THE SULFUR IMPORTANCE FOR HIGH QUALITATIV PRODUCTIONS AT WINTER WHEAT

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Abstract: *Wheat quality is a complex notion that involves more analysis parameters and the study of a large number of factors that act implicitly to determine it. Besides the genetic factor, mineral nutrition plays an important role in increasing the quality of the crops. Sulfur is an important element in plant nutrition, its absence causing similar damage to nitrogen deficiency. The experience was located at ARDS Lovrin, on a semicarbonatic chernozem, weakly-gleizated and weakly-alkalinised. The mobile P content in soil is 75.7 ppm, of mobile K is 205 ppm and the humus content is 3.47%. Four different agrofunds were studied, with the following graduations of experimental factors: N50, N50S20, N100 and N100S20. The aim of the paper is to highlight the importance of chemical sulfur fertilizers to increase the quality of wheat production. The analyzed parameters were: the percentage of protein, gluten, gliadin, glutenin and the accumulation of protein subunits with high and low molecular weight. Applying a dose of 20 kg/ha sulfur fertilizer active substance brings significant and very significant increases in the percentage of protein (2.8%) and gluten (6.5%), depending on the level of nitrogen fertilization used. The value of gluten proteins, gliadin and glutenin, expressed in g / 100 g flour, increases significantly when applying sulfur fertilizers. In conclusion, sulfur fertilizers, on the background of an adequate supply with nitrogen, help to achieve a balanced protein and gluten content and has a direct positive influence on gluten proteins content.*

Keywords: *sulfur, nitrogen, protein, gluten, gliadin, glutenin.*

INTRODUCTION

One of the challenges of the future is to provide food resources for the world's population - quantitatively and qualitatively. Wheat is one of the most important crops, with a high share of cultivation worldwide, given the multitude of products that can be obtained from it. The creation of varieties with high production potential and superior bakery qualities are desideratum that must be achieved.

When we talk about the quality of wheat we can not only refer to the protein and gluten content. Particularly important is the quality of the protein, given the participation rate of gliadin and glutenin (gluten proteins). Also, the accumulation rate of HMW and LMW gluten subunits is crucial for the bread quality of wheat flour.

Undoubtedly, besides the cultivar, fertilization plays an important role for the level of the product and for its quality.

Sulfur is a very important chemical element for living organisms and is found in the composition of cysteine, methionine, biotin, coenzyme A, thioredoxin and sulfolipids.. Sulfur is also part of other plant compounds that do not play an essential role but are involved in defense mechanisms against diseases and pests or give the specific taste and smell of the species (BENNETT and WALLSGROVE, 1994; ERNST, 1993; FENWICK et al, 1983).

Sulfur deficiency causes damage to plants almost similar to that of nitrogen deficiency. Actively involved in the synthesis of proteins at the cellular level, sulfur has a special role for obtaining superior qualitative harvests. The quality of wheat determines the quality of bakery products that reach the table of consumers. it is important not to avoid sulfur when drawing up the crop fertilization plan because a balanced fertilization with this compound increases the quality of the crop. (RANDALL and WRIGLEY, 1986).

The nitrogen is of course the chemical element considered responsible for increasing crop production and quality. Many studies demonstrate this. However, it is also a chemical element with the highest mobility in the soil, the efficiency of its use depending on many factors.

Several studies conducted over time by ZHAO (ZHAO et al, 1993, ZHAO et al, 1999) show thet for plant nutrition sulfur is an important element, its deficiency producing production losses, directly and indirectly. Directly by reducing biomass and indirectly by limiting the synthesis of some metabolites, involved in the physiological response of plants to biotic and abiotic stress. (RAUSCH et al, 2005, CHAN et al, 2013). Strategies to improve N and S fertilization in crops are based on studies that aimed to highlight the effect of these types of fertilizers on production and quality (MOSS et al, 1981)..

