

EFFECT OF SULPHATE FERTILISATION ON THE QUALITY OF WINTER WHEAT

R. KALOCSAI¹ – ZS. GICZI¹ – R. SCHMIDT² – P. SZAKÁL² – M. BARKÓCZY²

¹ UIS Ungarn Laboranalytical LTD Mosonmagyaróvár, Terv Str. 92.

² University of West Hungary Faculty of Agricultural and Food Sciences

Mosonmagyaróvár

E-mail: krenato@uis.hu

Introduction

In the past period sulphur input to agricultural lands was reduced. The growing of higher yield potential, better quality cultivars and hybrids (oilseed rape, winter wheat) raise the necessity of sulphur fertilisation. These cultivars have higher nutrient requirement that brings along increased sulphur demand as well (Hensier and Ninphius 1985, Tanács et al. 2005). The improved N, P, K nutrition besides increasing the yield of cultivated plants also increased their sulphur content (Lásztity 1991, Lásztity and Csathó 1995, Győri and Mars 2001).

The above-mentioned reasons could make sulphur fertilisation for obtaining satisfactory yield and quality necessary.

Therefore a reasonable sulphur fertilisation will have an increasing importance and could be a part of everyday fertilisation procedures.

Methods

In the field experiment the reaction of winter wheat to sulphate fertilisation was studied. In this 3 years long experiment with randomised block design we investigated the changes in chemical composition and in baking quality. The nutrient status of the soil was as follows: N- medium supply, P₂O₅- excellent supply, K₂O- poor supply (Table 1).

Table 1. Soil analysis values of the experimental soil

pH		Plasticity index	CaCO ₃ %	Humus %	Total N %	Nitrate mg kg ⁻¹	Sulphate mg kg ⁻¹	AL-extractable mg kg ⁻¹ (7)			nKCl extr. Mg mg kg ⁻¹	EDTA-extractable mg kg ⁻¹			
H ₂ O	KCl							P ₂ O ₅	K ₂ O	Na		Zn	Cu	Mn	Fe
7,9	7,4	37,2	4,4	2,5	0,2	37,9	13,22	176,8	92,9	13,1	63,3	1,2	2,6	53,6	24,3

The treatments of the experiment were arranged in 3 blocks and carried out in 4 replications. The treatments used in the experiment are shown in Table 2. In the first two years of the experiment (1999, 2000) the maturity group variety GK Csörnőc, in the third year (2001) the medium maturity Mv-Emma was grown. The crop management applied was identical to the crop management system of SOLUM Co.

During the experiment the chemical composition of the soil and plant samples and the wheat grain was studied.

Table 2. Treatments used in the sulphate fertilisation experiments

treatment	form of fertiliser			applied doses							
				kg ha ⁻¹				kg plot ⁻¹			
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	S	N	P ₂ O ₅	K ₂ O	S
K1.	NH ₄ NO ₃	MAP	K ₂ SO ₄	191	80	75	26	0,382	0,16	0,15	0,052
K2.	NH ₄ NO ₃	MAP	KCl	191	80	75	-	0,382	0,16	0,15	-
K3.	(NH ₄) ₂ SO ₄	MAP	K ₂ SO ₄	191	80	75	195	0,382	0,16	0,15	0,39
K4.	(NH ₄) ₂ SO ₄	MAP	KCl	191	80	75	169	0,382	0,16	0,15	0,338
K5.	CO(NH ₂) ₂	MAP	K ₂ SO ₄	191	80	75	26	0,382	0,16	0,15	0,052
K6.	CO(NH ₂) ₂	MAP	KCl	191	80	75	-	0,382	0,16	0,15	-
K7. control	-	-	-	-	-	-	-	-	-	-	-

Results and discussion

The soil samples taken at shooting and harvesting did not show any evidence and positive correlation between available sulphate content and the treatments used in the experiment. On the basis of the plant analysis results we established that the amount of sulphur supplied by the experimental soil was sufficient to cover the sulphur requirement of the cultivated plants. The S-content even of the untreated plants exceeds the 1.2 mg g⁻¹ value, which can be the threshold of sulphur deficiency Schnug *et al.* (2000).

