Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 1, 2020
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

RESEARCH ON THE INFLUENCE OF THE CROP SYSTEM ON YIELD AND ITS QUALITY IN WHEAT, TRITICALE AND BARLEY CROPS IN THE CONDITIONS OF THE LUVISOIL OF THE AGRICULTURAL RESEARCH AND DEVELOPMENT STATION OF SIMNIC

Elena ROȘCULETE[1], Ramona Aida PĂUNESCU[2], Cătălin Aurelian ROȘCULETE[1], Liviu Aurel OLARU[1]

[1]University of Craiova, Faculty of Agronomy, 19 Libertatii Street, Craiova, Romania
[2]ARDS Simnic, 54 Balcesti Street, Craiova, Romania

Corresponding author email: aida.paunescu@yahoo.com

Abstract

The paper presents the results of testing of five varieties of wheat, triticale and barley species, cultivated in the conventional and ecological luvisoil systems at the Agricultural Research and Development Station of Simnic (ARDS) between 2016 and 2018. The following factors were the subject of biometric determinations: grain production, plant height, test weight (TW), 1000 grains weight (TGW), no. of grains / ear, weight of grains / ear and the protein content. The results obtained were analyzed regarding the influence of the three experienced factors (A factor - species, B factor - variety, C factor - crop system) and their interaction. All varieties tested were more productive in the conventional system rather than in the ecological system. The obtained results suggest that the TW was influenced by the interaction between the three factors, while the TGW was largely influenced by the variety within a species, but less influenced by the crop system. The crop system had a major influence on the protein content in all species and all varieties.

Key words*: wheat, triticale, barley, crop systems, yield.*

INTRODUCTION

Prospectively, in the context of the evolution towards ecological agriculture, as well as of the ongoing climatic changes, the research on further diversification of the genetic basis of variability becomes a priority. Agricultural biotechnologies play an important role in facilitating adaptation to climate changing conditions, and help farmers to tailor their production to this new challenge (Bonciu, 2019).

The demand for environmentally certified products is steadily growing. Currently, the internal market for organic products is expanding.

The environmentally friendly way of production, based on the non-use of synthetic chemicals and concern for animals' welfare, is a sustainable solution. Generally, the chemicals used in conventional agriculture can have cytotoxic effects on crop plants which can affect the health of the consumers and the environment (Bonciu et al., 2018).

The 2010-2014 data show that the Romanian agricultural surface area cultivated with ecologic cereals or vegetables increased by almost 60% (www.finantariagricole.ro).

The number of ecological operators registered with the Romanian Ministry of Agriculture and Rural Development (RMARD) was 3,155 in 2010 and 14,470 in 2014. In 2014 the total surface area occupied by organic farms was of 301,148.1 ha, which represented an increase of 61% compared to 2010 (Burghelea et al., 2016; www.madr.ro).

The latest report of the Research Institute of Organic Agriculture FiBL indicates a 14.2% increase in the ecological surface area, Romania ranking the 6th in Europe in terms of growth dynamics. This shows an increased interest of the Romanian farmers in ecological products when compared to other countries in Europe. Over the last years, this increase has not placed Romania in leading positions in the share of organic products resulting from the total agricultural surface area at the national level (only 2% in Romania), being much lower in comparison with other countries (Estonia 20.5%, Czech Republic 12.2%, Slovakia 10%,

Lithuania 8.1%, Germany 8.2%, Hungary 4.3%, Poland 3.4%, Bulgaria 2.9%).

A large part of the products obtained from ecological farming was export-oriented. A percentage of approximately 70-80% of Romania's ecological products are exported annually.

In Romania, the competitiveness of ecological products is determined by the following factors: the number of operators registered in this sector constantly increases; the market of ecological products is expanding; now more than ever, consumers are aware that together with the quality and the value of ecological products for health, ecological farming has also a major contribution to sustainable development (Săucă, 2010). Sustainable development of agricultural systems from production to consumption contributes to enhancing sustainable food production and limiting the negative impact on the environment (Bonciu, 2017).

As far as conventional wheat is concerned, the average production in the European Union was 5757 kg/ha in 2017. Among the producing countries, the European Union top-ranks, six of the Member States (The Netherlands, Belgium, Denmark, Germany, Sweden, France) being in the first ten with an average production of 6,757 to 9,094 kg/ha in 2017 (FAOSTAT).

