Field Crop Studies (2018) XI(2): 203-210
http://fcs.dai-gt.org/bg/
ISSN: 2535-1133 (Online)
ISSN: 1312-3882 (Print)

ORIGINAL PAPER

Influence of the urea fertilization on the N, P, K and crude protein content in grain of winter barley (*Hordeum vulgare* L.)

Nesho Neshev[1] • Mariyan Yanev[1] • Anyo Mitkov[1] • Tonyo Tonev[1]

[1] Agricultural University of Plovdiv, Bulgaria

Corresponding Autor: Nesho Neshev; E-mail: n_neshev85@abv.bg

Received: October 2018 / Accepted: October 2018 / Published: December 2018

Abstract

Neshev, N., Yanev, M., Mitkov, A. & Tonev, T. (2018). Turkish seed sector: Current situation and future directions. Field Crops Studies, XI(2), 203-210.

During the period 2017-2018, a field study with winter barley (*Hordeum vulgare* L.) was conducted. The experiment was situated in the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. The trial was conducted by the randomized block design in 4 replications with the winter barley variety "Emon". The experiment included unfertilized control and three variants with fertilizer application that included Urea 125 kg/ha, Urea 165 kg/ha and Urea 250 kg/ha. The fertilization was performed in late winter - February. With the increasing of the fertilizer rates the nitrogen content in grain also increased. The highest nitrogen content was reported after the application of Urea 250 kg/ha – 2,62% average for the period. No influence of fertilization on the phosphorus content in the grain was found. At all variants, including the unfertilized control, the content of this macronutrient varied from 0,53% to 0,54% and the difference between the variants was not statistically proved. With increasing of the fertilizer rates, the potassium content in grain decreased. The potassium content in barley's grain was the highest for the unfertilized control – 0,41% and was the lowest after the application of Urea 250 kg/ha – 0,32% average for the period. The differences in the potassium content in grain between the two variants were statistically proved. A positive correlation regarding the crude protein content in grain was established. With increasing of the urea rates the grain crude protein content increased. The highest content of crude protein was recorded after the application of Urea 250 kg/ha – 14,90% average for both experimental years.

Key words: Barley, Content of N, P and K in grain, Fertilization, Urea

Introduction

Barley is a crop with a great importance for alcoholic beverages (Stoyanov, 2014). It is produced for forage and raw material for beer production. The barley

is one of the main cereals for Bulgaria. The brewing barley takes over 60%, and the forage barley - over 40% of the total production in the country (Penchev et al., 2004). For brewing barley, the most used rates of nitrogen are from 80 до 120 kg N/ha (Koteva, 2000). The high nitrogen rates increase the protein content in the grain, which above certain limits decreases the quality of barley's grain (Peev and Krusteva, 1989). Unlike the forage barley, the brewing should be fertilized with low nitrogen rates from the quality point of view. The quality of the brewing barley must meet a number of requirements: homogeneous and even grain; the protein content should not exceed 12%; etc. (Nikolova, 2010). On the content of nitrogen in the grain, respectively the raw protein content is affected by many factors. During the grain pouring, the nitrogen is redistributed from the vegetative parts to the grain. The roots remain active during grain pouring, where high nitrogen content in the soil at the end of vegetation may cause a higher percentage of nitrogen in the grain (Gastal and Lemaire, 2002). Ivanova et al. (2013) conclude that the influence of mineral fertilization and environmental conditions are determining the protein content of the barley grain. The gradual increase of the nitrogen fertilization increases the protein content in barley grain, and also the predecessor has a significant effect on the protein content in the grain. After an annual legume predecessor (pea) the crude protein content in the grain is the highest, and after predecessor oilseed rape – the lowest.

The aim of the study is to determine the content of nitrogen, phosphorus and potassium as well as the crude protein content in the grain of winter brewing barley grown after forage pea.

Materials and methods

A field study with winter brewing barley during the period of 2017-2018 was conducted. In the experiment, the effect of the urea fertilization on the content of nitrogen, phosphorus and potassium as well as the crude protein content in the grain of the barley variety „**Emon**" was evaluated. The variety is winter brewing barley, bred in the Institute of Agriculture – Karnobat, Bulgaria. Its botanical affiliation is *H. vulgare, subsp. distichon (L.) Koern*. The stem is middle in height – average 88 cm with very good resistance to lodging. Spiclet – double-row, var. erectum, with average length of 6.8 *cm*. Grain – wholesale, flattened, suitable for brewing purposes. The protein content varies from 11 to 12 % (Mersinkov, 2003).

