bio-organic fertilizer Condit is dispensed according to the needs of the crop, according to soil fertility unit and the crop rotation based on the prepared project fertilizing only once every two years. Condit fertilizer can be applied to the soil by commonly used fertilizer spreader (Vicon, Agromet), according to the needs of soil habitats and the crops. There is no need to add additional fertilizers (sulphate, nitrate) or lime, fully replaced by organic fertilizers (Ehrenbergová, 1995). Has all the substances, organisms and nutrients needed to optimize land and its life and its application is not require any other inorganic fertilizers (Ondrišík et al., 2010).

The average content of ammonium nitrogen during the whole research period was 5.56 mg kg^{-1} (Tab. 1) with standard deviation 1.2901 mg kg^{-1} (Tab. 1). The content of ammonium nitrogen was in the range 3.10 – 9.88 mg kg^{-1} (Tab. 1). Over the whole period the coefficient of variance of the ammonium nitrogen was 23.20 %, which is smaller than mentioned Ondrišík et al. (2010). The low rate of ammonium nitrogen in the soil was caused by climatic conditions. This corresponds with many authors (Soon, 2001; Garcia-Montiel, 2001; Crandall,

Table 1 Basic statistical characteristic of measured variables (N-NO_3^-, N-NH_4^+, N_{an})

	N-NH_4^+	N-NO_3^-	N_{an}
Count (1)	210	210	210
Average (2)	5.5609	5.0075	10.6551
Standard deviation (3)	1.2901	5.5396	5.5453
Standard error (4)	0.0890	0.3823	0.3827
Min (5)	3.10	0.77	5.47
Max (6)	9.88	34.02	43.84
Coefficient of variation (7)	23.20 %	110.63 %	52.04 %

Tabulka 1 Základné štatistické charakteristiky nameraných premenných (N-NO_3^-, N-NH_4^+, N_{an})
(1) počet, (2) priemer, (3) štandardná odchýlka, (4) štandardná chyba, (5) minimum, (6) maximum, (7) variačný koeficient

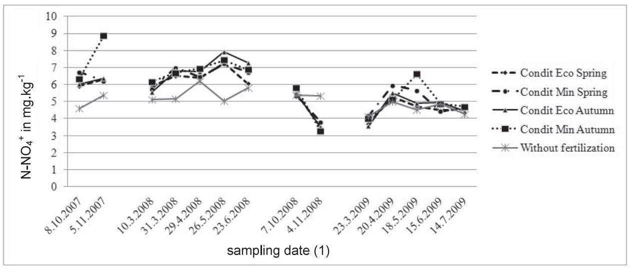

Figure 1 Dynamic of ammonium nitrogen in dependence on the fertilizer
Obrázok 1 Dynamika amónneho dusíka v závislosti od hnojenia
(1) dátum odberu

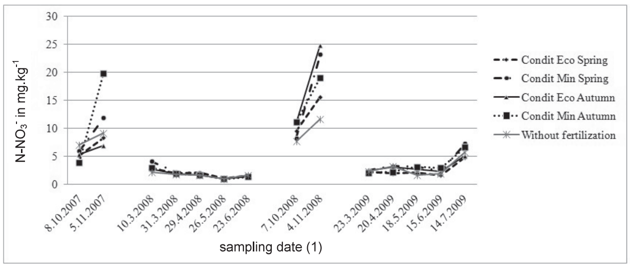

Figure 2 Dynamic of nitrate nitrogen in dependence on the fertilizer
Obrázok 2 Dynamika dusičnanového dusíka v závislosti od hnojenia
(1) dátum odberu

2005), where also determinate balanced dynamic of ammonium nitrogen in the soil. From the statistical results of the content of ammonium nitrogen in the soil, high significant effect (significant level α = 0.01) (Tab. 3) had sampling date and growing season. The rest of the parameters (fertilization) had no statistically significant effect, indicating that the dynamics of nitrogen is more influenced by climatic conditions than fertilization, which is confirmed also by Malhi et al. (2006) and Ondrišík et al. (2010). The highest content of ammonium nitrogen was detected during the second sampling date (8. 10. 2007, 9.88 mg kg^{-1}), the lowest content was during the second sampling date of the second year (4. 11. 2008, 3.513 mg kg^{-1}) (Tab. 2). The content of ammonium nitrogen was 52.19 % from the total content of inorganic nitrogen. Similar results have also Bielek (1982), Gábriš et al. (2000), Ondrišík et al. (2000) and Ondrišík et al. (2010), they also determinate dominance of ammonium nitrogen. The lowest value (5.03 mg kg^{-1}) of ammonium form of nitrogen occurred at variant without fertilization what was expected, on another hand the highest value (5,98 mg kg^{-1}) was in the case of Condit Mineral autumn application.

