THE EFFECT OF DIFFERENT GROWING AREA ON THE Cu, Mn AND Zn CONTENT OF WINTER WHEAT

Zita Burján[a]*, Mariann Móré[a], Béla Kovács[a] and Zoltán Győri[b]

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In the present study the contents of Cu, Mn and Zn were investigated in the grains of winter wheat (*Triticum aestivum* L.). Plant samples were collected of the year 2004 when the weather conditions were very humid and wet. Samples were harvested and 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 elements content of samples were measured using inductively coupled plasma optical emission spectrometer (ICP-OES) and inductively coupled mass spectrometer (ICP-MS) followed by digestion with HNO_3-H_2O_2 solution. 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. The results of studies proved that the different regions caused significant (P <0.01) difference in the element content of winter wheat samples.

*Corresponding Authors
Tel.: +(36) (52) 417572
Fax: +(36) (52) 417572
E-mail address: burjan@agr.unideb.hu (Z. Burján).
[a] Centre for Agricultural and Applied Economic Sciences, Faculty of Agricultural and Food Sciences and Environmental Management, University of Debrecen, 138. Böszörményi Street, Debrecen, H-4032, Hungary
[b] Szent István Egyetem Gazdaság- és Társadalomtudományi Kar, Regionális Gazdaságtani és Vidékfejlesztési Intézet, 1 Páter Károly Street, Gödöllő, H-2103, Hungary

Introduction

In this study the Cu, Mn and Zn content of winter wheat grains from different growing fields were subjected to investigation. Microelement content of winter wheat grains harvested from different regions was found significantly different in the examination by Škrbić and Onjia.[1] These differences were due to different soil specifications like organic material content, pH, calm and mineral element content that could affect the availability of components.

Globally, wheat is cultivated in one of the three largest quantities of cereals. It is harvested 600 tonnes per year.[2] In Hungary production area of winter wheat varies from 1.0 to 1.2 million hectares.[3] Cereal crops are important source of mineral elements and nutrients for human beings.[4] In healthy human diet, 55% of the carbohydrates come from wheat.[5] Deficiency of mineral element intake is an alarming problem in the diet of human beings.[6]

Based on studies of the year 2000/01 National diet and nutrition survey of adults in the range of 19-64-year in United Kingdom reveals that, cereals and their products provide about 31% of the daily intake of Cu and 25% of Zn.[7] According to Szalay et al.[8] at least 70% of Mn intake comes from cereals in human diet. As per the literature data available so far manganese content of wheat grains is 32-88 mg kg^{-1}, [9,10] or 25-40 mg kg^{-1},[11,12] and zinc concentration is 12-44 mg kg^{-1}, [9-12] Copper content of cereal grains varies from 5 to 10 mg kg^{-1}.

Experimental

The Hungarian national long-term fertilization trials were set up in 1966 to study the effect of different NPK levels. The experiment marked as 18 has a split-split-plot design with 40 treatments in 4 replications. The crop rotation sequence was as follow: maize, maize, winter wheat and winter wheat. Samples of winter wheat variety Mv Csárdás were harvested and collected from Iregszemcse, Karcag, Nagyhörcsök and Putnok field stations. These experimental fields were having different soil types and climatic conditions. Tested samples are derived from the untreated control plots. Plant samples were collected from the year 2004. According to the Hungarian national weather service this year was also forecasted humid and wet.[14]

Bicsérd is located in Baranya Hills, in the South Transdanubian region of Hungary. The experimental field is 134 meters above the sealevel. It has humid climate. The soil is chernozem brown forest soil formed on loamy loess soils. It has slightly acidic pH. The humus layer is moderately thick and the topsoil is slightly leached. The cultivated layer has sandy loam mechanical composition. The soil has crumb structure with moderate soil moisture management. The cultivated layer has the following characteristics: pH (KCl): 5.45, $CaCO_3$: 0 %, humus: 1.93%, S-Value: 17.4 mekv/100 g, whereof Ca^{2+}: 79.4%; Mg^{2+}: 17.6%; Na^+: 0.1%; K^+: 2.9%.

Iregszemcse is located in Transdanubian Hills, Outer-Somogy. The experimental area is 173 meters above the sea level. The soil is typical chernozem soil formed on slightly having clay loess sediments. It has slightly alkaline pH. The humus layer is moderately thick. The cultivated layer has sandy loam mechanical composition and the soil has crumb structure. Soil moisture is balanced. The cultivated layer has the following characteristics: pH (KCl): 7.49, $CaCO_3$: 10.69%, humus: 2.69%, S-Value: 13.3 me/100 g, whereof Ca^{2+}: 94.8%; Mg^{2+}: 4.7%; Na^+: 0.04%; K^+: 0.63%.

