

THE EFFECT OF DIFFERENT REGIONS AND NPK FERTILIZER ON PROTEIN AND SULPHUR CONTENT OF WINTER WHEAT (*TRITICUM AESTIVUM* L.) GRAINS

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Abstract

*In this study the effect of different regions and different NPK treatments on the content of protein and S were investigated in the kernels of winter wheat (*Triticum aestivum* L.). Plant samples were collected from five experimental stations of the Hungarian National Long-term Fertilization trials. These stations are as follows: Bicsérd, Iregszemcse, Karcag, Nagyhörcsök and Putnok. These experimental fields have different types of soil and climatic conditions. The sulphur content of samples was measured using inductively coupled plasma optical emission spectrometer (ICP-OES) followed by digestion with $\text{HNO}_3\text{-H}_2\text{O}_2$ solution. The protein content was determined using Kjeldhal method. Data analysis was done using SPSS for Windows 13.0 Software package. All data were subjected to ANOVA method, but after detection of significant differences ($P < 0.05$) data were subjected to Duncan's test to allow separation of means. During our investigations it was proved that different growing places are having significant ($P < 0.01$) difference in the S and protein content of samples. Sulphur and protein content of the treated samples were found higher than the element content of the untreated grains.*

Key words: sulphur, protein, winter wheat, NPK fertilizer, production area.

INTRODUCTION

In this study the effect of different regions and different NPK treatments on the content of protein and S were investigated in winter wheat (*Triticum aestivum* L.) grains.

Sulphur is an important component of the sulphur-containing amino acids, peptides, proteins and lipids. It has a specific role in the enzymes and coenzymes which contains SH-groups (Loch and Nosticzius, 1992; Kalocsai et al., 2005).

Wheat grains are the richest in protein among cereals (Lásztity, 1981). High protein concentration of kernels is one of the most important baking quality requirements of winter wheat and it has great influence on the digestibility of bread too (Loch and Nosticzius, 1992; Loch, 1999).

According to Randall and Wrigley (1986) sulphur deficiency in wheat grains may cause poor baking quality through the reduced essential amino acids content.

Nutrition and fertilization is one of the most important factors during the cultivation of winter wheat (Pepó, 2004).

Based on results of previous researchers N fertilization enhanced the protein concentration in plant organs and raised the quality of proteins too (Dubetz et al., 1979; Hegedus et al., 2002; DuPont and Altenbach, 2003; Labuschagne et al., 2006; Kindred et al., 2008). Other researchers found that the increase of sulphur content had been correlated with N and NP fertilization (Lásztity, 1992; Lásztity, 1997; Kádár, 2004).

Wheat production is determined by the ecological factors of the growing area (Tolner, 1999). In the experiment of Destain et al. (1991) there were less influence of different N doses on the N intake of wheat but the effect of different production areas caused significant differences. According to Škribic and Onjia (2002) element content of winter wheat grains harvested from different regions also showed significantly difference.

MATERIALS AND METHODS

The Hungarian National Long-term Fertilization trials were set up to study the effect of different NPK levels. The experiment

has a split-split-plot design with 40 treatments in 4 replications. Samples of winter wheat were collected from Bicsérd, Iregszemcse, Nagyhörcsök, Karcag and Putnok experimental stations. Plant samples were harvested in 2004 when the weather conditions were humid.

Bicsérd is a township located in Baranya Hills, in Hungary. The soil is chernozem brown forest soil formed on loamy loess soils. The cultivated layer has moderate soil moisture management. The characteristics of the cultivated layer is the following: pH (KCl): 5.45; CaCO₃: 0%; humus: 1.93%.

Iregszemcse is located in Transdanubian Hills. The production area has typical chernozem soil formed on slightly having clay loess sediments. The soil moisture is balanced. The characteristics of the cultivated layer is the following: pH (KCl): 7.49; CaCO₃: 10.69%; humus: 2.69.

Naghörcsök is located in the Transdanubian region of Hungary. The experimental station has calcareous chernozem soil formed on loess. The soil has excellent soil moisture management. The characteristics of the cultivated layer is the following: pH (KCl): 7.3; CaCO₃: 4.27%; humus: 3.45%.