The experiment was situated in the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. A predecessor of the barley during the two experimental years was forage pea (*Pisum sativum* L.). The trial includes 4 variants in 4 replications as follows: 1. Unfertilized control; 2. N 58,5 kg/ha active substance (Urea 125 kg/ha); 3. N 75,9 kg/ha active

substance (Urea 165 kg/ha) and 4. N 117,0 kg/ha active substance (Urea 250 kg/ha). The nitrogen was applied as Urea (46% N) in winter – February. All variants including the control were fertilized with phosphorus as Triple superphosphate and potassium as Potassium sulfate at rates of 60 and 90 kg active substance per hectare respectively. The soil of the trial field is with pH 7.4. The content of available nutrients before the beginning of the experiment was 53,98 mg/kg N_{min}, 32,75 mg P_2O_5 and 31,81 mg K_2O/100 g soil.

For establishing the content of nutrient elements in the barley's grain the taken samples were dried 60 °C. They were mineralized with concentrated H_2SO_4, and as catalyst H_2O_2 was used. The nitrogen content was determined by the Kjeldahl method by distillation in apparatus of Parnas-Wagner (Tomov et al., 2009). The phosphorus was determined calorimetrically on spectrophotometer Camspec M105 (Tomov et al., 2009), and the potassium – photometrically on flame photometer PFP-7 (Ivanov and Krastev, 2005). For calculation of the crude protein content in the grain, the values of N content were multiplied by coefficient 5,70.

For statistical analysis of the collected data, Duncan's multiple range test and regression analyses from the software of SPSS 19 program were used.

Results and discussion

Increasing nitrogen rates increases the content of the element in plant parts (AL-Humaid, 2003). The same statement was observed in the present study. Increasing N rates led to a higher content of the element in the barley's grain. The N content in the grain between the fertilized with urea variants varied from 2,23% at variant 2 (Urea 125 kg/ha) to 2,62% at variant 4 (Urea 250 kg/ha). The differences between the variants are with proved differences according to Duncan's multiple range test ($p < 0,5$). The lowest N content was determined in the grain of the control plants – 1,96 % average for the period of the study (Table 1).

Table 1. Content of nitrogen (N) in the grain of barley, %

Variants/Years	2017	2018	Average for the period
1. Unfertilized control	2,01 d	1,91 d	1,96 d
2. Urea 125 kg/ha	2,29 c	2,16 c	2,23 c
3. Urea 165 kg/ha	2,43 b	2,32 b	2,38 b
4. Urea 250 kg/ha	2,54 a	2,69 a	2,62 a

Figures with different letters are with proved difference according to Duncan's multiple range test ($p < 0.05$).

The phosphorus content in the grain of the studied barley variety was not influenced by the applied fertilization in our experiment. At all variants including the control, the content of phosphorus varied from 0,53 to 0,54% average for the

period and the differences in the values of the different variants were not statistically proved according to Duncan's multiple range test.

Table 2. Content of phosphorus (P) in the grain of barley, %

Variants/Years	2017	2018	Average for the period
1. Unfertilized control	0,56 a	0,51 a	0,53 a
2. Urea 125 kg/ha	0,58 a	0,50 a	0,54 a
3. Urea 165 kg/ha	0,51 a	0,56 a	0,53 a
4. Urea 250 kg/ha	0,54 a	0,55 a	0,54 a

Figures with different letters are with a proved difference according to Duncan's multiple range test ($p < 0.05$).

Increasing N rates led to decreasing of potassium content in the barley's grain. The highest values were recorded for the control – 0,41% average for the period (Table 3). The potassium content in the grain at variant 2 (Urea 125 kg/ha) was lower – 0,38%. After the fertilization with Urea 165 kg/ha (variant 4) the content of potassium decreased to 0,36%. The difference in the potassium content in the grain from control was statistically proved with the other variants of our trial (Table 3).

