RESEARCHES REGARDING THE YIELD AND QUALITY OF SOME WINTER WHEAT VARIETIES IN INTERACTIONS WITH NITROGEN FERTILIZATION

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Abstract: *In this paper are presented some results regarding the yielding potential of a new own wheat variety, Crisana comparative to another Romanian wheat varieties in last three years, 2008, 2009 (very drought) and 2010 (very raining) in western part of country. Also, we present some results regarding the backing qualities of this new variety comparative to another ones, in last years. The experiments were conducted in the experimental field of Agricultural Research-Development Station Oradea, a representative area for north-west of Romania. The results confirm that our new variety, Crisana, registered in 2005, is one of the best wheat varieties, regarding the yielding potential and backing qualities, with or without nitrogen fertilization. Other varieties with good yielding potential are: Ciprian, Glosa and Romulus. This paper presents the qualities indicators and yields potentials of the cultivars in two comparative variants, fertilized and unfertilized with nitrogen. The difference between the two variants of fertilization is evident: 29, 7% comparative to 23.2% wet gluten, demonstrating that nitrogen fertilization is very important for bred-making quality. The total proteins (%) varied in optimal limits in fertilized variant: 10.6% to 13.0% (Alex), another 4 cultivars exceeding 12.0%. Without nitrogen fertilization, the content of grains proteins is with 1.2% under fertilized variant. The results demonstrate that it is possible to create wheat varieties that have in the same time, good yielding potential and very good qualities, like wet gluten, protein, falling number, Zeleny index, etc. The relation between yields and wet gluten contents in fertilized and unfertilized variants demonstrated that the wet gluten content is very dependent of genetically factor, variety, but it is dependent too of fertilization with nitrogen. The general trend suggests the negative tendency between yield and quality. The genotypes with good yielding potential have usual pour quality. There are some exceptions, like the variety Ciprian, highly yielding but with good quality, in the same time. The results demonstrate that Crisana has a good yielding potential in the years with very drought spring and summer (like 2009) but not so good in excessive raining year. In the same time, its quality indicators are stable from a year to another and it is competitive to another Romanian and foreign cultivars*

Key words*: wheat, variety, backing quality, yields potential.*

INTRODUCTION

In Romania, the average area cultivated with winter wheat reaches about 2 million ha, with a total production between 7 and 12 million tones/ year, but only 2- 5 million tones are acceptable regarding the quality.

Crisurilor Plain, (western Romania) is one of the most important areas for the winter wheat. I this area are cultivated some varieties created at National Institute for Agricultural Research and Development Fundulea (Dropia, Boema, Flamura 85, Glosa), Agricultural Research and Development Station Turda (Ariesan) , Agricultural Research and Development Station Lovrin (Alex, Romulus, Ciprian, Lovrin 34) and Agricultural Research and Development Station Oradea (Crisana), All of them are appreciate with good qualities (11). In the last three years, the most cultivated varieties in this area were: Alex, Romulus, Dropia,

Ariesan (Romanian), Serina, Josef and Renesansa (foreign).

In Hungary are registered more than hundred cultivars, some of them being superiors in numerous quality parameters: Lupulus (Austrian cultivar), Mv. Palotás, G. K. Memento. Fatima (Romanian cultivar registered in Hungary) and Lupulus show high wet gluten content in non fertilized conditions (1). Some of these varieties are cultivated in western Romania, too.

Generally, wheat quality (1) is defined by:

- Physical properties: hectoliter weight, thousand kernels weight (TKW), grain hardness;
- Protein-linked properties: total protein and gluten contents, gluten index, expansiveness, sedimentation volume, protein and amino-acid composition;
- Reologic properties: farinograph or valorigraph test, alveograph value, extensograph test;
- Enzymatic properties: Hagberg falling number, amilograph test;
- Other examinations: test backing, micotoxin content, residues of pesticides and insecticides.

Nutrition value and bread-making quality in winter wheat (11) depends on:

- Starch from the endosperm;
- Fats from the embryo and aleuronic layer;
- Mineral substances in pericarp;
- Vitamins in tegument and pericarp;
- Proteins, witch varies between 8- 26%.