In Romania, the average production per hectare in the period 1925-1938 was of 9.4 q/ha, with variation limits of 5.1 to 13.1 q/ha. Between 1960-1970 the average wheat production ranged from 12.11 to 14.36 q/ha. Wheat production per hectare has increased in our country over the recent years compared to the inter-war period by 300%. In 2017, the national average production was 4,888 kg/ha.

The FAO data reported in 2017 regarding barley yields shows that Russia is the main conventional producer (7,847,738 ha), followed by Australia (4,834,102 ha).

In 2017, the surface area cultivated with barley in Romania was of 455,460 ha, for which an average production of 4,186 kg/ha and a total production of 1,906,700 tons was yielded.

Genetic and cytogenetic research on barley was carried out in numerous fields. Studies on the heritability of the main components of the production capacity have highlighted the effects of the additivity and the dominant actions of the genes involved for both barley and two-row barley (Popescu, 1985).

A special program of diversification of the genetic basis was developed for the peeled barley, an initial biological material represented by DH lines and well adapted to ecological agriculture (Mihăilescu, 2007).

Over the recent years, the interest of cultivators in triticale has increased, as the new cereal has proved to be a good alternative to traditional cereals. Thus, significant progress has been made in Europe. In Germany, triticale was grown on 389,000 ha in 2017. In Poland, the growth was more than significant, going from 66,700 ha in 1993 (Wolsky and Pojmaj, 1995) to 1,352,013 ha in 2014 (FAOSTAT). The surface area cultivated in Romania in 2017 was of 80,120 ha.

With regard to the triticale, real interest genetic stocks were created for introgression works (Giura and Mihăilescu, 2000; Giura et al., 2007).

The first wheat-rye hybrid was obtained by Săulescu in our country in 1927, and the first form of octoploid triticales (2n = 56) by Priadcencu in 1939 (Priadcencu, 1952).

An important step in favour of the diversification of the genetic basis for triticale was achieved by transferring the genes to reduce the height plant of wheat and rye. The trait of resistance to sprouting (low amylolytic activity) was transferred from wheat, obtaining the first forms of triticale with a Hagberg index over 300 (Ittu et al., 2006).

A comparative study in the ecological system at SCDA Pitesti led to the following conclusions: varieties of the two species, with better adaptability to unfavorable environmental conditions, were identified: FDL Miranda, Izvor, Delabrad 2, Dropia, Faur F, Plai, varieties well adapted to favorable environmental conditions: Alex, Litera, Boema1, Glosa, Haiduc, Cascador F, and varieties with high adaptability to contrasting environmental conditions, such as Trivale, varieties that produce high yields both under favourable and unfavourable environmental conditions; by cultivating varieties with high adaptability to different environmental conditions, the risks of decreasing yield in years with less favourable climatic conditions can be reduced (Voica, 2014).

Globally, studies have been much more diverse. Breeders in France, particularly those belonging to INRA, have made this new species - triticale very appealing to farmers to use as animal feed. Currently, triticale has yielded crops that are equivalent or even better than those obtained from wheat. The breeding program for triticale started in 1971, the first variety being registered in France - Clercal created in the laboratories at Clermont Ferrand in 1983 (Bernard and Bernard, 2005).

Montana (USA) triticale crops consistently show higher yields than spring and winter wheat grown under irrigation and drought conditions. With reference to Montana, under non-irrigated conditions between 1990-1993, the winter triticale registered a 9% increase in yield compared to the winter wheat and to the spring triticale 12% compared to the spring wheat (Karpstein-Machan and Heyn, 1992). Under irrigation conditions, the increase obtained in the spring triticale compared to the spring wheat was of 22%. The authors conclude that triticale use the soil and nitrogen more effectively than winter wheat.

Comparative triticale - wheat experiments were carried out in North Dakota (USA) between 1981-1983. Triticale were 4-6 days earlier and more susceptible to rust than common wheat and durum wheat, their height being equal to that of the common wheat and durum wheat, displaying lower test weight, and slightly lower protein content (Oelke et al., 1989).

Comparative winter wheat and triticale experiments were conducted at the University of Ontario in the United States. The crop yield was within the range: 3,452 kg/ha in the durum wheat variety, and 5,201 kg/ha for a common wheat variety. The experienced triticale variety (Bogo) recorded the highest production - 8,661 kg/ha. In contrast, the protein content was the lowest for triticale (8.6%), while the highest value (11.4%) was associated with the common winter wheat variety. With regard to the heading date, the earliest was the variety of triticale, the wheat varieties registering the heading date even 2 weeks later (Eldredge et al., 1999).