Table 3. Content of potassium (P) in the grain of barley, %

Variants/Years	2017	2018	Average for the period
1. Unfertilized control	0,40 a	0,41 a	0,41 a
2. Urea 125 kg/ha	0,37 a	0,39 a	0,38 a
3. Urea 165 kg/ha	0,37 b	0,35 b	0,36 b
4. Urea 250 kg/ha	0,31 c	0,33 c	0,32 c

Figures with different letters are with a proved difference according to Duncan's multiple range test ($p < 0.05$).

With increasing of nitrogen fertilization rates the content of crude protein in the grain of barley is also increased (Bishop and MacEachern, 1971; Del Moral et al., 1985; Qi et al, 2006; Slamka et al., 2008; Bleidere et al., 2013; Noworolnik et al., 2014). The obtained results from our study confirmed this statements. After the increase of the fertilizer rates the crude protein in the grain increased. The protein content is with close connection with the grain nitrogen content. In the control, the protein content is within optimal limits - 11,17%, which does not decrease the quality of brewing barley. This optimal content is probably due to the fact that barley is grown after forage peas as a predecessor significantly enriching the soil with nitrogen. It was established that after the fertilization with Urea 165 kg/ha (variant 3) the barley grain quality began to decrease as the protein content reached unwanted from the brewing industry levels – 13,54% average for the period of the study. At the highest fertilizer rate, the crude protein content in the barley's grain

ISSN: 2535-1133 (Online)
ISSN: 1312-3882 (Print)

reached 14,90% which is decreasing the quality of the barley more obviously.

Table 4. Content of crude protein in the grain of barley, %

Variants/Years	2017	2018	Average for the period
1. Unfertilized control	11,45 d	10,88 d	11,17 d
2. Urea 125 kg/ha	13,05 c	12,31 c	12,68 c
3. Urea 165 kg/ha	13,85 b	13,22 b	13,54 b
4. Urea 250 kg/ha	14,47 a	15,33 a	14,90 a

Figures with different letters are with proved difference according to Duncan's multiple range test ($p < 0.05$).

The regression analysis of the data for the impact of the urea fertilization on the protein content of the barley grain gives a clearer picture of the obtained results (Figure 1).

From the statistical analysis of the regression module between the crude protein content and the fertilizer rate, we obtained a high coefficient of regression (R=0.994). From the calculated regression, the coefficient equation is as follows: У=11,055+0,149X, i.e. the crude protein content will increase by 0.149% when increasing the fertilizer rate by 10 kg/ha.

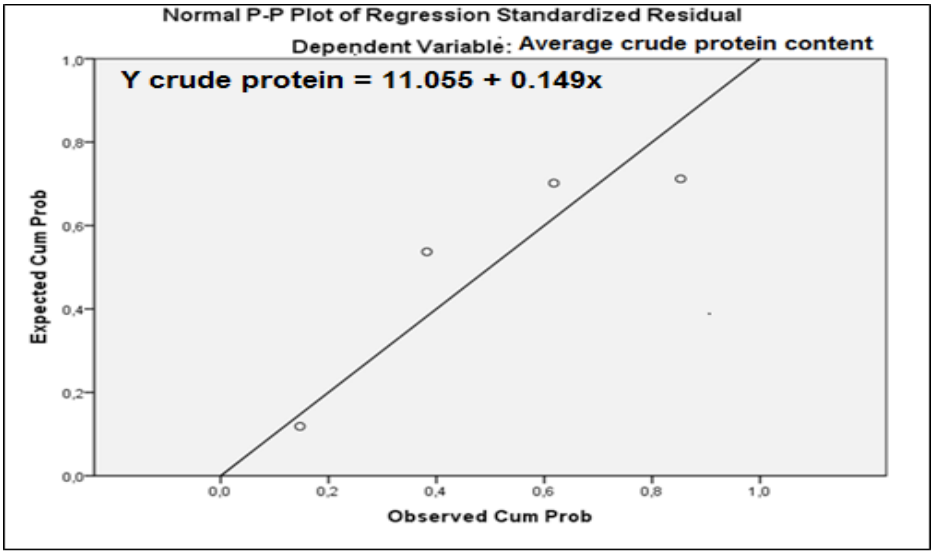

Figure 1. Regression analysis of the relationship between crude protein content and fertilizer rate

Conclusions

The highest nitrogen content in the grain was found after the fertilization with the highest fertilizer rate, and the lowest nitrogen content was recorded for the

unfertilized control.