Wheat quality, especially protein content and bread-making quality is influenced by type of soil, climate conditions, nitrogen fertilization, plant protection and genotype (4; 5; 7; 12). The mineral fertilization can increase the protein content with 26- 42% comparative to non fertilized (control).

Proteins are very important for human body because they are vital in constitutions substances, amino acids, antibodies, and hormones.

High yielding ability with good bread-making quality is the main aim in bread wheat breeding programs (8). It is known that the baking quality of wheat is under genetic as well as environmental control (3). Another authors (2) concluded that the heritability coefficients are small for protein content, but large for sedimentation index, gluten content and deformation index. The cultivars created at A. R. S. Turda (Apullum, Turda 95 and Turda 2000) are considered to be a new level of quality in Central and North Romania.

Other authors (5) appreciate that the stability of wheat quality is strongly dependent on genotypes, agricultural production technology, soil fertility, nitrogen fertilization and water availability.

The genetic and molecular control of cereal quality and methods for its manipulations is possible by conventional breeding methods or by genetic engineering (6). Using genetic maps, they concluded that the increase of grain protein content is associated with markers on chromosomes 1A, 2B, 2D, 3B 5BS/7BS and 6B. Another allele situated on chromosomes 3A, 6A and 7A have a smaller effect in wheat. So, the genetic control of quality in wheat is very complex, cereals having around of 50.000 genes.

In *durum* wheat (9), rising the nitrogen rate, rise too the protein content in grain by 15-17, 3%. Very important are, in the same time, the crop, storage and milling management.

An group of co-worker (10) present the standard values for wheat quality in Romania (812- ISO 7970/2001): hectoliter weight more than 75 kg/hl, falling number between 180-260 seconds, wet gluten more than 22%, gluten index between 65 and 80%.

MATERIAL AND METHODS

In this paper are presented the results regarding the yield potential of some cultivars during the last three years in The Crisurilor Plain, respectively at Oradea. Also, are presented results regarding the quality of these cultivars in correlation with nitrogen fertilization and clime.

The total number of cultivars tested during 2008-2010 in this location is 25, from Romania, Hungary, Austria, Serbia and France. We were tacked in study these cultivars because they were the most spreader in our zone in last years.

Regarding to the climatic conditions, the year 2008 was on of the most favorable for winter wheat. These data are reflected in grain yields.

The year 2009 was very drought, the difference of rains being -119, 0 mm, especially in April, May, and July. It was very worm, the difference comparative to a multi annual average being $+16,8^0$C.

In 2010, the sum of total reins exceeded 830 mm, a singular situation in the last 50 years. Consequently, the incidence of leaf and ear disease was strongly, with large effects on yield and quality.

All 25 cultivars are compared with experimental average and Crisana too, our new cultivar created at Agricultural Research and Development Station Oradea and registered in 2005.

By official quality analyses, Crisana variety was classified in A2 (B1) valuable group, being appreciated like an ameliorative one. It is recommended to be cultivating in hill zone from Crisana, Maramures, Transylvania and Bucovina counties and in western Romania plain zone.

The field experiences were done at Oradea conforms to a balanced square lattice scheme, in 6 replications and two factors: cultivar and fertilization. The variant without nitrogen is concept to show its role in protein accumulation. The variant with nitrogen fertilization consists in 100 kg/ha active substance (300 kg/ha of ammonium nitrate), administrated in two fazes.

The statistical analyze is conformer to ANOVA (analyze of variance) and the differences were compared by LSD (limit standard difference). The quality testes and determinations were done in Wheat Breading Laboratory of Agricultural Research – Development Station Oradea, by an Agri-check Bruins Instrument.

RESULTS AND DISCUSSIONS

In 2010, an extremely rainy year, the grain yield varied between 5709 kg/ha and 9027 kg/ha, the most yielding variety being Apache, fallowed by a Romanian one, Ciprian. They exceed very significant experimental average, with more than 1400 kg/ha (27.0%, respectively 20.6%).

It is significant that the experimental average is very great, exceeding 7100 kg/ha.

