RESULTS REGARDING THE INFLUENCE OF VARIETY, SOIL TYPE AND CROP YEAR FACTORS ON THE PROTEIN CONTENT IN SPRING BARLEY GROWN IN NORTH-EAST BĂRĂGAN

REZULTATE PRIVIND INFLUENȚA FACTORILOR SOI, TIP DE SOL ȘI AN DE CULTURĂ ASUPRA CONȚINUTULUI DE PROTEINĂ LA ORZOAICA DE PRIMĂVARĂ CULTIVATĂ ÎN BĂRĂGANUL DE NORD-EST

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Abstract. *The contents of protein substances, expressed as a percentage of the dry matter, is a characteristic of varity but, at the same time, it is strongly influenced by the pedoclimatic conditions and cultivation techniques, ranging widely within the same variety, from one year to another and from one place to another. The main aim of the research was to study the influence of the observed factors and of the interactions between those factors on the production of spring barley in Vădeni area, Brăila County.*
Keywords *barley varieties, production, soil*

Rezumat. *Conținutul de substanțe proteice, exprimat în procente din substanța uscată este o caracteristică de soi, dar în același timp este puternic influențat de condițiile pedoclimatice și modul de cultură, variind în limite largi în cadrul aceluiași soi, de la un an la altul și de la o localitate la alta. Scopul principal al cercetărilor a fost acela de a urmări influența factorilor studiați și a interacțiunillor dintre aceștia asupra producției de orzoaică de primăvară cultivată în zona Vădeni, județul Brăila.*
Cuvinte cheie *soiuri de orz, producție, sol*

INTRODUCTION

The contents of protein substances in barley varies widely from 8 to 13.5% of dry matter. It is recommended that the barley used for making beer should have a content of protein substances between 9 and 11.5% (Berzescu et al., 1981).

Protein substance content, expressed as a percentage of dry matter, is a characteristic of variety, but it is also strongly influenced by pedo-climatic conditions and how the culture is grown (Bîlteanu, 2003), varying widely in one and the same variety, from one year to another and from one place to another.

MATERIAL AND METHOD

The research was conducted in 2008-2010, in Vădeni area, Brăila county, on two different types of soil, typical chernozem (with the following physical and chemical

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properties: bulk density (DA): 1.15 g/cm^3, pH (water): 7.60, humus content (H): 3.5%, phosphorus (P_{AL}): 45 ppm, Potassium (K_{AL}): 222 ppm and indicate N (IN): 3.55) and calcaric aluviosoil (with the following physical and chemical properties: bulk density (DA): 1,35 g/cm^3, pH (water): 7.75, humus content (H): 2.93%, Phosphorus (P_{AL}):47 ppm Potassium (K_{AL}):111 ppm and indicate N (IN): 2.93). Four varieties of spring barley were studied - Annabell, Thuringia, Cristalia and Tunika.

The precedent plant was corn. The sowing was done in all the years of research, at the optimum age for this area (the first decade of March) at a density of 400 b.g./m^2.

Climatic conditions during the period in which the experiments took place were different from year to year (Table 1). Analysing the annual amount of rainfall compared to the multi-annual average (447 mm), it appears that the agricultural year 2007-2008 was a normal year (481 mm), 2008-2009 was dry (363 mm), 2009-2010 was a year with more precipitation (714 mm) irregularly distributed throughout the year.