Studying the sulphur content of the plant samples taken at shooting we found that there was no significant relationship between the treatments and plant sulphur content. At the same time comparing the sulphur content of the control and the plants fertilised we established, that the sulphur assimilation of the plants increased due to fertilisation. The strong correlation between the raw protein content and the sulphur content of the samples refers to the basic role of sulphur in protein synthesis ($R=0,4643$, $P=0,1\%$) (Figure 1).

Studying the sulphur content of flag leaves we could measure the highest values in the case of the (NH₄)₂SO₄ treatments. At the same time there was no significant difference in the raw protein content of the fertilised treatments. Regarding the correlation between the two values it was found that the highest raw protein value was measured at 0.24 % sulphur content of the flag leaf (Figure 2). When sulphur content is higher than this value the raw protein content of the flag leaf decreases. The same sulphur concentration gave the best baking quality. Parallel with the S-content of the flag leaf the wet gluten content of the flour increases. The relationship can be described by the equation $y=-3455, 6x^2+1668, 3x-164, 15$ ($R=0, 7201$, $P=1\%$). Similar relationship can be described between the S-content of the flag leaf and the protein content of the flour. The maximum protein content is at 0.24 % S-content of the flag leaf. Considering the quality parameters of flour there was no significant difference between the particular fertilised treatments, but the worse baking quality was measured in the case of the untreated control. The S-content of the flour samples in all treatments exceeded the 0.12 % threshold value that refers to sufficient S-supply (Schnug *et al.* 1993).

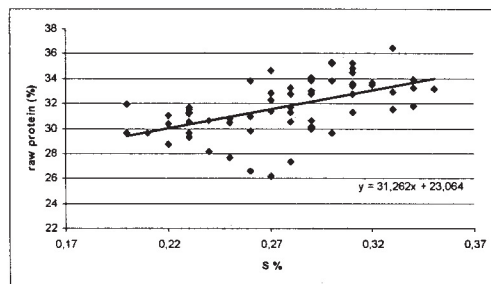


Figure 1. The relationship between the raw protein and S content of the plant samples at shooting (2000-2002)

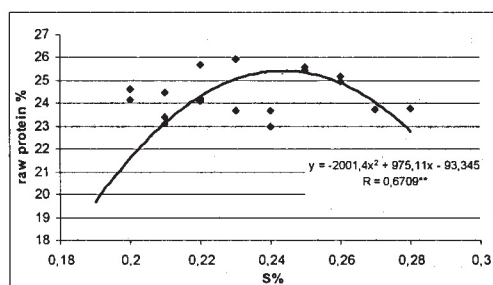


Figure 2. The relationship between the raw protein- and S content of the flag leaves %

Regarding N:S ratio, the ratio of the control treatment in all three blocks were significantly smaller than that of the fertilised treatments ($P=0,1$ %). The smallest ratios were measured in the case of ammonium sulphate and the highest in the case of ammonium nitrate treatments. During flour quality studies of 2001 the best baking quality was detected at 20-21:1 N: S ratio, which is considerably higher than that of the ratio mentioned (17:1) in the literature (Haneklaus *et al.* 1992, Bloem *et al.* 1995, Byers and Bolton 1979, Byers *et al.* 1987). Our results indicate that the N:S=20-21:1 ratio does not necessarily mean sulphur deficiency, moreover we detected the best baking quality at this ratio. The relationship between N: S ratio and the wet gluten content of flour can be described by the equation $y=-0,1607x^2+6,812x-36,907$ ($P=1$ %). The maximum wet gluten content was calculated at the $y'=0$ point at the N: S= 21:1 ratio.

For the interpretation of these facts the relationship between N- and S-content of flour and the baking quality supply additional information. We can establish that in determining baking quality N has higher influence than S. We could find hardly any significant relationship between S-content and baking quality but N-content determined it by 82 % ($P=0,1$ %).

