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Effect of tillage and fertilization on soil N_{in} forms

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The aim of this study was to evaluate the effect of different tillage, fertilization, depth of soil sampling and date of sampling on dynamics of N_{in} forms in a Haplic Luvisol under winter wheat (*Triticum aestivum* L.). In the experiment three main tillage systems for winter wheat were used: B1 = conventional tillage (to 0.25 m); B2 = shallow tillage (to 0.20 m); B3 = minimization tillage (to 0.15 m). Three variants of the fertilization were used within each treatment: 0 = unfertilised control; PH = NPK fertilization; PZ = NPK fertilization + plough down of postharvest residues. The highest average concentration of inorganic nitrogen (28.68 mg kg^{-1}) was found in autumn period. It was result of more favourable temperature and moisture conditions in the soil and also of poor uptake by plants. Based on our results, the highest concentration of N_{in} was found under shallow tillage (14.07 mg kg^{-1}). Analysis of variance showed that only fertilization ($p=0.8956$) had no statistically significant effect on amount of N_{in}. Despite this fact, slight increase of concentration of inorganic nitrogen has been seen in the variant PZ (13.33 mg kg^{-1}) compared with variants PH (13.11 mg kg^{-1}) and 0 (13.21 mg kg^{-1}). On the basis of our results we can conclude that soil and climatic conditions were major factors that influenced concentration of N_{in} in the soil.

Keywords: ammonium nitrogen, nitrate nitrogen, tillage, fertilization, winter wheat

1 Introduction

Wheat is the most widely grown crop in the world and provides 20 % of the daily protein and of the food calories for 4.5 billion people. It is the second most important food crop in the developing world after rice (FAO, 2012). The aims of agricultural N management are to provide enough N to plants to maximize crop growth and yield and to minimize environmental impact of other ecosystems (Giola et al., 2012; Guo et al., 2012). Chen et al. (2011) reported that good fertilizer management can improve soil quality, but poor fertilizer management can degrade soil physical, chemical, and biological properties. Since we need to improve knowledge on nitrogen dynamics and nitrogen balance, which are essential to increase the N use efficiency through minimizing nitrogen losses, determine optimal levels of N-fertilizer application (Devkota et al., 2013). Conservation tillage increases the amount of crop residue left in the soil after harvest, thereby reducing soil erosion and increasing organic matter, aggregation, water infiltration, water holding capacity (Franzluebbers et al., 1999) and decreasing N loss from fields compared with conventional tillage (Patni et al., 1998). Aim of this study was to observe the effect of different tillage and fertilization on dynamics of inorganic nitrogen forms in soil under winter wheat during the growing season 2012/2013.

2 Material and Methods

The study site was located at Dolná Malanta (48°19'N, 18°09'E) in southwest region of Slovak Republic during the growing season 2012/2013. Locality Dolná Malanta is in 175 – 185 m above sea level and belongs to warm climate zone. A mean temperature of growing season was 10.8 °C and a mean annual rainfall was 669.4 mm. The studied soil was

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a Haplic Luvisol (loess parent material). The experiment was organized by method of vertically divided blocks (divided into four parts). For each tillage systems were randomly placed three variants of the fertilization. Experiment had four replications.

The field was planted with winter wheat (*Triticum aestivum* L.) and preceding crop was pea (*Pisum sativum*). WE used three main tillage systems for winter wheat: B1 = conventional tillage (to 0.25 m); B2 = shallow tillage (to 0.20 m); B3 = minimization tillage (to 0.15 m). Within each treatment were used three variants of the fertilization: 0 = unfertilised control; PH = NPK fertilization according to its content in soil, as well as requirement of winter wheat to grain yield 6 tons; PZ = NPK fertilization according to its content in soil, as well as requirement of winter wheat to grain yield 6 tons + plough down of postharvest residues. Dynamics of inorganic nitrogen forms was monitored in two soil depth (0 – 0.3 m; 0.3 – 0.6 m).

Soil samples were taken in the two weeks intervals, in the growing season 11 takings of soil samples were made. In the collected samples were determined contents of inorganic nitrogen forms ($N\text{-}NO_3^-$ and $N\text{-}NH_4^+$) in 1% solution of potassium sulphate (K_2SO_4) by the following methods: $N\text{-}NO_3^-$ → by acid 2.4-phenoldihydrosulphide; $N\text{-}NH_4^+$ → by Nessler test solution. The results were processed by mathematical-statistical methods (programs Statgraphics Plus 5.0 and MS Excel).

3 Results

On the basis of our results, the concentration of $N\text{-}NO^{3-}$ was 6.20 mg kg^{-1}, which represents 46.9 % from total inorganic nitrogen. Dynamics of $N\text{-}NO_3^-$ were significant during the whole growing season. It is characterized by its high coefficient of variation (129.36 %) and also by its minimum concentration – 1.29 mg kg^{-1} and maximum concentration 39.18 mg kg^{-1}. Tillage, depth of soil sampling and date of sampling, show a statistically significant effect on concentration of nitrate nitrogen at the 99% confidence level. On the other hand, fertilization had no statistically significant effect on $N\text{-}NO_3^-$.

Dynamics of $N\text{-}NH_4^+$ did not show significant changes against the dynamics of $N\text{-}NO_3^-$. Its coefficient of variation was approximately three times lower (41.96 %). Values of $N\text{-}NH_4^+$ varied between 0.36 – 17.25 mg kg^{-1} and its average concentration was 7.02 mg kg^{-1}. Tillage and date of sampling have statistically significant effect on $N\text{-}NH_4^+$ concentration at the 99% confidence level ($P < 0.01$). Fertilization and depth of soil sampling had no statistically significant effect on $N\text{-}NH_4^+$.

The highest concentration of N_{in} was found in the autumn period. Ondrišík et al. (2009) also found more significant concentration of N_{in} in autumn period. It is associated with more favourable temperature and humidity parameters in this season of year. For the statistical evaluation tillage, depth of soil sampling and date of sampling had statistically significant influence on the content of inorganic nitrogen.

The result showed that tillage treatments B2 (14.07 mg kg^{-1}) and B3 (13.57 mg kg^{-1}) increased N_{in} compared with conventional tillage (B1 = 12.00 mg kg^{-1}). Derpsch et al. (2010) also reported many other positive effects of shallow tillage respectively minimization tillage. They indicated that conservation tillage systems such as shallow cultivation, reduced- or no-till, have been adopted extensively in several countries of the world during the last few decades. This was mostly due to labour and energy savings, reduced soil erosion and better soil moisture conservation.

On the base of our results, without statistical significance was only fertilization. Despite this fact, we can observe moderate increase in variant PZ = 13.33 mg kg^{-1} compared with variant PH = 13.11 mg kg^{-1} and also variant 0 = 13.21 mg kg^{-1}. Crop residues are an important source of nutrients, which can positively influence the biological, chemical and physical properties of soil. Cassman et al. (1996) have also found that the incorporation of crop residues increases total nitrogen in soil.

4 Conclusions

We found out that tillage, depth of sampling and date of sampling had statistically significant effects on the concentration of inorganic nitrogen in the soil under wheat. On the other hand, fertilization did not show a statistically significant influence on N_{in}. Shallow tillage significantly increased inorganic nitrogen concentration. This treatment may also reduce labour costs and the use of fossil fuel when preparing fields for crop growing. The results indicated that dynamics of inorganic nitrogen was mainly influenced by soil and climatic conditions in our region. This fact was confirmed by significantly higher amount of N_{in} in the autumn period, which ensure favourable amount of necessary nutrient for initial growth of the winter wheat.

5 Ackwledgements

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