**Сельское хозяйство. Текст 1.**

 **Nitrogen efficiency of spring barley in long-term experiment**

**Š. Shejbalová, J. Černý, F. Vašák, M. Kulhánek, J. Balík**

*Department of Agro-Environmental Chemistry and Plant Nutrition, Facultyof Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Prague, Czech Republic*

**ABSTRACT**

The aim of this study was to evaluate nitrogen (N) efficiency from different organic and mineral fertilizers applied to the spring barley. Dry matter yield, N content and N uptake of spring barley from 16 years of experiments at two sites in the Czech Republic with different soil and climatic conditions were analyzed. For assessing of nitrogen ef­ficiency nitrogen utilization efficiency (NUtE, kg/kg), recovery efficiency of applied N (%), agronomic efficiency of applied N (kg/kg) and summary N balances (ΣΔN, kg/ha) were observed. Six fertilization treatments were utilized: no fertilization (control); sewage sludge; farmyard manure (FYM); N in mineral fertilizers (N); NPK in mineral fertilizers (NPK) and N in mineral fertilizers + straw (N + ST). Yields were about 68% higher at NPK (S1 site) and 55% at N + ST (S2 site) in comparison with control. The highest NUtE was recorded at both locations after applica­tion of FYM. Higher NUtE from mineral fertilizers was obtained at low productive S1 site. At both sites a trend of decreasing ΣΔN over time was observed. At both sites a trend of decreasing negative N balance was observed. At lower productive site the decline of N balance was minimized for mineral fertilizers treatments in last experimental years. At higher productive site the differences between treatments with mineral nitrogen and control were lower and the decline of N balance continued over all 16 years of experiment duration.

**Keywords**: N balance; mineral fertilizers; organic fertilizers; yield; nitrogen utilization

 Barley (*Hordeum vulgare* L.) is an important cereal, which is grown in many parts of world. In 2011 the total growing area for barley was 54 millionhectares with production of around 152 mil­lion tons. It is the third most important cereal in Europe after wheat and maize (FAO 2011). Efficient nitrogen fertilization is essential for economic production and protection of the environment. For this reason improvement in nitrogen use ef­ficiency (NUE) has become a desirable goal in barley research. Nitrogen use efficiency in the crop is influenced by N uptake from the soil, N assimilation in the plant and N redistribution from vegetative parts to the grain (Andersson and Holm 2011). The key targets of the NUE research are to increase the proportion of N recovered from the soil (REN) and to obtain an enhanced efficiency of utilization of the N taken-up for yield forma­tion (NUtE). Increased N recovery and utilization efficiency may allow growers to maximize yield under a moderate rate of N fertilization instead of the high rate of N fertilization (Anbessa and Juskiw 2012, Bingham et al. 2012). If N is applied and not taken up by the crop or immobilized in soil organic N pools, which include both micro­bial biomass and soil organic matter, is vulnerable to losses from volatilization, denitrification and leaching (Cassman et al. 2002). Only 30–50% of applied nitrogen fertilizer is taken up by crops (Dobermann 2005), hence the improvement in NUE is important to reduce input costs and the negative impact of excessive N on the environment (Snyder 2009, Anbessa and Juskiw 2012).

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**MATERIAL AND METHODS**

**Experimental site**. The experiment was es-tablished in 1996 in the Czech Republic – at two sites with different soil and climatic conditions: S1 (Humpolec, 49°33'16''N, 15°21'2''E), S2 (Červený Újezd, 50°4'22''N, 14°10'19''E). S1 site is localized 525 m a.s.l., average annual temperature is 7°C with 665 mm average annual precipitation. The soil type is Cambisol with sandy loam soil texture. S2 site is 410 m a.s.l., average annual temperature is 7.7°C with 493 mm average annual precipitation. The soil texture at S2 site is silt loam (Luvisol). A simple crop rotation included: potatoes (S1)/silage maize (S2), winter wheat and spring barley. Each year all of the crops were grown. Fertilization treatments were repeated in three blocks. The size of experi­mental plots was 60 m2 at S1 and 80 m2 at S2 site.