Barley - oats - rye - triticale comparative tests were performed in Texas, Oklahoma, Pennsylvania, Virginia and Georgia. Barley recorded a 5% increase in yield, while rye recorded a 9% decrease. In the rye case, a yield loss of 20% compared to wheat was observed in the same experiment (Ortiz-Monasterio et al., 2002).

Gibson et al. (2004) evaluated 2 varieties of triticale: Trical 815 and Danko Presto at 4 planting dates: 15.09, 24.09, 5.10, 15.10. The yields obtained during the first three planting dates were not differentiated. However, sowing at 15.10 induced a 19% yield reduction compared to sowing at 15.09.

MATERIALS AND METHODS

The research was carried out on the Luvisoil of the Agricultural Research and Development Station of Simnic (ARDS).

The experiment with three factors was set according to the method of the subdivided plots, at 3 replications. The factors studied were: factor A (species) with three graduations: wheat, triticale, barley; factor B (variety) with 5 graduations and factor C (crop system) with 2 graduations: ecological system and conventional system.

The aim of the research was to identify which of the cereal species cultivated in the two crop systems behaved best by comparing the species among them. At the same time it was studied how the varieties tested, regardless of the species, are placed in relation to the most widespread wheat variety in Romania, namely the Glosa variety.

The Glosa, Boema, Otilia, Adelina and Alex varieties were tested for wheat; the varieties Plai, Negoiu, Utrirom, Utrifun, Vifor for triticale, while the Dana, Cardinal, Univers, Ametist and Smarald varieties were tested for barley.

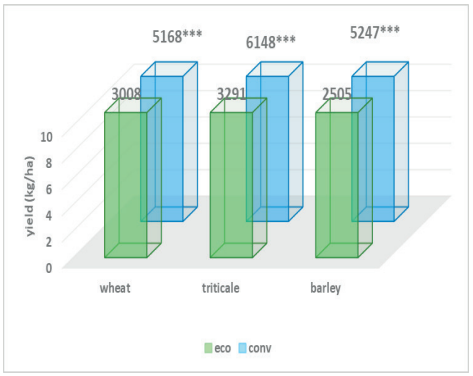
The experimental research carried out focused on how the varieties of these species behaved in an ecological system and in a conventional system, in terms of yield, plant height, number of grains/ear, weight of grains/ear, test weight, 1000 grains weight and protein content.

The following were analyzed: the influence of the species, regardless of variety and crop system; the influence of the variety, regardless of species and crop system; the influence of the crop system, regardless the species and variety; species x crop system interaction; variety x species x crop system interaction; crop system

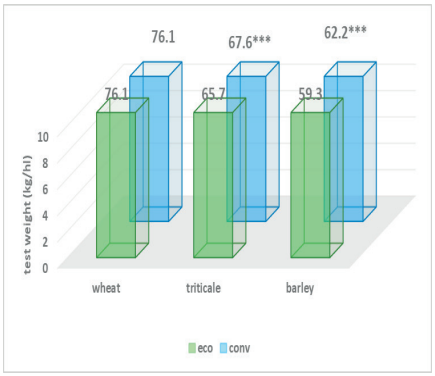
x species x variety interaction. The reporting was done with respect to the Glosa variety - the most widespread variety in Romania.
The practical implications of this paper refer to drawing up recommendations regarding the most adapted species and varieties of cereals depending on the studied crop systems in the central area of Oltenia.

RESULTS AND DISCUSSIONS

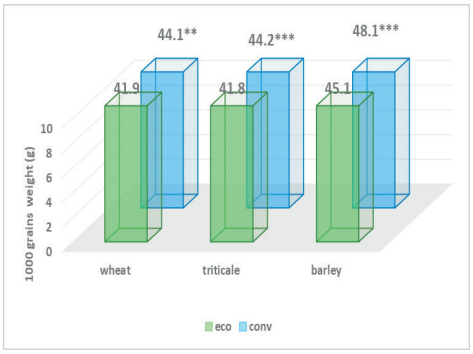
The crop system x species interaction. For all the studied characters, regardless of the variety, the interaction showed that the values obtained in the conventional system were significantly higher than in the ecological system for all species (Figure 1).