The nitrate nitrogen had relatively linear dynamics with lower content of nitrate nitrogen during the spring season of vegetation (March – Jun), however during November (5. 11. 2007, 4. 11. 2008) the content was almost double (Tab. 2). The average content of nitrate nitrogen over the whole research period (2007/2008, 2008/2009) was 5.01 mg kg^{-1}. The content of nitrate nitrogen was 47.81 % from the total content of inorganic nitrogen, which is almost equal to percentage of content of ammonium nitrogen. Gilliam et al. (1999) reported that the inorganic forms of nitrogen were extractable almost equally to NO_3^- and NH_4^+ in old field soils. The interval of content for nitrate nitrogen was 0.77 – 34.02 mg kg^{-1} (Tab. 1). This wide interval suggests difficult finding some correlation between watched parameters. From the statistical results of the

Table 2 Average contents of inorganic nitrogen forms over the whole research period in mg kg^{-1}

Parameter (1)		Average values in mg kg^{-1} (2)		
		$N\text{-}NH_4^+$	$N\text{-}NO_3^-$	N_{an}
Fertilization (3)	without fertilization (7)	5.030	4.132	9.596
	condit Eco spring (8)	5.428	4.355	9.782
	condit Mineral spring (9)	5.719	5.643	11.362
	condit Eco autumn (10)	5.651	5.193	10.844
	condit Mineral autumn (11)	5.976	5.715	11.691
Year (4)	2007/2008	6.657	3.772	10.429
	2008/2009	4.730	6.681	11.411
Sampling date (5)	1	5.900	7.435	13.461
	2	5.226	15.067	21.455
	3	4.840	2.654	7.598
	4	6.107	2.364	8.424
	5	6.054	2.192	8.382
	6	6.068	1.639	7.748
	7	5.661	3.699	9.372
Tillage (6)	B1	5.367	4.337	9.703
	B2	5.932	5.779	11.710
	B3	5.783	5.564	11.346

Tabulka 2 Priemerné obsahy anorganických foriem dusíka počas celeho sledovaného obdobia v mg kg^{-1}
(1) parameter, (2) priemerné hodnoty, (3) hnojenie, (4) rok,(5) dátum odberu, (6) obrábanie, (7) bez hnojenia, (8) Condit Eco – jarná aplikácia, (9) Condit Mineral – jarná aplikácia, (10) Condit Eco – jesenná aplikácia, (11) Condit Mineral – jesenná aplikácia

Tabulka 3 Kruskal-Wallis analyses

Form of Nitrogen (1)	Resource of Variability (2)	Statistic test (K – W) (3)	P-value (4)
$N\text{-}NH_4^+$	fertilization (5)	12.526	0.0138
	year (6)	96.6073	0.0000
	sampling date (7)	20.543	0.0022
	tillage (8)	7.425	0.0244
$N\text{-}NO_3^-$	fertilization (5)	2.7463	0.6011
	year (6)	22.9997	0.0000
	sampling date (7)	133.091	0.0000
	tillage (8)	2.4229	0.2978
N_{an}	fertilization (5)	8.7838	0.0667
	year (6)	0.5635	0.4529
	sampling date (7)	123.134	0.0000
	tillage (8)	10.5342	0.0052

Table 3 Štatistický test Kruskal-Wallis
(1) forma dusíka, (2) zdroj variability, (3) štatistický test (Kruskal-Wallis), (4) P-hodnota, (5) hnojenie, (6) rok, (7) dátum odberu, (8) obrábanie

nitrate nitrogen content in the soil, the statistically high significant effect (significant level α = 0.01) (Tab. 3) had just sampling date and growing season. The rest of the parameters (fertilization) had no statistically significant effect.

These data show a significant effect of weather conditions during the vegetation on the course and intensity of mineralization and nitrification and thus the content of inorganic nitrogen in the soil. The influence of weather conditions (temperature and rainfall) stack up during the vegetation by higher value of nitrate nitrogen during the first season of grooving season 7.44 – 15.07 mg kg^{-1} (Tab. 2) with the comparison of the second part of growing season 2.36 – 3.70 mg kg^{-1} (Tab. 2), which is mainly due to distribution of precipitation during the vegetation activity.

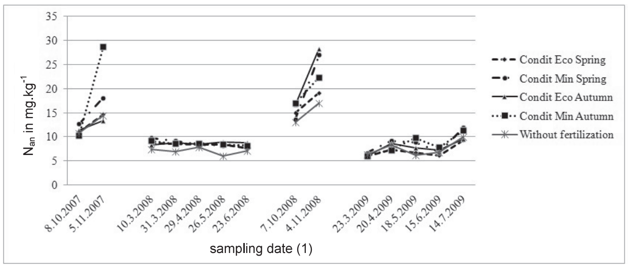

Figure 3 Dynamic of inorganic nitrogen in dependence on the fertilizer
Obrázok 3 Dynamika anorganického dusíka v závislosti od hnojenia
(1) dátum odberu

The content of nitrate nitrogen in the variant of fertilization with organic fertilizers Condit Eco and Condit Mineral was almost equal (5.22 – 5.69 mg kg^{-1}) (Tab. 2). The autumn application was more pronounced (Fig. 2) analogous to Ondrišík et al. (2010). Also in this case the lowest value (4.132 mg kg^{-1}) encountered in variant without fertilization.