Table1

The main climatic elements for the agricultural years 2007-2008, 2008-2009 and 2009-2010 compared to the normal

Elemente climatice		Valori lunare												Total/media an agricol
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	
Precipitatii (mm)	Normala	31	36	33	27	27	29	36	52	63	47	42	29	447
	2007/2008	81	53	77	7	2	15	44	86	40	7	0	60	481
	Abatere	+50	+17	+44	-20	-25	-14	+18	+34	-23	-40	-42	+31	+34
	2008-2009	21	18	24	64	27	29	11	32	25	43	16	15	363
	Abatere	-10	-18	-9	+37	0	0	-25	-20	-38	-4	-26	-14	-84
	2009-2010	37	22	114	89	70	28	10	54	165	88	19	21	717
	Abatere	+6	-14	+81	+62	+43	-1	-26	+2	+102	+41	-23	-8	+270
Temperaturi in aer (°C)	Normala	11,7	5,6	0,4	-2,5	-0,3	4,6	10,9	16,9	20,7	22,8	22,1	17,5	10,9
	2007/2008	11,8	3,9	0,1	-1,3	2,6	8,3	12,3	16,3	21,6	22,9	24,3	16,3	11,6
	Abatere	+0,1	-1,7	-0,3	+1,2	+2,9	+3,7	+1,4	-0,3	+0,9	+0,1	+2,2	-1,2	+0,7
	2008-2009	12,1	6,6	3,3	0,3	2,5	5,6	11,5	17,5	21,4	24,5	22,6	17,6	12,1
	Abatere	+0,4	+1,0	+2,9	+2,8	+2,8	+1,0	+0,6	+0,6	+0,7	+1,7	+0,5	+0,1	+1,2
	2009-2010	12,8	7,2	0,2	-3,3	0,2	5,1	11,6	17,8	21,2	23,5	25,0	17,5	11,6
	Abatere	+1,1	+1,6	-0,2	-0,8	+0,5	+0,5	+0,7	+0,9	+0,5	+0,7	+2,9	0	+0,7

The researched observed the influence of the soil factor, the variety factor and crop year factor and also of the interactions between those factors on grain production in spring barley.

The experimental results were statistically processed by analysis of variance, the F test and limit differences (Săulescu and Săulescu, 1967). The production data capitalizing was done in a series, following the trifactorial model (2x4x3), as an experiment with two different soil types and four varieties grown in three years.

RESULTS AND DISCUSSION

From the analysis of the variance table for the protein content in the varieties of spring barley (Table 2) the following conclusions emerge:

- the varieties/error F test shows that there are distinctly significant differences between varieties grown on the two soil types in different experimental years.

- the soils/error F test shows there are distinctly significant differences between the two types of soil.

- the AxB combined varieties/action F test and the BxC combined varieties/action F test show that the varieties have distinctly significant differences, with different responses to soil type and respectively crop-year, which shows the superiority or inferiority of certain varieties regardless of soil type or crop year.

Table 2

Analysis of variance and the F test

Cause of variance	**GL**	**SP**	**s^2**	**F test**		
				Compared to error	Compared to AB	Compared to BC
Total	23	5,38				
Soil type (A)	1	0,28	0,280	33,6 ** (*5.99; 13.74*)	7,64 (10,13; 13,74)	
Varieties(B)	3	4,55	1,517	182** (*4.76; 9.78*)	41,36** (*9,28; 29,46*)	30,33** (4,76; 9,78)
Crop years (C)	2	0,07	0,035	4,4 (*5.14; 10,92*)		
Interaction AxB	3	0,11	0,040	5,0* (*4.76; 9.78*)		
Interaction AxC	2	0,3	0,050	6,0* (*4.28; 8.47*)		
Interaction BxC	6	0,02	0,007			
Interactions AxBxC (error)	6	0,05	0,008			

From the data presented in Table 3 it is found that the lowest value of protein content is obtained on aluviosoil, with a difference of 0,22% from chernozem, which is very significant statistically. Regarding the difference from the average content of protein, this is of 0,11%, being statistically significant.

Table 3

The influence of soil on the protein content of spring barley

Soil	**protein** (% d.m.)	**Dev. from mt.**		**Signif.**	**Dev from the average**		**Signif.**
		% d.m.	%		% d.m.	%	
Typical chernozem (**mt**)	10,44	0	100		0,12	101,2	*
Calcaric aluviosoil	10,21	-0,22	97,9	000	-0,11	98,9	0
Average	10,32				mt	100	
DL 5% =0,89% s.u., DL1% =0,13% s.u., DL 0,1% =0,22% s.u.							