It has been suggested that foliar – applied nitrogen and sulphur, have synergistic effects on increasing their assimilation in grain and can inprove bread-baking qualities. Sulphur deficiency will reduce nitrogen absorbtion, affecting protein content and affecting flour quality (TAO et al, 2018). Protein content in wheat flour was reported to be significantly affected by the activity of nitrat reductase (NR) and glutamine synthetase (GS) (TAO et al, 2018).

MALLE JÄRVAN also, in 2017, shows that the sulphur application during wheat growth may have in parallel with increased grain yields and improved protein quality – also a positive impact on certain properties of dough and baked products.

Sulfur deficiency in wheat grains decreases the bread quality of gluten, the dough being firmer and less extensible. (MOSS et al., 1981; MACRITCHIE and GUPTA, 1993). An increased sulfur content in the flour results in a less hard dough and a higher baking volume. (MOSS et al., 1981).

MATERIALS AND METHODS

The experience was located at ARDS Lovrin, on a semicarbonatic chernozem, weakly-gleizated and weakly-alkalinised. The mobile P content in soil is 75.7 ppm, of mobile K is 205 ppm and the humus content is 3.47%.. The annual total rainfall is about 500 mm, and the average temperature of 10.8 ° C.

The Ciprian wheat variety was used for experimentation, a variety created at ARDS Lovrin. Were analyzed five experimental variants, with sulfur applied unilaterally and in various combinations with nitrogen. To obtain the flour, the wheat samples were milled and subsequently analyzed. Technique Lab-on-a-Chip (LoaC) was used to extract the two gluten proteins. For the separation and quantification of proteins this technique is one of the fastest, according to the literature (H. Goetz et al, 2004, J. S. Hey, 2007, Živančev, 2015).

From 30 g of flour, after removing the albumin and globulins, gliadin and glutenin were extracted.. The separation of protein subunits at the molecular mass level (HMW and LMW) was done using chip electrophoresis technique on Agilent 2100 Bioanalyzer with Protein 230 Plus Lab-on-a-Chip kit.

The statistical interpretation of the results was made using the variance analysis method (ANOVA).

RESULTS AND DISCUSSIONS

Analyzing the data presented in Table 1, which shows the variation of the percentage of protein on the five studied agrofonds, under the climatic and soil conditions at ARDS Lovrin, is remarkable variants N100 and N100S20, recording differences of 2.0% and respectively 2.8%, compared to the non-fertilized variant. Spores brought by applying these fertilizer doses are 17% and 23%, statistically as distinctly significant and very significant. As compared to just nitrogen fertilized variant, protein percentage increases by 6%, highlighting the direct effect of sulfur application on grain quality.

Table 1

The significance of differences compared to unfertilized variant for protein content and gluten content

Variant	Protein %	%	Dif.	Semnif.	Gluten %	%	Dif.	Semnif.
V1 – control (unfertilized)	12.1	100.0	**mt**		27.6	100.0	**mt**	
V2 – fertilized with N_{50}	12.9	106.0	0.8		29.5	106.8	1.9	*
V3 – fertilized with $N_{50}S_{20}$	13.6	112.3	1.5	*	31.3	113.4	3.7	**
V4 – fertilized with N_{100}	14.1	116.5	2.0	**	32.2	116.6	4.6	**
V5 – fertilized with $N_{100}S_{20}$	14.9	123.1	2.8	***	34.1	123.5	6.5	***

Protein - DL 5% = % 1.3%; DL 1% = 1.9; DL 0,1% = 2.7. Wet gluten - DL 5% = 1.8%; DL 1% = 3.6; DL 0.1% = 5.1.

Concerning wet gluten, it recorded significant differences from the control in all four fertilized variants. Thus, all fertilization graduations are registered with statistical insurance. The percentage of wet gluten varies from 27.6%, in the control variant to 34.1%, in the variant fertilized with 100 kg nitrogen / ha and 20 kg sulfur / ha, and differences between variants are significantly positive (V2), distinctly significant (V3 and V4) and very significant (V5). It is also noted in this case the superiority of the variants in which, besides the nitrogen fertilization, apply 20 kg/ha of sulfur.