The phosphorus content in the barley grain was not affected by urea fertilization.

As nitrogen fertilization increases, the potassium content of the grain decreases. The highest potassium content was recorded for the unfertilized control.

With the increase of the N fertilizer rates and predecessor forage peas the crude protein content in the barley grain increased, as at the rates 165 and 250 kg/ha decreased the quality of brewing barley.

References

AL-Humaid, A. (2003). Effects of compound fertilization on growth and alkaloids of datura (Datura innoxia Mill.) plants. Journal of Agriculture and Rural Development in the Tropics and Subtropics. Vol. 104, No.2, p. 151–165.

Bishop, R. & MacEachern, C. (1971). Response of spring wheat and barley to nitrogen, phosphorous, and potassium. Can J Soil Sci 51: 1–11.

Bleidere, M., Zute, S., Brunava, L., Bobere, N. & Jâkobsone, I. (2013). Yield and Grain Quality of Hulless Spring Barley in Field Trials Under Different Nitrogen Management Conditions. Proceedings of the Latvian Academy of Sciences. Section B, Vol. 67, No. 3 (684), pp. 229–235.

Del Moral, G., Ramos, M. & Recalde, L. (1985). Relationships between vegetative growth, grain yield and grain protein content in six winter barley cultivars. Can. J. Plant Sci. 65: 523-532.

Gastal, F. & Lemaire, G. (2002). Nitrogen uptake and distribution in crops: an agronomical and ecophysiological perspective. Journal of Experimental Botany, Vol. 53, No 370, 789-799.

Ivanov, K. & Krastev, S. (2005). A course of Instrumental Methods for Analysis. Academic publisher of Agricultural University Plovdiv, 69. (BG)

Ivanova, À., Mihova, G. & Doneva, S. (2013). Effect of some agronomy factors fn grain protein content of barley grown in the region of Dobrudzha. Scientific Works of Institute of Agriculture - Karnobat, Vol. 2, Book 1, 229-240.

Koteva, B. (2000). Impact of fertilization and soil fertility on the parameters of the crop and barley yield, grown on leached vertisol in Southeastern Bulgaria. Bulgarian Journal of Crop Science 37 (10), 873-878. (BG)

Mersinkov, N. (2003). Winter two-row brewing barley variety *"*Emon*"*. Filed Crops Studies, 40, 184-186. (BG)

Nikolova, M. (2010). Potassium – nutritional element for yield and quality. IPI Research Topics No. 18. Second revised edition. Pages 35-36.

Noworolnik, K., Wirkijowska, A. & Mikos-Szymanska, M. (2014). Effect of genotype and nitrogen fertilization on grain yield and quality of spring barley intended for health food use. Bulg. J. Agric. Sci., 20: 576-580.

Peev, P. & Krasteva, A. (1989). Physico-chemical indicators of brewing barley at

increasing norms of balanced nitrogen fertilization. Filed Crops Studies 26 (4), 18- 22. (BG)

Penchev, P. et al. (2004). Technology for growing barley in conditions of low temperatures and water deficit. Publisher „PublishSaySetEco", Sofia. (BG)

Qi, J., Zhang, G. & Zhou, M. (2006). Protein and hordein content in barley seeds as affected by nitrogen level and their relationship to beta-amylase activity. Journal of Cereal Science 43(1):102-107.

Slamka P., Hanáčková, E., Benčíková, M., Macák, M. & Demjanová, E. (2008). Effect of Nitrogen Phosphorus and Potassium Supply Level in Soil on Malt Characteristics of Winter Barley Grain. Canadian Journal of Soil Science, Vol.51 No. I: Cereal Research Communications Vol. 36, Supplement: Proceedings of the VII. Alps-Adria Scientific Workshop, Stara Lesna, Slovakia (June 2008), pp. 1439-1442.

Stoyanov, H., 2014. Determination and importance of some parameters during malting process of varieties and lines two- and six-rowed barley (*Hordeum vulgare* L.). Scientific Works of Institute of Agriculture – Karnobat, Volume 3 (1). 77-92.

Tomov, T., Rachovski, G., Kostadinova, S. & Manolov, I. (2009). A guidebook of exercises on agrochemistry. Publisher: Agricultural Universty – Plovdiv. (BG)