The same range of cultivars tested without nitrogen fertilization yielded less with about 1500 kg/ha (table 1 and 2). The results sugest that the effect of nitrogen fertilization is that 1kg N determine 1.5 kg grain yield in addition.

The biggest yield in the variant without fertilization was realized by the same varieties, Apache and Ciprian. The unexpected level of yield is explained by the raining regime, similar to irrigated conditions.

Analyzing the results of grain yield during the last three years (2008- 2010), it is evident that yield is very dependent of climatically conditions of year (table 3). In 2008, a normal climatic year, the average grain yield was more than 5500 kg/ha for 16 Romanian varieties. In 2009, a year with deficit of precipitations, the yield averages don't exceeded 4500

kg/ha, except our variety Crisana, in the fertilized variant.

In 2010, an exceptional climatic year, the range of varieties vas completely changed, but the variety Ciprian confirmed its superiority in yielding potential.

Regarding the level of averages yields of cultivars is close: 4886 kg/ha (Ariesan) to 6134 kg/ha (Ciprian). It is interesting that the new varieties had the best yield stability. In the top, Crisana has a medium place 11 by 16 variants.

Table 1

Grain yield of some winter wheat tested at Oradea in 2009/2010.
(Fertilized)

Class.	Variety	Yield (kg/ha)	Relative yield (%)	Differences to experimental average (kg/ha)	Significance of differences
1	Apache	9027	127.0	+1921	***
2	Ciprian	8568	120.6	+1462	***
3	Litera	7735	108.9	+629	
4	Izvor	7669	107.9	+563	
5	Faur	7647	107.6	+541	
6	Glosa	7450	104.8	+344	
7	Serina	7365	103.6	+259	
8	Kristina	7334	103.2	+228	
9	Capo	7312	102.9	+206	
10	Miranda	7301	102.7	+195	
11	Romulus	7219	101.6	+113	
12	Boema	7191	101.2	+85	
13	Dropia	7113	100.1	+7	
Experimental average		7106	100.0	0	
14	Flamura 85	7102	99.9	-4	
15	Renesansa	7101	99.9	-5	
16	Kiskun Gold	6921	97.4	-185	
17	Lovrin 34	6883	96.9	-223	
18	Ardeal	6805	95.8	-301	
19	Alex	6680	94.0	-426	
20	Delabrad	6791	95.6	-315	
21	Gruia	6613	93.1	-493	
22	Crisana	6108	85.9	-998	o
23	Briana	6059	85.3	-1047	o
24	Ariesan	5946	83.7	-1160	oo
25	Josef	5709	80.3	-1397	oo

$LSD_{5\%}$ = 780 Kg/Ha; $LSD_{1\%}$ = 1057 Kg/Ha; $LSD_{0,1\%}$ = 1415 Kg/Ha.

In order to determine the quality of cultivars and the influence of nitrogen to them, the samples of grain were tested in order to se: wet gluten, protein content and sedimentation index (Zeleny index).

Is evident (table 4) that Alex, Ariesan, Dropia, Lovrin 34 and Crisana (all of them exceeding 30% wet gluten) are very good for baking, according with the researches of others authors (10). Even without nitrogen, some of cultivars were able to cumulate more than 25% wet gluten: Alex, Delabrad, Dropia, Faur, Gruia and Briana.

The difference between the two variants of fertilization is evident: 29, 7% comparative to 23.2% wet gluten, demonstrating that nitrogen fertilization is very important for

bred-making quality.

The total proteins (%) varied in optimal limits in fertilized variant: 10.6% to 13.0% (Alex), another 4 cultivars exceeding 12.0%.

Without nitrogen fertilization, the content of grains proteins is with 1.2% under fertilized variant.

Zeleny index is strongly different in the two variants: 31.7 versus only 19.6, resulting that is very important to assure an optimal fertilization for good protein content. Again, Alex has the highest value: 45, fallowed by Dropia and Delabrad.