Table 4

The influence of variety on the protein content of spring barley

Variety	protein (% d.m.)	Dev. from mt.		Signif.	Dev from the average		Signif.
		% d.m.	%		% d.m.	%	
Thuringia (**mt**)	9.75	mt	100		-0,58	94,4	0
Annabell	10.60	0,85	108,7	**	0,27	102,6	-
Cristalia	10,87	1,12	111,5	***	0,54	105,2	*
Tunika	10,09	0,34	103,5	-	-0,24	97,7	-
Average	10,33				mt	100	
DL 5%=0,39% s.u. DL1%=0,59% s.u. DL 0,1%=0,95% s.u.							

The range of protein content of spring barley grain is between 9,75% d.m. for the Thuringia variety and 10,87% for the Cristalia variety. Compared to the control variety, Thuringia, for the Annabell and Cristalia varieties there have been distinctly significant differences and very significant statistical differences of +0,85% and +1,12% (Table 4).

Table 5

The influence of the crop year on the protein content of spring barley

Crop year	protein (% d.m.)	Dev. from mt.		Signif.	Dev from the average		Signif.
		% d.m.	%		% d.m.	%	
2008 -(**mt**)	10,31	mt	100		-0,02	99,8	-
2009	10,39	+0,08	100,8	-	+0,06	100,6	-
2010	10,28	-0,03	99,7	-	-0,04	99,5	-
Average	10,33				mt	100	
DL 5%=0,34% s.u. DL1%=0,52% s.u. DL 0,1%=0,83% s.u.							

The data in Table 5 shows that, compared to the average content of protein obtained in 2008, took as a reference year, the climatic conditions in the other two research years were different, and so in 2009 a protein increase of 0.08% was obtained and in 2010, a deficit of 0,03%, without statistical coverage. Compared to the average protein content of the research, it can be seen that the year of 2009 has favoured the achievement of a higher content of protein, with a difference of 0,06% from the average, without statistical coverage.

Table 6

The influence of the variety/crop-year interaction on the protein content of spring barley

Variety		protein (% d.m.)	Dev. from mt.		Signif.	Dev from the average		Signif.
			%d.m	%		%d.m	%	
Thuringia (mt)	2008	10,50	mt	100		+0,17	101,6	-
	2009	10,66	mt	100	-	+0,33	103,2	-
	2010	10,66	mt	100	-	+0,33	103,2	-
Annabell	2008	9,65	-0,85	91,90	0	-0,68	93,4	*
	2009	9,85	-0,81	92,40	0	-0,48	95,3	-
	2010	9,75	-0,91	91,46	0	-0,58	94,4	-

Cristalia	2008	11,05	+0,55	105,23	-	+0,72	106,9	*
	2009	10,73	+0,07	100,65	-	-0,40	103,8	-
	2010	10,84	+0,18	101,68	-	+0,51	104,9	-
Tunika	2008	10,05	-0,45	95,71	-	-0,28	97,3	-
	2009	10,35	-0,31	96,71	-	-0,02	100,1	-
	2010	9,89	-0,77	92,77	0	-0,44	95,7	-
Average		10,33				mt	100	
DL 5%=0,68% s.u. DL1%=1,03% s.u. DL 0,1%=1,66% s.u.								

According to data presented in Table 6 the following facts emerge: compared to the control variety, Thuringia, significant negative differences of 0,85% were recorded for the Annabell variety in 2008, of 0,81% in 2009 and of 0,91% in 2010 while for the variety Tunika a significant negative difference of 0,77% was recorded in 2010. Compared to the research average (10,33%) there were significant positive differences of 0,68% for the Annabell variety and 0,72% for the Cristalia variety in 2008.