In the case of inorganic nitrogen (what is actually the amount of content nitrate and ammonium nitrogen) is also its content depending on the sampling date, which confirm another authors also (Crandall et al., 2005, Davidson et al., 2000, Ondrišík, 2001, Ondrišík et al., 2010). From the date of Table 2 is shown, that statistically significant effect (significant level α = 0.01) (Tab. 3) had just sampling date, what is similar conclusion as in the case of nitrate and ammonium nitrogen.

From the observation follows that Condit Mineral fertilizer had greater influence on the content of nitrogen in the soil as fertilizer Condit Eco and also as variant without fertilization.

In the autumn application were higher average values Nan, possibly due to better biological decomposition of organic fertilizers and Condit Mineral and Condit Eco as well as lower doses of the spring application.

Conclusion

The field experiment conducted during growing seasons 2007/2008 and 2008/2009, which investigated the effect of bio-organic fertilizers Condit Mineral and Condit Eco on the dynamics of inorganic nitrogen in the soil under winter wheat confirm the significant dependence of the dynamics of inorganic nitrogen in the soil on weather conditions, mainly from rainfall associated with soil moisture. During the first growing period soil ammonium nitrogen predominated. Applied fertilizers had not significant effect on the content of inorganic nitrogen. The content of inorganic nitrogen forms was higher in the Condit Mineral treatment.

Súhrn

V poľnom stacionárnom pokuse sme v rokoch 2007/2008 a 2008/2009 sledovali vplyv bioorganických hnojív Condit Mineral a Condit Eco na dynamiku anorganických foriem dusíka v pôde pod pšenicou letnou f. ozimnou. Pôdne vzorky boli odoberané mesačne z dvoch hĺbok (0,0 – 0,3 m a 0,3 – 0,6 m). V odoberaných vzorkách sme stanovili obsahy anorganických foriem dusíka v 1% roztoku K_2SO_4 použitím kolorimetrických metód. Zmeny obsahov anorganických foriem dusíka boli sledované s viacerými premennými ako hĺbka odberu, dátum odberu a iné. Vyššie hodnoty amónneho dusíka sme zaznamenali v prvom sledovanom roku (2007/2008), priemerný obsahu amónneho dusíka v tomto roku bol 6,657 mg kg^{-1} a vyššie obsahy dusičnanového dusíka sme zaznamenali v druhom sledovanom roku (2008/2009), priemerný obsah dusičnanového dusíka v tomto roku bol 6,681 mg kg^{-1}, priemerný obsah amónneho dusíka počas celej dĺžky sledovaného obdobia bol 5,78 mg kg^{-1}. Výsledky experimentu potvrdili vyššiu závislosť dynamiky anorganických foriem dusíka v pôde od klimatických podmienok počas vegetačného obdobia ako aplikované hnojivá. Rozdiely medzi hnojenými variantmi neboli štatisticky významný. Vyššie obsahy anorganických foriem dusíka boli vo variantne s jesennou aplikáciou hnojiva Condit Mineral.

Kľúčové slová: dusík, amónny dusík, dusičnanový dusík, pšenica, obrábanie, hnojenie

Referrences

BIELEK, P. 1982. Intenzita akumulácie dusíkatých zlúčenín ako funkcia pedoekologického stanovišťa. II. Zovšeobecnené pre podmienky SR. In: Poľnohospodárstvo, roč. 28, 1982, č. 3, s. 206 – 216.

CONDIT pre zúrodňovanie pôdy, unikátny slovenský výrobok hnojivo – kondicionér – liek. [online]. [cit. 28.11.2011]. Dostupné na internete: <http://archiv.condit sk/>.

CRANDALL, S. M. – RUFFO, M. L. – BOLLERO, G. A. 2005. Cropping system and nitrogen dynamics under a cereal winter cover crop preceding corn. In: Plant and Soil, vol. 268, 2005, no. 1 – 2, p. 209 – 219.

DAVIDSON, E. A. – VERCHOT, L. V. 2000. Testing the hole-in-the-pipe model of nitric and nitrous oxide emissions from soils using the TRAGNET databaze. In: Global Biogeochemistry Cycles, vol. 14, 2000, no. 4, p. 1035 – 1043.