Table 2

Grain yield of some winter wheat tested at Oradea in 2009/2010.
(No fertilized)

Class.	Variety	Yield (kg/ha)	Relative yield (%)	Differences to experimental average (kg/ha)	Significance of differences
1	Apache	7519	132.2	+1832	***
2	Ciprian	6912	121.5	+1225	***
3	Capo	6419	112.9	+732	*
4	Renesansa	6342	111.5	+655	*
5	Kiskun Gold	6074	106.8	+387	
6	Litera	6032	106.1	+345	
7	Serina	5992	105.4	+305	
8	Izvor	5955	104.7	+268	
9	Ariesan	5889	103.6	+202	
10	Lovrin 34	5786	101.7	+99	
11	Faur	5750	101.1	+63	
12	Boema	5717	100.5	+30	
Experimental average		5687	0.0	-	
13	Glosa	5606	98.6	-81	
14	Miranda	5579	98.1	-108	
15	Dropia	5475	96.3	-212	
16	Romulus	5414	95.2	-273	
17	Delabrad	5402	95.0	-285	
18	Flamura 85	5364	94.3	-323	
19	Kristina	5250	92.3	-434	
20	Ardeal	5198	91.4	-489	
21	Briana	5173	91.0	-514	
22	Gruia	4950	87.0	-737	o
23	Alex	4879	85.8	-808	o
24	Crisana	4812	84.6	-875	o
25	Josef	4688	82.4	-999	oo

$LSD_{5\%}$ = 651 Kg/Ha; $LSD_{1\%}$ = 882 Kg/Ha; $LSD_{0,1\%}$ = 1181 Kg/Ha.

In 2010, even the fertilization was the same, the climatic conditions determined some important changes in quality indicators. The experimental average of wet gluten is greater with 4%, the protein content is similar and Zeleny index is greater with more than 20%.

In the variant with zero nitrogen, the trend is the same, but the level of values is, evident, lower.

We can conclude that Ariesan, Ciprian, Gruia and Alex are the best varieties regarding

the backing quality, both in 2009 and 2010 and in both fertilization variants. That confirms the large genetic control of qualities indexes and also, the good stability to phenotypic changes.

In figures 1 are presented the relations between wet gluten contents of eighteen winter wheat varieties during the years 2009 and 2010, in the variant fertilized with nitrogen. It is evident that there is a strongly dependence between the wet gluten content of the varieties series. That suggests a high genetic control of this character, even when the climatic conditions are so different.

In the unfertilized variant with nitrogen (fig. 2), the regression trend between the content of wet gluten is more evident. This suggests that the quality of wheat is affected by nitrogen fertilization, but in the same time is strongly controlled by genetics factors.

Table 3

Grain yields of some winter wheat cultivars tested in the last three years.
Oradea, 2008-2010 (Fertilized)

Class.	Cultivar	Grain yield (kg/ha)			Yield average of cultivar (kg/ha)
		2008	2009	2010	
1	Ciprian	5645	4188	8568	6134
2	Glosa	6323	3992	7450	5922
3	Romulus	5697	4480	7219	5799
4	Izvor	6263	3073	7669	5668
5	Lovrin 34	5867	4215	6883	5655
6	Delabrad	5729	4219	6791	5580
7	Flamura 85	5580	3692	7102	5458
8	Boema	5382	3591	7191	5388
9	Dropia	5416	3584	7113	5371
10	Faur	5563	2881	7647	5364
11	Crisana	5177	4706	6108	5330
12	Gruia	5319	4057	6613	5330
13	Alex	6109	3164	6680	5318
14	Ardeal	5166	3819	6805	5263
15	Briana	5146	3601	6059	4935
16	Ariesan	5140	3573	5946	4886
Annual yields averages, kg/ha		5595	3802	6990	5462

In the same time, the figures suggests that nitrogen fertilization enrich gluten content with more than 5%, which is very important for backing processes.

In figures 3 and 4 are presented the relation between yields of the sames varieties and wet gluten contents in fertilized and unfertilized vatioants. It is demonstrated that the wet gluten content is very dependent of geneticaly factor, variety, but it is dependent too of fertilization with nitrogen. The general trend suggest the negative tendence between yield and quality. The genotypes with good yielding potential have usual pour quality. There are some exceptions, like the variety Ciprian, highly yielding but with good quality, in the same time.