An analysis of the data in Table 7 shows that: the Annabell variety recorded very significant negative differences compared to the control variety, Thuringia, on both chernozem and aluviosoil in all three crop years; the Tunika variety had distinctly significant negative differences on chernozem in 2008 and 2010 and on aluviosoil in 2008 and very significant negative differences in 2009 and 2010; the Cristalia variety showed significant positive differences in 2008 both on chernozem and aluviosoil and distinctly significant differences in 2010.

Compared to the average of the research, there were very significant negative differences for the Annabell variety on chernozem in 2008 and 2010 and on aluviosoil in all three experimental years, and the Tunika variety on aluviosoil in 2010; distinctly significant negative differences for the Annabell variety grown on chernozem in 2009 and the Tunika variety grown on aluviosoil in 2008; a significantly negative difference for the Tunika variety on chernozem in 2009; very significant positive differences for the Cristalia variety grown on chernozem in all three research years and on aluviosoil in 2008; distinctly significant positive differences for the Thuringia variety on chernozem and aluviosoil in 2009 and 2010 and for the Cristalia variety grown on aluviosoil in 2010; significant positive differences on chernozem for the Thuringia variety in 2008 and on aluviosoil for the Cristalia variety in 2009.

Table 7

The influence of the soil type/variety/crop-year interaction on the protein content of spring barley

SSoil	Variety	Crop year	protein (%d.m.)	Dev. from mt.		Signif.	Dev from the average		Signif.
				%d.m	%		%d.m	%	
Typical	Thuringia (mt)	2008	10,55	0,00	100,0		+0,23	102,2	*
		2009	10,70	0,00	100,0		+0,38	103,6	**
		2010	10,67	0,00	100,0		+0,35	103,3	**
	Annabell	2008	9,70	-0,85	91,94	000	-0,62	93,9	000

		2009	9,92	-0,78	92,70	000	-0,40	96,1	00
		2010	9,85	-0,82	92,31	000	-0,47	95,4	000
	Cristalia	2008	11,15	+0,60	105,68	***	+0,83	108,0	***
		2009	10,87	+0,17	101,58	-	+0,55	105,3	***
		2010	10,97	+0,30	102,81	**	+0,65	106,2	***
	Tunika	2008	10,15	-0,40	96,20	00	-0,17	98,3	-
		2009	10,55	-0,15	98,59	-	-0,23	98,3	0
		2010	10,27	-0,40	96,25	00	-0,05	99,5	-
Calcaric Aluviosoil	Thuringia	2008	10,27	0,00	100,0		-0,05	99,5	-
		2009	10,62	0,00	100,0		+0,30	102,9	**
		2010	10,65	0,00	100,0		+0,33	103,1	**
	Annabell	2008	9,60	-0,67	93,47	000	-0,72	93,0	000
		2009	9,77	-0,85	91,99	000	-0,55	94,6	000
		2010	9,65	-1,00	90,61	000	-0,67	93,5	000
	Cristalia	2008	10,95	+0,68	106,62	***	+0,63	106,1	***
		2009	10,60	-0,02	99,81	-	+0,28	102,7	*
		2010	10,72	+0,07	106,62	-	+0,40	103,8	**
	Tunika	2008	9,95	-0,32	96,88	00	-0,37	96,4	00
		2009	10,15	-0,47	95,57	000	-0,17	98,3	-
		2010	9,52	-1,13	89,38	000	-0,80	92,2	000
Average			10,32				mt	100,0	
DL 5%=0,19% s.u. DL1%=0,29% s.u. DL 0,1%=0,47% s.u.									

CONCLUSIONS

1. All four varieties analysed both on chernozem and aluviosoil in the three years of research obtained a protein content (between 9,52 -11,15%) which complies with the standards of beer producers (9 – 11,5%).

2. The most stable variety in terms of protein content is Annabell which was the least affected by the studied factors.

3. The soil type influences the protein content of barley grain, a higher value of protein content being obtained on chernozem than on aluviosoil for the same varieties grown under the same environmental conditions.

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