Conclusions

In the sulphur fertilisation experiment we proved that the sulphur content of the soil was sufficient to fulfil the sulphur requirement of winter wheat.

The chemical analyses proved that due to N, P, K fertilisation the S content of the plants increased. The basic role of soil organic matter in S absorption of plants was proved. The maximum raw protein content of the flag leaf was detected at 0.2 % S-content and 0.3 % S-content of the flag leaf and the tillering plant samples respectively. In case of higher sulphur

content the raw protein content decreased. The N:S ratio of flour samples was 20-21:1 which is higher than the results found in the literature (17:1). The highest baking quality number and protein content was measured at the N:S =21:1 ratio which is higher than the corresponding data in the literature. The highest wet gluten content of the flour was measured at 0.24 % S-content of the flag leaf.

References

- Bloem, E. Paulsen, H.M. Schnug, E. 1995 Schwefelmangel nun auch in Getreide. DLG-Mitteilungen, 8:18-19.
- Byers, M. Bolton, J. 1979 Effects of nitrogen and sulphur fertilizers on the yield, N and S content, and amino acid composition of the grain of spring wheat. J. Sci. Food Agric. 30:251-263.
- Byers, M. Franklin, J. Smith, S.J. 1987 The nitrogen and sulphur nutrition of wheat and its effect on the composition and baking quality of the grain. Asp. of Appl. Biol. 15, Cereal Quality, p. 337-344.
- Győri, Z. Mars, É. 2001 A műtrágyázás hatása az őszi búza kéntartalmának változására a tenyészidőszak folyamán. II. Növénytermesztési Tudományos Nap „Integrációs feladatok a hazai növénytermesztésben” MTA Növénytermesztési Bizottság, Budapest p. 63.
- Haneklaus, S. Evans, E. Schnug, E. 1992 Baking Quality and Sulphur Content of Wheat I. Influence of grain sulphur and protein concentrations on loaf volume. Sulphur in Agriculture 16:31-34.
- Hensier, R.F. Nimphius, N. 1985 Sulphur emissions: a soil balance perspective. An educational series of the Cooperative Extension Service and the College of Natural resources. University of Wisconsin- Stevens Point, p. 142-187.
- Lásztity, B. Csathó, P. 1995 NPK műtrágyázás vizsgálata tartamkísérletben mezőföldi csernozjom talajon. Agrokémia és Talajtan, 44:47-60.
- Lásztity, B. 1991 A NPK tápanyag ellátás hatása az őszi búza kéntartalmának- és felhalmozásának dinamikájára. Agrokémia és Talajtan, 40:131-139.
- Tanács, L., Matuz, J., Gerő, L., Petrőczy, I. M. 2005 Effect of NPK Fertilisers and Fungicides on the Quality of Bread Wheat in Different Years. Cereal Res Comm 33 2-3 627-635
- Schnug, E. Bloem, E. Haneklaus, S. 2000 Schwefelmangel in Getreide. Getreide 6. Jg. 1:60-61.
- Schnug, E. Haneklaus, S. Murphy, D. 1993 Impact of sulphur supply on the baking quality of wheat. Aspects of Appl. Biol. 36:337-346.
- Kádár, I. (2004): Szennyvíziszap-adagok hatása a növény (*Triticum vulgare* L.)-talaj rendszer néhány mikrobiológiai és biokémiai tulajdonságára (Impact of sludge treatments on some microbiological and biochemical properties of plant (*Triticum vulgare* L.)-soil system. – in Hungarian). Agrokémia és Talajtan. 53. 3-4. 331-342 pp
- Svetková, K.; Henselová, M.; Morvová, M. (2005): Effects of a carbonization product as additive on the germination, growth and yield parameters of agricultural crops. Acta Agron. Hun. 53. (3). 241-250 pp
- Tanács, L., Matuz, J., Gerő, L., Petrőczy, I.M. (2005): Effect of NPK Fertilizers and Fungicides on the Quality of Bread Wheat in Different Years. Cereal Res. Commun. 33 (2-3): 627-634 pp