Comparing the individual variety reactions, we can conclude that the varieties: Alex, Ariesan, Dropia and Gruia are wheat varieties with high qualities indicators, but their yielding potential is not suitable. Another ones, Ciprian, Glosa and Delabrad, have good yielding potential and, in the same time, good backing qualities.

Table 4

Results regarding some baking quality characthers of the cultivars tested.
Oradea, 2009

Nr.	Cultivar	Fertilized			No fertilized		
		Wet gluten (%)	Protein (%)	Zeleny index	Wet gluten (%)	Protein (%)	Zeleny index
1	Flamura 85	30	11.5	33	24	10.3	19
2	Lovrin 34	29	11.3	27	21	10.7	26
3	Ariesan	32	12.1	36	21	10.2	12
4	Dropia	32	12.3	39	25	10.5	23
5	Alex	34	13.0	45	26	11.0	32
6	Ardeal	29	11.4	27	22	10.3	13
7	Romulus	27	10.6	19	21	10.1	16
8	Boema	26	10.6	18	23	10.1	13
9	Delabrad	30	11.8	38	26	11.0	31
10	Faur	29	11.4	32	25	10.8	26
11	Glosa	30	11.6	32	24	10.2	20
12	Gruia	32	12.3	35	25	11.0	22
13	Izvor	30	12.0	37	22	10.3	23
14	Ciprian	28	11.4	31	19	9.2	14
15	Briana	29	11.6	29	25	10.5	19
16	Crisana	30	11.6	32	24	10.2	19
Experimental averages		29.7	11.6	31.7	23.2	10.4	19.6

Table 5

Results regarding some baking quality characthers of the cultivars tested.
Oradea, 2010.

Nr.	Cultivar	Fertilized			No fertilized		
		Wet gluten (%)	Protein (%)	Zeleny index	Wet gluten (%)	Protein (%)	Zeleny index
1	Flamura 85	34	15.7	56	25	13.1	33
2	Lovrin 34	34	15.6	55	24	12.9	30
3	Ariesan	37	16.7	65	27	13.9	42
4	Dropia	34	15.9	60	25	13.3	35
5	Alex	35	15.8	55	27	14.1	46
6	Ardeal	33	15.3	53	24	13.0	33
7	Romulus	35	15.9	59	24	13.0	32
8	Boema	31	14.9	49	24	13.0	33
9	Delabrad	33	15.4	55	25	13.4	38
10	Faur	33	15.5	57	24	13.1	32
11	Glosa	33	15.5	55	25	13.3	35
12	Gruia	36	16.5	62	27	14.1	43
13	Izvor	28	13.8	33	23	12.8	25
14	Ciprian	38	14.1	72	25	13.4	39
15	Briana	36	16.4	61	26	13.5	37
16	Crisana	32	15.0	52	22	12.2	27
Experimental averages		33.9	15.5	56.2	24.8	13.3	35.0

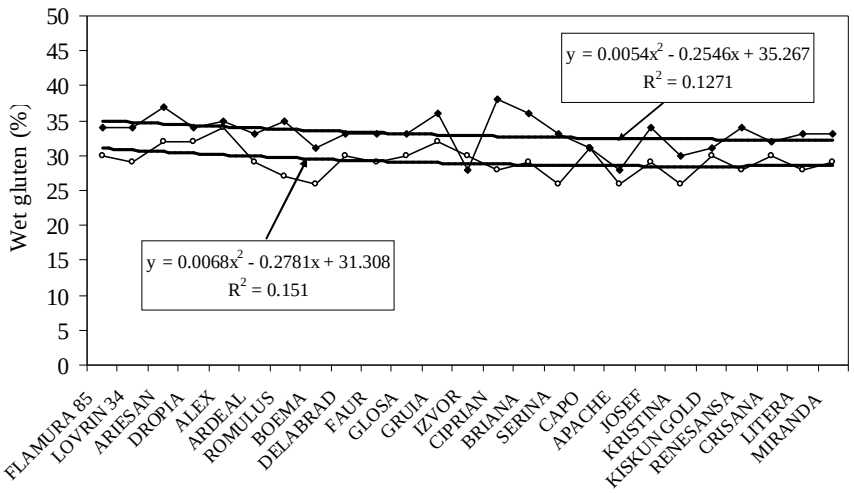

Fig. 1 The relation between wet gluten contents of some wheat varieties in the year 2010 comparative to 2009 (fertilized).