**Field experiment**. Six fertilization treatments were utilized: 1. no fertilization (control); 2. sew­age sew­age sludge (SS); 3. farmyard manure (FYM); 4. Nin mineral fertilizers (in calcium ammonium ni­trate) (N); 5. NPK in mineral fertilizers (NPK) and 6. mineral N fertilizers + 5 t/ha spring barley straw (N + ST). The whole experiment was based on the same nitrogen rate 330 kg N/ha to the crop rotation (of which 70 kg N/ha to the spring bar­ley) except the non-fertilized control treatment as detailed in Table 1. By this rate of nitrogen high yields with adequate grain crude protein were achieved for malting barley (Pettersson and Eckersten 2007). Organic fertilizers (sewage sludge, farmyard manure, straw) were applied in autumn only to the potatoes (S1)/silage maize (S2) in the crop rotation. Mineral N fertilizers were applied to the spring barley before sowing. Between the years 1996–2004 cv. Akcent of spring barley was grown, between 2005–2011 cv. Calgary and then in 2012 cv. Xanadu.

**Plant sampling and analysis**. Plant samples were collected after the plants were harvested (at maturity). Results of the experiment were ob­tained from the years 1997–2012, which means five crop rotations. Determination of total nitrogen was carried out by the Kjeldahl method on the KjeltecAuto 1030 Analyzer (Tecator, Hoganas, Sweden) (1997–2005) and Vapodest 50s (Gerhardt Gmbh & Co. KG, Germany) (2006–2012).

**Сельское хозяйство. Текст 3.**

**RESULTS AND DISCUSSION**

The average dry matter yield, N content in DM and N uptake by grain and straw of spring barley are shown in Table 2 (S1 and S2). DM yield of grain and straw was similar at both locations, however a slightly larger yield was achieved at S1 site. The highest increases of yield were obtained after us­ing nitrogen in mineral form. The increased yields were about 68% by NPK (S1) and 55% by N + ST (S2) higher in comparison with non-fertilized treatment. Obtaining the highest yields after using nitrogen in mineral forms confirm Cossani et al. (2009), who achieved 4.5 t/ha of barley grain after the application of 80 kg N/ha and by Cantero-Martinéz et al. (2003), who obtained, in a 3 year experiment, an average yield of 4.3 t/ha after an annual dose of 75 kg N/ha. The effect of treatment on grain yield was highly significant at both sites: S1 (*df* = 5; *F* = 11.833; *P* < 0.05), S2 (*df* = 5; *F* = 9.532; *P* < 0.05), differences in post-hoc test are in Tables 2 and 3. DM yields of unfertilized control treatment were more balanced at S2 site, situated on Luvisol. The effect of soil type on sustainable production of crops confirms the results of many studies (Kunzová and Hejcman 2009, Černý et al. 2010, Hejcman et al. 2012). The highest increase of nitrogen content in grain was achieved at S1 by N treatment (10% higher than control) and at S2 by N + ST (26% higher than control) and by uptake of nitrogen at both sites by N + ST. Use of fertilizers with nitrogen in mineral form at S2 site led to significantly higher content of nitrogen in grain and straw compared to unfertilized treat­ment, which is in agreement with many research­ers (Pettersson and Eckersten 2007, Sedlář et al. 2011, Hejcman et al. 2013). Previous application of organic fertilizers resulted in lower or com­parable value of nitrogen content to unfertilized treatment. Delogu et al. (1998) in the experiment with nitrogen fertilization of barley, described that after using of 80 kg N/ha average nitrogen content in grain increased about 18% compared to unfertilized treatment.