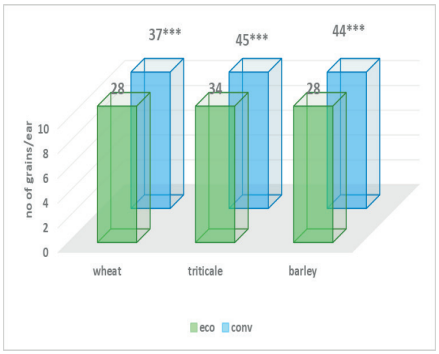
a)



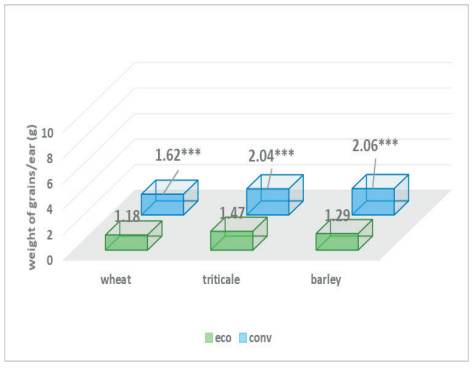
b)



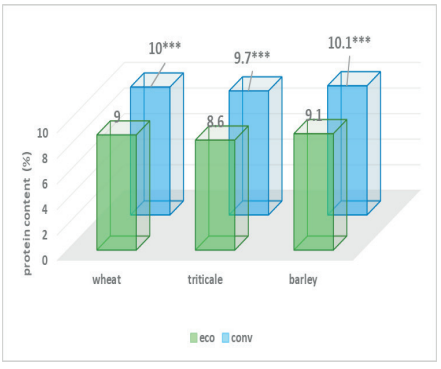
c)



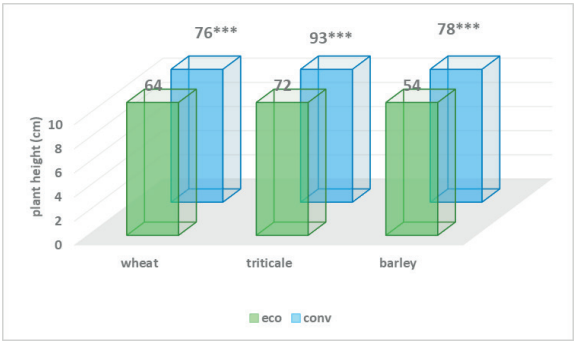
d)



e)



f)



g)

Figure 1. The interaction crop system x species, regardless of the varieties tested:

a) Yield: DL 5% = 271 kg/ha; DL 1 % = 365 kg/ha; DL 0.1 % = 485 kg/ha
b) Test weight: DL 5% = 0.9 kg/hl; DL 1% = 1.2 kg/hl; DL 0.1 % = 1.6 kg/hl
c) 1000 grains weight: DL 5% = 1.2 g; DL 1% = 1.7 g; DL 0.1 % = 2.3 g
d) Number of grains/ear: DL 5 % = 4 grains/ear; DL 1% = 5 grains/ear; DL 0.1% = 6 grains/ear
e) Weight of grains/ear: DL 5% = 0.19 g/ear; DL 1% = 0.26 g/ear; DL 0.1% = 0.34 g/ear
f) Protein content : DL 5% = 0.2%; DL 1% = 0.3%; DL 0.1% = 0.4%
g) Plant height: DL 5% = 7 cm; DL 1% = 9 cm; DL 0.1 % = 12 cm

The exceptions registered were those related to the test weight for wheat, which was identical in both crop systems, and in the 1000 grains weight for wheat, in the conventional system the difference being distinctly positive compared to the ecological system.

Regarding the obtained yield, the results show that this is influenced by the species. On an average of 3 years, the triticale species was significantly more productive than wheat, while the barley species with an average yield of 3,876 kg/ha registered a significant decrease compared to the wheat species (Table 1).

Table 1. The influence of species (A factor) on the yield

Species	Yield kg/ha	Dif. Ct	Signifi cance
Wheat	4,088	Ct	
Triticale	4,719	631	***
Barley	3,876	-212	o

DL 5% = 187 kg/ha; DL 1% = 309 kg/ha; DL 0.1% = 578 kg/ha

The influence of variety. The minimum yield in this experiment was recorded for the Smarald barley variety - 2,402 kg/ha in the ecological system, whereas the maximum for the Vifor triticale variety - 6,739 kg/ha in the conventional system (Table 2).

Comparative results between the yield of the wheat variety Glosa, taken as a control variety, and the other varieties, regardless of species and the crop system, showed that three of the varieties of barley (Dana, Univers and Ametist), were inferior, with statistical assurance. All the tested wheat varieties were at the control level. In contrast, the varieties of triticale were distinctly superior to the Glosa variety (Table 2).