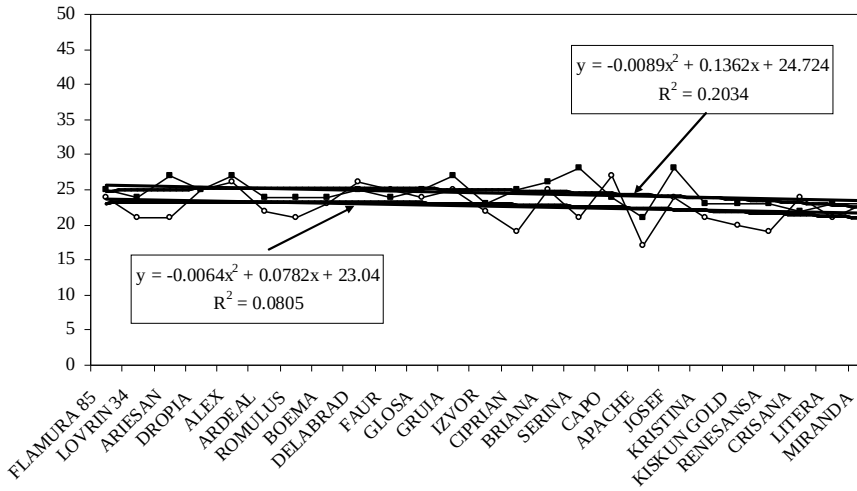

Fig. 2 The relation between wet gluten contents of some wheat varieties in the year 2010 comparative to 2009 (unfertilized).

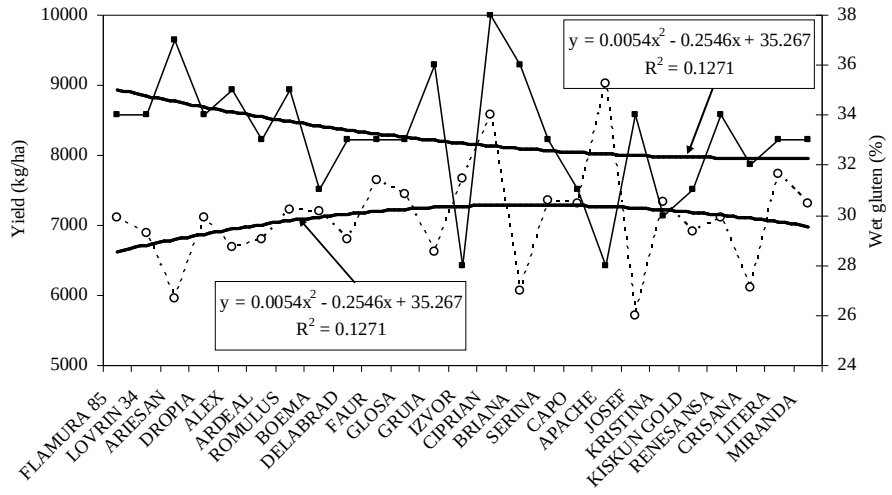

Fig. 3 The relation between yield and wet gluten of some wheat varieties in the year 2010 (fertilized).