Karcag is located in the Tisza floodplain in the Great Hungarian Plain. The experimental field has non-carbonated meadow chernozem soil formed on infusion loess and the soil moisture is very favorable. The characteristics of the

cultivated layer is the following: pH (KCl): 5.45; CaCO₃: 0%; humus: 3.09%.

Putnok is located in North Hungarian Mountains. The soil is non-podzolic forest infiltration clay soil. The cultivated layer has heavy water retention and low drainage, permeability and available water resources. The characteristics of the cultivated layer is the following: pH (KCl): 5.00; CaCO₃: 0%; humus: 2.29% (Debreczeni and Németh, 2009). The sulphur content of samples was measured using inductively coupled plasma optical emission spectrometer (ICP-OES) followed by digestion with HNO₃-H₂O₂ solution (Kovács et al., 1996). The protein content was determined using Kjeldal method (MSZ 6830-4:1981). Data analysis was done using SPSS for Windows 13.0 Software package. All data were subjected to ANOVA method, but after detection of significant differences ($P < 0,05$) data were subjected to Duncan's test to allow separation of means.

RESULTS AND DISCUSSIONS

Table 1 shows the effect of different N, P₂O₅ and K₂O levels on the protein and sulphur content of winter wheat grains from the experimental station of Bicsérd. According to our experimental results the protein content were higher in every NPK treatments than the control but there were no significant effect of the different NPK doses on the sulphur content of kernels.

Table 1. Effect of N, P₂O₅ and K₂O levels on the protein and sulphur content of wheat grains (Bicsérd)

N treatment (kg/ha)	Protein content		Sulphur content	
	Mean (%)	SD _{5%}	Mean (mg/kg)	SD _{5%}
0	12.55	a	1436	a
150	15.75	b	1417	a
200	16.05	b, c	1440	a
250	16.56	c	1444	
P ₂ O ₅ treatment (kg/ha)		c		
0	15.01	a	1436	a
50	16.40	b	1421	a
100	15.94	b	1418	a
150	15.96	b	1420	a
200	16.28	b	1458	a
K ₂ O treatment (kg/ha)				
0	15.01	a	1436	a
100	15.95	b	1418	a
200	15.93	b	1447	a

Our results proved that different production areas caused significant ($P < 0.01$) difference in the protein and sulphur content of winter wheat grains. Table 2 shows the protein content of wheat samples from five different experimental stations.

Samples, which were collected from Karcag, have the highest protein contents. Lowest protein contents were measured in samples from Iregszemcse. The protein content sequence of samples was the following: Iregszemcse < Nagyhörscsök < Putnok < Bicsérd < Karcag.

We compared our results with previous ones. During our investigation protein concentration was found similar to the literature value which was 12-15% (Lásztity, 1981).

Table 2. Protein content of winter wheat grains from different regions

Protein content		
Production area	Mean (%)	SD _{5%}
Iregszemcse	13.94	a
Nagyhörscsök	14.34	a, b
Putnok	14.68	b
Bicsérd	15.69	c
Karcag	15.85	c

Table 3. Sulphur content of winter wheat grains from different regions

Sulphur content		
Production area	Mean (mg/kg)	SD _{5%}
Bicsérd	1430	a
Putnok	1439	a
Nagyhörscsök	1512	b
Iregszemcse	1665	c
Karcag	2032	d

Table 3 shows the sulphur content of wheat grains from different production areas. The sulphur content sequence of wheat grains was different from previous one: Bicsérd < Putnok < Nagyhörscsök < Iregszemcse < Karcag.

In our study the measured values were analogous with published ones, which were 1211-1960 mg/kg (Dániel et al., 1998). The only exception was Karcag.

CONCLUSIONS

During our investigations it was proved that different areas having significant ($P < 0.01$) difference in the protein and sulphur content of

winter wheat samples and they were mostly determined by the production areas.

Protein content were found higher in the treated samples than in that samples which were harvested from the control plots and the N fertilizer enhanced the protein concentration of kernels but there were no significant effect of the different NPK levels on the sulphur concentrations of wheat grains.

ACKNOWLEDGEMENTS

Authors are highly acknowledge the support by the TÁMOP-4.2.2 / B-10 / 1-2010-0024 and TÁMOP - 4.2.1 / B-09 / 1 / KONV-2010-0007 projects. The projects are also co-financed by the European Union and the European Social Fund.

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