Karcag is located in the central region of Tisza floodplain in the Great Hungarian Plain. The experimental area is 86 meters above the sea level. The soil is non-carbonated meadow chernozem soil formed on infusion loess. It has acidic pH. Organic matter content is moderate. The cultivated layer has clay loam mechanical composition and the soil has crumbly, grainy texture. Soil moisture is very favorable. The cultivated layer has the following characteristics: pH (KCl): 5.45, $CaCO_3$: 0%, humus: 3.09%, S-Value: 20.4 me/100 g, whereof Ca^{2+}: 76.1%; Mg^{2+}:20.9%; Na^+:0.3%; K^+:2.7%.

Nagyhörcsök is located in Fejér county, Transdanubian region of Hungary. The experimental station is 140-150 meters above the sea level. It has arid climate. The soil is calcareous chernozem formed on loess. It has slightly alkaline pH. Humus layer is thick. The cultivated layer has loam mechanical composition and the soil has crumb structure with excellent soil moisture management. The cultivated layer has the following characteristics: pH (KCl): 7.3, $CaCO_3$: 4.27%, humus: 3.45%, S-Value: 26.8 me/100 g, whereof Ca^{2+}: 92.6%; Mg^{2+}: 5.4%; Na^+: 0.1%; K^+: 1.9%.

Putnok is located in Heves-Borsodi Hills in North Hungarian Mountains. The experimental area is 163 meters above the sea level. The soil is non-podzolic forest infiltration clay soil. It has slightly acidic pH. The cultivated layer has clay loam mechanical composition. The soil has grainy, heavily clogged structure with heavy water retention and low drainage, permeability and available water resources. Natural nutrients service is poor. The cultivated layer has the following characteristics: pH (KCl): 5.00, $CaCO_3$: 0%, humus: 2.29%, S-Value: 21.6 me/100 g, whereof Ca^{2+}: 79.7%; Mg^{2+}: 17.5%; Na^+: 0.3%; K^+: 2.5%.[15]

The elements content of samples were measured using inductively coupled plasma optical emission spectrometer (ICP-OES) and inductively coupled mass spectrometer (ICP-MS) following digestion with HNO_3-H_2O_2 solution. Data analysis was performed using SPSS for Windows 13.0 Software package. All data were subjected to ANOVA method, and when significant differences (P<0,05) were detected, Duncan's test was performed to allow separation of means.

Results and discussion

The test results proved that different regions caused significant (P <0.01) difference in the element content of winter wheat samples. Table 1 shows the Cu content of wheat samples from different field stations. Means (mg kg^{-1}) express the means of four replications of the untreated control plots where samples were collected.

Table 1. Copper content of winter wheat (*Triticum aestivum* L.) grains from different regions

Production area	Means (mg kg^{-1})	SD
Karcag	3,474	a
Bicsérd	4,025	b
Putnok	4,674	c
Nagyhörcsök	4,693	c
Iregszemcse	5,266	d

Samples, which were collected from Iregszemcse, have the highest Cu contents. Lowest Cu contents were measured in samples from Karcag. Our study reproduced the same results in these samples of wheat grains as the literature data, which is 3,6-7,6 mg kg^{-1}.[9,10]

Table 2. Manganese content of winter wheat (*Triticum aestivum* L.) grains from different regions

Production area	Means (mg kg^{-1})	SD
Iregszemcse	13,323	a
Bicsérd	14,505	a
Karcag	29,989	b
Nagyhörcsök	40,593	c
Putnok	57,159	d

During our investigation Mn content of samples from Putnok field stations found to be the highest one (Table 2). In the case of Iregszemcse and Bicsérd fields measured values are lower than literature data.[9-12]

Table 3. Zinc content of winter wheat (*Triticum aestivum* L.) grains from different regions

Production area	Means (mg kg^{-1})	SD
Karcag	14,283	a
Iregszemcse	15,982	a, b
Nagyhörcsök	17,521	b
Bicsérd	25,023	c
Putnok	45,225	d

Table 3 shows the Zn contents of wheat grains from different field stations. The highest Zn content was measured in samples from Putnok and the lowest value was detected in grains from Karcag area. These results match with literature data.[9-12]

Conclusion

During our investigations it was proved that different growing places of the Hungarian national long-term fertilization trials such as Bicsérd, Iregszemcse, Karcag, Nagyhörcsök and Putnok are having significant (P <0.01) difference in the Cu, Mn and Zn content of winter wheat grains samples. These experimental stations have different soil and climatic conditions also.

In this study we compared our results with the work already done by other scientists. This investigation gives the same results in the case of Cu content as available in literature. During our investigation Mn content was found lower than the literature value in case of Iregszemcse and Bicsérd field stations. Literature data match with our results in the case of Zn contents.

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