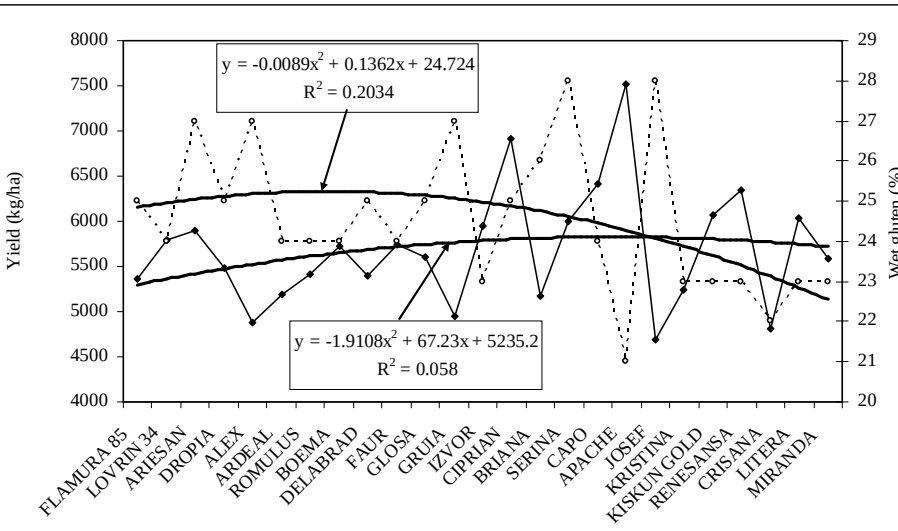

Fig. 4 The relation between yield and wet gluten of some wheat varieties in the year 2010 (unfertilized)

CONCLUSIONS

1. The new cultivar Crisana has a good yielding potential, even in a very drought year, 2009, because of its tolerance to drought, large root system and scorching heat. In an excessive raining year, 2010, it doesn't perform so well.

2. The baking quality of this cultivar is demonstrated by his good wet gluten, protein content, Zeleny index, comparative to the best Romanian varieties.

3. Crisana variety responds well to the nitrogen fertilization, but even without, its yield potential and bread making quality are superior.

4. The fertilization with nitrogen in springtime is essential for a wheat yield with good backing quality.

BIBLIOGRAPHY

1. GYŐRI Z., SIPOS P., 2006- Investigation of wheat quality on different samples. Buletin USAMV-Cluj-Napoca, 62. p. 258-263.
2. KADAR R., MOLDOVAN V., MOLDOVAN MARIA, 2009- Genetic progress in breeding of bread-making quality in winter wheat at ARS Turda: opportunities and constrains. Annual Wheat Newsletter, 47, p. 139-140.
3. LUPTON, F., 2005- Advances in work on breeding wheat with improved grain quality in the twentieth century. The J. of Agric. Science., 143, p. 113-116.
4. PEPÓ P., 2002- Őszibúza-fajták trágyareakciója eltérő évjáratokban. Növénytermelés, 51, p. 189-198.
5. RANIERI R., 2000- Durum wheat quality management. CIHEAM- Options Mediterranean's, p. 555-557.
6. SNAPE J., FISH L., LEADER D., BRADBURNE R., TURNER A., 2005- The impact of genomics and genetics on wheat quality improvement. Turk J. Agric. 29, p. 97-103.
7. SZENTPÉTERY ZS., HEGEDŰS Z., JOLÁNKAI M., 2004- Impact of agrochemicals on yield quality and pesticide residues of winter wheat varieties. Cer. Res. Comm., 32. 2, p. 635-642.
8. ŞEMUN T., 2008- Grain yield and agronomic characteristics of Romanian bread wheat varieties under the condition of Northwestern Turkey. African J. of Biotechnology, 7 (10), p. 1479-1486.
9. TABĂRĂ V., OLTEANU G., 2008- Principalele însusiri de calitate ale grâului *Triticum durum* (soiul Pandur) sub influenta unor măsuri agrotehnice. Buletinul Agir, 1-2, p. 9-13.
10. TABĂRĂ V., PUSCĂ I., WAGNER L., POP G., NITĂ S., GORINOIU GABRIELA, PRODAN M.,2008- Calitatea panificabilă a unor soiuri de grâu de toamnă în conditiile Statiunii de cercetări Agricole Lovrin. Buletinul AGIR, 1-2., p. 3-6.
11. TABĂRĂ V., NITĂ S., POP G., PRODAN M., DUMA C., TABĂRĂ C. G., PASCA M., NEDELCU F., 2009- Breadmaking quality of some winter wheat cultivars in western Romania. Buletinul AGIR, 1-2, p. 182-185.
12. TANÁCS L., MATUZ J., GERŐ L., PETRÓCZI I. M., 2004- Effect of NPK fertilizers and fungicides on the quality of bread wheat in different years. Cer. Res. Comm., 32. 2, p. 627-634.