Table 2. The influence of varieties (B factor) on the yield

Varieties	Yield kg/ha	Dif. ct	Signifi cance
GLOSA	4,102	Ct	
BOEMA	3,925	-177	
OTILIA	3,944	-158	
ADELINA	4,240	138	
ALEX	4,229	127	
PLAI	4,697	595	***
NEGOIU	4,386	284	**
UTRIROM	4,619	517	***
UTRIFUN	4,759	657	***
VIFOR	5,135	1,033	***
DANA	3,793	-309	Oo
CARDINAL	4,010	-92	
UNIVERS	3,842	-261	Oo
AMETIST	3,687	-416	Ooo
SMARALD	4,048	-54	

DL 5% = 187 kg/ha; DL 1% = 254 kg/ha; DL 0.1% = 340 kg/ha

The influence of the crop system showed that under the conditions of the conventional system, the yield increase of 2,586 kg/ha in relation to the ecological system is highly significant (Table 3).

The variety x species x crop system interaction showed that in the ecological system no variety was highlighted for any of the species, whereas in the conventional system, the varieties reacted slightly differently within each species.

Table 3. The influence of the crop system (C factor) on the yield

Crop system	Yield kg/ha	Dif. Ct	Signifi cance
Ecological system (ct)	2935	Ct	
Conventional system	5521	2586	***

DL 5% = 157 kg/ha; DL 1% = 211 kg/ha; DL 0.1% = 280 kg/ha

Thus, for triticale, the Vifor variety was distinctly higher than the Plai control variety, with an increase of 799 kg/ha; for barley, the Smarald variety was significantly higher than the control variety Dana, with an increase of 571 kg/ha. For wheat, the Adelina variety recorded an increase of 376 kg/ha compared to Glosa, but it did not have statistical assurance (Table 4).

The influence of the **crop system x variety x species interaction** was highlighted through the fact that, with no exception, all varieties of wheat, triticale and barley recorded significantly higher yields in the conventional system compared to the ecological system on an average timeframe of over 3 years, the differences being mostly over 2 t/ha and even over 3 t/ha for the varieties of triticale Utrirom and Vifor and for the barley variety Smarald. Basically, on the Luvosoil of the Agricultural Research and Development Unit of Simnic (ARDS), the yield in the ecological system is halved in comparison to the conventional system. Even if the price of ecological wheat is almost double, the recommendation that it should be grown must be accompanied by calculations of economic efficiency, based on the gross and net product index (Table 4).

Table 4. The influence of the variety x species x crop system interaction and the crop system x variety x species interaction on the yield

Crop system	Species	Variety	Yield kg/ha	Dif. ct	Signifi cance	Dif. ct	Signifi cance
Variety x species x crop system interaction						Crop system x variety x species interaction	
Ecological systems	WHEAT	GLOSA	3,042	ct		ct	
		BOEMA	2,887	-155		ct	
		OTILIA	2,867	-175		ct	
		ADELINA	2,943	-99		ct	
		ALEX	3,303	261		ct	
	TRITICALE	PLAI	3,454	ct		ct	
		NEGOIU	3,047	-407		ct	
		UTRIROM	3,052	-402		ct	
		UTRIFUN	3,368	-86		ct	
		VIFOR	3,532	78		ct	
	BARLEY	DANA	2,463	ct		ct	
		CARDINAL	2,755	292		ct	
		UNIVERS	2,502	39		ct	
		AMETIST	2,403	-60		ct	
		SMARALD	2,402	-61		ct	
Conventional systems	WHEAT	GLOSA	5,162	ct		2120	***
		BOEMA	4,963	-199		2076	***
		OTILIA	5,021	-141		2154	***
		ADELINA	5,538	376		2595	***
		ALEX	5,156	-6		1853	***
	TRITICALE	PLAI	5,940	ct		2485	***
		NEGOIU	5,725	-215		2679	***
		UTRIROM	6,186	246		3133	***
		UTRIFUN	6,150	210		2782	***
		VIFOR	6,739	799	**	3207	***
	BARLEY	DANA	5,123	ct		2660	***
		CARDINAL	5,266	143		2511	***
		UNIVERS	5,181	58		2679	***
		AMETIST	4,970	-153		2568	***
		SMARALD	5,694	571	*	3292	***

Variety x species x culture system interaction: DL 5% = 537 kg/ha; DL 1% = 726 kg/ha; DL 0.1% = 967 kg/ha
Crop system x species x variety interaction: DL 5% = 606 kg/ha; DL 1% = 817 kg/ha; DL 0.1% = 1,084 kg/ha

The other studied characters showed different results depending on the factors taken into consideration. The analysis was made only from the point of view of the influence of each factor separately, regardless of their interaction (Table 5).

