

BAKING QUALITY AND CHNS-CONTENTS OF WINTER WHEAT VARIETIES

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Abstract: Effect of small dose of sulphur fertilization on the chemical features of the tested soil and of the baking quality parameters of winter wheat and correlations between them were examined. It was established that the CHNS contents of the flour are in close positive correlation to the flour quality parameters generally used in the practice.

Keywords: baking quality, CHNS contents, sulphur fertilization

Introduction

Soil sulphur deficiency is an increasing incident in Western Europe and in Hungary as well (FLAETE et al. 2005). This may be derived from leaving the application of super phosphate fertilizers and the decrease of S-deposition from the air (GYŐRI 1999). Anyway, reducing of fertilization is a tendency of the Hungarian crop production in spite of all the known positive effects of these chemicals on grain yield (SCHREYER 2001). Although HAGEL (2005) found no effects of any S-application on baking quality, several studies establish that applying gypsum as a fertilizer can result in higher grain yield and better quality (WIESER et al. 2004, MARS 2006, ZIA et al. 2007), whereas sulphur containing gluten proteins largely determine the baking quality of winter wheat (PRANGE et al. 2001). Analyses showed that S status (S concentration and N:S ratio) was more influential on breadmaking quality (ZHAO et al. 1999a) and on loaf volume (ZHAO et al. 1999b) compared to grain N concentration. According to the observation of GYŐRI (1999) the quality parameters of winter wheat flour are strongly dependent on the conditions of the cropping site. This study was conducted to evaluate the effects of different gypsum doses on the CHNS contents and the baking quality of winter wheat in the Middle-Tisza region.

Materials and methods

Our study was carried out on a meadow chernozem soil at Karcag. The soil is slightly acidic but has a significant potential acidity. Its phosphorous and potassium supply is good.

In this experiment we examined the effect of two gypsum doses (2 and 4 t ha⁻¹) on the quality and CHNS content of the flour of 14 winter wheat varieties and lines. Samples from the yield of the plots were taken at harvest time and which were grinded with a laboratory mill. We established the following quality parameters: valorigraphic value, wet gluten content, gluten spreading, Zeleny sedimentation value and Hagberg falling number. The CHNS contents of the flour were determined with a Vario MACRO CHNS element analyzer. The concentrations of the combustion products were determined against sulfadiazine as a known standard.

Soil samples were taken from the upper 20 cm of the soil of the plots after harvest. The acidity, hydrolytic acidity, humus content, AL-soluble P₂O₅, K₂O, Ca, Mg, Na and

SO₄²⁻ contents of the samples were determined according to the relevant standards (MSZ-08-0206-2, MSZ-20135). The experimental data were processed with the statistical methods of MANOVA and regression analyses.

Results and discussion

The results of the analysis of the soil samples taken from the plots treated with different gypsum doses are shown in *Table 1.* in the average of the examined varieties. It can be seen that statistically significant decreases of each pH value occurred as a result of the application of the larger gypsum dose. The value of hydrolytic acidity tended to increase as a result of the gypsum treatment, but the differences were not statistically significant. The humus matter content was not modified by the gypsum treatment as it was expected. Similarly to this observation we found no differences in the AL-soluble P₂O₅ and K₂O contents. The process leading to the decrease of the AL-soluble Ca content of the soil in the case of gypsum application could not be discovered. Further examinations are necessary to solve this problem. While the Mg content of the soil showed decreasing tendency as a result of the gypsum treatments, the AL-soluble Na content did not change. The sulphate fertilization resulted in an increase of SO₄²⁻ content of the soil, but these changes were not statistically significant. Differences between the SO₄²⁻ contents of the plots treated with different gypsum doses were significant only at the probability level of 10 %.