EHRENBERGEROVÁ, J. 1995. Zakládání a hodnocení pokusu. Brno: MZLU, 1995. 109 s. ISBN 80-7157-153-9.

GÁBRIŠ, Ľ. – ONDRIŠÍK, P. – BERNHAUSEROVÁ, M. 1995. Dynamika amoniakálneho dusíka v ílovitej fluvizemi. In: Poľnohospodárstvo, roč. 41, 1995, č. 1, s. 1 – 9.

GARCIA-MONTIEL, D. C. – STEUDLER, P. A. – PICCOLO, M. C. – MELILLO, J. M. – NEILL, C. – CERRI, C. C. 2001. Controls on soil nitrogen oxide emissions from forest and pasture in the Brazilian Amazon. In: Global Biogeochemistry Cycles, vol. 15, 2001, no. 4, p. 1021 – 1030.

GILLIAM, F. S. – MAY, J. D. – FISHER, M. A. – EVANS, D. K. 1999. Short-term changes in soil nutrients during wetland creation. In: Wetlands Ecol Mgmt, vol. 6, 1999, no. 4, p. 203 – 208.

LEÓN, J. – VELÁZQUEZ, P. 2002. Rotación de cultives mais, frijol, trigo en la Mixteca Oaxaquena. In: CIMMYT NRG Copublicacion, vol. 98, 2002, no. 2, p. 54 – 56.

MALHI, S. S. – LEMKE, R. – WANG, Z. H. – CHHABRA, B. S. 2006. Tillage, nitrogen and crop residue effects on crop yield, nutrient uptake, soil quality, and greenhouse gas emissions. In: Soil and Tillage Research, vol. 90, 2006, no. 1 – 2, p. 171 – 183.

MYROLD, D. D. – HUSS-DANELL, K. 2003. Alder and lupine enhance nitrogen cycling in a degraded forest soil in Northern Sweden. In: Plant and Soil, vol. 254, 2003, no. 1, p. 47 – 56.

ONDRIŠÍK, P. – JEDLOVSKÁ, L. – FRIDRICHOVÁ, M. 2000. Obsah anorganických foriem dusíka v pôde pod zeleným úhorom. In: Acta fytotechnica et zootechnica, roč. 3, 2000, č. 4, s. 101 – 103.

ONDRIŠÍK, P. 2001. Obsah anorganických foriem dusíka v pôde pod monokultúrou kukurice. In: Poľnohospodárstvo, roč. 47, 2001, č. 12, s. 913 – 922.

ONDRIŠÍK, P. – URMINSKÁ, J. – PORHAJAŠOVÁ, J. – PAČUTA, V. – ČERNÝ, I. – SOVIŠOVÁ, M. 2010. Dynamika anorganického dusíka v pôde pod repou cukrovou v závislosti od aplikovaných hnojív. In: Listy cukrovarnícke a řepářské, roč. 126, 2010, č. 11, s. 372 – 375. ISSN 1210-3306.

PEOPLES, M. B. – MOSIER, A. R. – FRENEY, J. R. 1995. Minimizing gaseous losses of nitrogen. In BACON, P. E.: Nitrogen fertilization in the environment, Sydney, 1995, p. 565 – 602. ISBN 0-8247-8994-6.

SOON, Y. K. – ARSHAD, M. A. – HAQ, A. – LUPWAYI, N. 2007. The influence of 12 years of tillage and crop rotation on total and labile organic carbon in a sandy loam soil. In: Soil & Tillage Research, vol. 95, 2007, no. 4, p. 38 – 46.

SOON, Y. K. – CLAYTON, G. W. – RICE, W. A. 2001. Tillage and previous crop effects on dynamics of nitrogen in a wheat-soil system. In: Agronomy Journal, vol. 93, 2001, no. 4, p. 842 – 849.

SPAGNI, A. – MARSILI-LIBELLI, S. 2009. Nitrogen removal via nitrite in a sequencing batch reactor treating sanitary landfill leachate. In: Bioresource Technology, vol. 100, 2009, no. 2, p.609 – 614.

TÓTH, Š. Condit [online] [28.11.2011]. Dostupné na internete: http://scpv-ua.sk/index.php/2007-pr-18/37-condit

VALE, M. – MARY, B. – JUSTES, E. 2007. Irrigation practices may affect denitrification more than nitrogen mineralization in warm climatic conditions. In: Biol Fertil Soils, vol. 43, 2007, no. 6, p. 641 – 651.

WEST, T. O. – POST, W. M. 2002. Soil carboon sequestration by tillage and crop rotation: a global data analysis. In: Soil Sci Soc Am J, vol. 66, 2002, no. 6, p. 1930 – 1946.

ZUMFT, W. G. 1997. Cell biology and molecular basis of denitrification. In: Microbiol Mol Biol Rev, vol. 61, 1997, no. 4, p. 533 – 616.

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