Table 2

The influence of fertilization with nitrogen and sulfur over the accumulation of gliadin and glutenin

Variant	Glutenin (g/100 g flour)	%	Dif.	Semnif.	Gliadin (g/100 g flour)	%	Dif.	Semnif.
V1 – control (unfertilized)	7.9	100	mt		25.6	100	mt	
V2 – fertilized with N_{50}	8.4	106.3	0.5		27.3	106.6	1.7	
V3 – fertilized with $N_{50}S_{20}$	10.0	126.5	2.1	*	28.1	109.7	2.5	
V4 – fertilized with N_{100}	12.9	163.2	5.0	**	31.5	123.0	5.9	*
V5 – fertilized with $N_{100}S_{20}$	16.6	210.1	8.7	**	33.8	132.0	8.2	**

Gliadin -DL 5% =1.1 g; DL 1% = 4.9 g; DL 0,1% = 13.8 g. Glutenin - DL 5% = 3.1 g; DL 1% = 7.8 g; DL 0,1% = 12.4 g.

If we analyze the variance of glutenin values, there are significant differences from the control at the fertilization rates applied of 100 kg / ha of nitrogen and 100 kg / ha of nitrogen + 20 kg / ha of sulfur. When comparing glutenin values from fertilized variants with glutenin value from unfertilized variant, are obtained increases ranging from 6% to 110% (Table 2). The amount of gliadins / 100 g flour varies between 25.6 g / 100 g flour and 33.8 g / 100 g flour, with increases between 6.6 g (V2) and 32.0 g (V5).

Regarding the accumulation of HMW (high molecular weight) gluten subunits, the differences recorded against the unfertilized variant range from 0.3 to 4.8 g / 100 g of flour. Spores brought by application of the fertilizer doses of variants 3,4 and 5 are significantly positive (Table 3). LMW (low molecular weight) gluten units record increases over the control ranging from 11% to 46.3%.

Only in the fertilized version with the maximum amount of fertilizer statistical insurance is recorded.

Table 3

The significance of differences compared to unfertilized variant for glutenins

Varianta	Glutenin ng/µl		Glutenin g/100 g faina							
	HMW	LMW	HMW	%	Dif.	Semnif.	LMW	%	Dif.	Semnif.
V1 – control (unfertilized)	48.71	1087.8	0.3	100	mt		8.2	100	mt	
V2 – fertilized with N_{50}	0	1209.5	0	0	-0.3		9.1	111.0	0.9	
V3 – fertilized with $N_{50}S_{20}$	74.3	1324.8	0.6	200	0.3	*	9.9	120.7	1.7	
V4 – fertilized with N_{100}	361.5	1484.8	2.7	900	2.4	**	11.0	134.1	2.8	
V5 – fertilized with $N_{100}S_{20}$	674.2	1674.7	5.1	1700	4.8	***	12.0	146.3	3.8	*

HMW - DL 5% = 0.1 g; DL 1% = 1.3 g; DL 0,1% = 3.9 g. **LMW** - DL 5% = 3.2 g; DL 1% = 5.3 g; DL 0,1% = 9.9 g.

Analyzing the matrix of correlation coefficients presented in Table 3 we can conclude: The correlation between sulfur fertilizer and: glutenin is positive statistically assured, the transgression probability α = 1% (r = 0.97 **) - the correlation is distinctly significant; HMW is positive at α = 1% (r = 0.96 ***) - the correlation is distinctly significant; LMW is positive at α = 1% (r = 0.95 **) - the correlation is distinctly significant.

Table 4

The matrix of correlation coefficients

	S	Glutenin	Gliadin	HMW	LMW
S	1.00	0.97**	-0.12	0.96**	0.95**
Glutenin		1.00	-0.33	0.96**	0.97**
Gliadin			1.00	-0.22	-0.21
HMW				1.00	0.98***
LMW					1.00

CONCLUSION

Sulfur fertilizers, on the background of an adequate supply with nitrogen, help to achieve a balanced protein and gluten content and has a direct positive influence on gluten proteins content.

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