Table 1. Effect of different gypsum doses on the chemical features of the soil (Karcag, 2007)

Treatments	pH (H ₂ O)	pH (KCl)	y1	Humus %	P ₂ O ₅ mg/kg	K ₂ O mg/kg	Ca mg/kg	Mg mg/kg	Na mg/kg	SO ₄ ²⁻ mg/kg
Ø	6.21	5.18	15.68	3.33	135.4	464	3550	486	43.25	12.11
G1	6.06	5.04	16.65	3.22	110.3	398	3468	482	40.00	35.57
G2	5.75	4.84	18.48	3.26	105.9	449	3188	464	40.75	71.59
SD _{5%}	0.33	0.17	-	-	26.11*	-	175.89	-	-	53.15*

*= SD 10%

On the base of the analysis of variance of the flour quality parameters (*Table 2.*) of the examined winter wheat varieties, we established that the flour quality of crops originated from the plots treated with the less gypsum dose declined in many cases comparing to the control. Such quality parameters were the valorigraphic value, the gluten content, the Zeleny sedimentation value and the Hagberg falling number. Except for the gluten spreading and the falling number, the observed differences were statistically significant in the cases of all parameters. The values of all parameters increased as a result of the application of the bigger gypsum dose and showed numerical values similar to the observed ones in the cases of the control plots. We found consequent changes (increase) caused by the sulphate fertilization only in the case of gluten spreading. There were significant differences between the flour quality of the examined winter wheat varieties and lines. In our opinion, the different genetic backgrounds could play the main role in the development of these differences.

We established that the changes of the N and S contents of the flour samples were similar to the changes in the case of the tested flour quality parameters described above. The concentration of these elements decreased significantly as a result of the 2 t CaSO₄ ha⁻¹ treatment comparing to the control. But, this unfavourable effect was compensated by the further increase of the gypsum dose. While significant differences were observed between the wheat varieties in the case of the flour C content, the C and H contents of the flour did not vary significantly as an effect of the sulphate fertilization treatments.

Table 2. Effect of different gypsum doses on the quality parameters and CHNS contents of winter wheat flour (Karcag 2007)

Treatment	Valorigraphic value	Gluten content %	Gluten spreading (mm)	Zeleny value	Falling number (s)	C content (w%)	H content (w%)	N content (w%)	S content (w%)
Ø	66.87	31.14	2.19	36.32	374	41.08	6.21	2.07	0.23
G1	57.30	26.98	2.41	31.29	360	40.99	6.11	1.82	0.18
G2	62.74	29.55	2.53	35.55	367	41.07	6.22	2.03	0.20
SD _{5%}	3.27	1.61	-	1.77	-	-	-	0.07	0.03

Table 3. Correlations between the CHNS contents and the examined quality parameters

Parameters	C (%)	H (%)	N (%)	S (%)
C (%)	-	-	-	-
H (%)	-	-	-	-
N (%)	0.705 ^{xxx}	-	-	-
S (%)	0.430 ^{xx}	-	0.538 ^{xxx}	-
Zeleny value	0.414 ^{xx}	-	0.739 ^{xxx}	0.570 ^{xxx}
Falling number (sec)	0.342 ^x	-	0.567 ^{xxx}	0.416 ^x
Gluten content (%)	0.650 ^{xxx}	-	0.915 ^{xxx}	0.566 ^{xxx}
Gluten spreading (mm)	0.509 ^{xx}	-	0.481 ^{xx}	-
Valorigraphic value	0.436 ^{xx}	-	0.754 ^{xxx}	0.570 ^{xxx}

xxx Correlation is significant at the 0.001 level

xx Correlation is significant at the 0.01 level

x Correlation is significant at the 0.05 level

The correlation coefficient indicating the closeness of the correlation between the CHNS contents and the tested quality parameters of the flour are shown in Table 3. We found close positive linear correlation between the N content and the other tested quality parameters. The S content was in close correlation with all the tested features, except for the H content. The S content of flour had significant effects on Zeleny sedimentation values, gluten contents and valorigraphic values. None of the quality

parameters was influenced by the H content of the flour. All the observed correlations between the tested features were linear except for the correlations between the S content and Zeleny sedimentation value, and between the S content and the Hagberg falling number.

Conclusions

On the basis of the experimental data it was established that significant changes occurred in the values of some chemical parameters of the soil caused by the small dose sulphur fertilization, of which the decrease of the AL-soluble P content and the increase of acidity and sulphate concentration can be mentioned first of all. While the values of the examined flour quality parameters were reduced by the smaller sulphate treatment, the bigger gypsum dose influenced them positively. The effect of the different genetic background of the tested varieties was well traceable in the case of all the examined parameters. The CNS contents of the flour were in close, and in the most part of the cases, positive linear correlation with the flour quality parameters.

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