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Average values of NUtE, REN and AEN can be found in Table 3. Higher efficiency of nitrogen from mineral fertilizers was evaluated at low productive S1 site. This confirms Hejcman et al. (2012), who found a negative influence of naturally fertile soils (situated in lowlands) on the efficiency of mineral N application due to insufficient precipitation at these sites. On the contrary the efficiency of nitrogen from organic fertilizers was greater at S2 site. Angás et al. (2006) published results from the 3 year experiment on the effects of nitrogen fertilization on barley. After application of 75 kg N/ha in mineral form average NUtE was 56.6 kg/kg,which corresponds to our results. Higher values of NUtE occurred at treatments with organic fertil­ization compared to the treatments with mineral form of nitrogen. It was probably caused by lower available nitrogen in the third year of using organic fertilizers. The highest NUtE was recorded at both locations after application of FYM because of lower N content in grain at FYM treatment compared to treatment with mineral N fertilizers. There is also effect of increased post-anthesis nitrogen uptake from soil due the higher mineralization of organic residues from FYM at this treatment (Montemurro et al. 2006). Yield of barley is limited by the storage capacity (sink) of grains rather than the supply of assimilate for grain filling. A limited storage capacity may lead to feedback inhibition on the rate of photosynthesis post-anthesis (Bingham et al. 2007). For treatment with mineral fertilizers average values of REN ranged between 46.2% (N) and 60.3% (N + ST). Snyder (2009) and Ladha et al. (2005) determined values of REN between 30–50% as typical for N recovery in cereals and values between 50–80% as achieved in the best management in cereals. At S1 site lower values of REN were observed than in S2, it signalized a greater risk of nitrogen losses at S1, which can be due to sandy loam soil texture. The average of AEN for treatments with nitrogen in mineral form was 25 kg/kg. N agronomic efficiency is according to Delogu et al. (1998) a parameter representing the ability of the plant to increase yield in response to N applied. The agronomic efficiency of N widely depends on growing conditions (Mengel et al. 2006).

**Сельское хозяйство. Текст 5.**

 **The influence of fertilization and crop rotationon the winter wheat production**

**M. Babulicová**

*National Agricultural and Food Centre Lužianky – Research Institute of Plant Production Piešťany, Piešťany, Slovak Republic*

**ABSTRACT**

In a long-term field experiment winter wheat was grown in crop rotations with 40, 60 and 80% proportion of ce­reals. Two levels of fertilization were used: H1 – mineral fertilization N, P, K + organic fertilization Veget®; H2 – only mineral fertilization N, P, K. Winter what was grown after two preceding crops: pea and winter barley. In2010–2012 the grain yield of winter wheat after pea was statistically higher at fertilization with mineral fertiliz­ers N, P, K and organic manure Veget® (7.15 t/ha) in comparison with mineral fertilizers only (6.65 t/ha). In crop rotation with 80% of cereals the grain yield of winter wheat after pea as a preceding crop was statistically higher(6.81 t/ha) than after winter barley (5.59 t/ha). The rising of grain yield at 1.9 t/ha was achieved by suitable preced­ing crop (pea) and by combined fertilization (mineral fertilizers N, P, K + organic manure Veget®). The grain yield of winter wheat 5.24 t was obtained by mineral fertilization N, P, K only and after winter barley. By mineral fertiliza­tion N, P, K + organic manure Veget®) and after pea as a preceding crop the grain yield of winter wheat 7.14 t/ha was reached.

**Keywords**: crop rotation; *Triticum aestivum*; proportion of cereals; grain yield; bulk weight

 In agricultural production the crop rotations are always one of the principal agrotechnical measures which contribute to increased crop production. From foreign and national literature it follows that farms use high proportion of cereals and the pro­portion of root crops decreases. In crop rotations they use the cereals after cereals, in better case after oil crops. By a higher proportion of cereals the decrease of grain yield is expected. In general, the reasons of grain yield decrease lie in the damage caused by fungal diseases, stronger weed infesta­tion rate, the degradation of soil structure and in negative impacts on the water and air regime. Other reasons include the worse balance of humus in the soil and the nutrient-supply. According to Khosro et al. (2011) cropping systems in Iran farmland areas are characterized by continuous cultivation of crops with consumption of chemical fertilizer leading to serious soil erosion and fertility decline. The disrupted balance of agro-ecosystem can be compensated by rotation of crops with various requests on the nutrients. We can keep the stability of agrosystem by using adequate input of organic and mineral fertilisers as well as by using the suit­able applications of pesticides. The efficiency of nitrogen fertilization is evaluated most often with respect to the amount of qualitative changes in grain yield. However, a thorough evaluation of the results of fertilization requires a wider approach (Kolodziejczyk et al. 2013). Engström and Bergkvist (2009) in their the study quantified the effect of three N fertilization strategies on the number of tillers at growth stage (GS) 30–31 and the grain yield of winter wheat. They suggested the N ap­plication before growth stage 30 to avoid yield reductions. Kato and Yamagistri (2011) investigated the growth response of winter wheat to different fertilization regimes in long-term experiments.