The influence of species (A factor). Plant height, the number of grains/ear and the weight of the grains/ear were superior with the statistical assurance at triticale in relation to wheat, regardless of variety and crop system. The weight of the grains/ear, the 1,000 grains weight and the protein content were higher with barley statistical assurance in comparison to wheat, also, regardless of variety and crop system.

Table 5. The influence of the studied factors on other characters determined for the three species in different crop systems

Studied factors		Plant height (cm)	No. grains/ ear	Weight grains/ ear (g)	1000 grains weight (g)	Test weight (kg/hl)	Protein content (%)
Between species (A factor)	Wheat (ct)	70	33	1.40	43.0	76.1	9.5
	Triticale	82***	40**	1.76**	43.0	66.7^{ooo}	9.1^{oo}
	Barley	66	36	1.68**	46.6***	60.8^{ooo}	9.7*
	DL 5%	5	4	0.16	1.0	0,3	0,2
	DL 1%	7	7	0.26	1.6	0,4	0,4
	DL 0.1%	8	14	0.50	3.0	0,8	0,7
Between varieties (B factor)	GLOSA (ct)	68	35	1.62	46.8	75.8	9.8
	BOEMA	70	34	1.44^{o}	42.5^{ooo}	75.3^{o}	9.7^{o}
	OTILIA	69	32^{o}	1.37^{oo}	42.8^{ooo}	77.4***	9.4^{ooo}
	ADELINA	68	30^{oo}	1.30^{ooo}	42.7^{ooo}	76.8***	9.4^{ooo}
	ALEX	75***	33	1.29^{ooo}	40.2^{ooo}	75.2^{oo}	9.2^{ooo}
	PLAI	99***	38*	1.71	41.3^{ooo}	68.0^{ooo}	9.1^{ooo}
	NEGOIU	86***	41***	1.93**	45.9	64.7^{ooo}	9.2^{ooo}
	UTRIROM	75***	38*	1.50	39.8^{ooo}	65.9^{ooo}	9.4^{ooo}
	UTRIFUN	75***	41***	1.88**	44.9^{ooo}	66.9^{ooo}	9.1^{ooo}
	VIFOR	78***	41***	1.77	43.2^{ooo}	67.7^{ooo}	9.0^{ooo}
	DANA	69	34	1.64	47.8*	59.6^{ooo}	9.8
	CARDINAL	65	39**	1.77	45.2^{oo}	61.1^{ooo}	9.2^{ooo}
	UNIVERS	65	34	1.58	47.4	62.2^{ooo}	10.0**
	AMETIST	68	35	1.67	47.7	60.4^{ooo}	10.0**
	SMARALD	65	39**	1.74	44.8^{ooo}	60.4^{ooo}	9.3^{ooo}
Between crop systems (C factor)	Ecological system (ct)	63	30	1.31	42.9	67	8.9
	Conventional system	82***	36***	1.61***	44.2***	68.6***	10.0***
	DL 5%	4	2	0.11	0.7	0.4	0.1
	DL 1%	6	3	0.15	1.0	0.5	0.2
	DL 0.1%	8	4	0.20	1.3	0.7	0.3

For both species, triticale and barley, the test weight was significantly lower compared to wheat. The protein content in triticale was significantly lower in relation to wheat.

The influence of varieties (B factor). The varieties of triticale, without exception, were significantly higher than the Glosa variety, although the architecture of the new varieties of triticale is directed towards varieties of smaller height. Of the wheat varieties, the Alex variety was significantly higher than Glosa.

As for the number of grains/ear, the varieties of triticale, with no exception, and the Cardinal and Smarald barley varieties were superior, with statistical assurance, compared to wheat. The Otilia and Adelina wheat varieties were inferior to the Glosa variety with 3 and 5 grains/ear less. The weight grains/ear of all wheat varieties was lower with statistical assurance compared to Glosa, while the Negoiu and Utrifun - triticale varieties were significantly higher.

The 1,000 grains weight and the test weight were lower, with statistical assurance for all varieties of triticale and barley, with the exception of the Dana barley variety (MMB = 45.4 g), significantly higher compared to the Glosa wheat variety. From the point of view of the 1,000 grains weight, as well the varieties of

wheat tested were significantly lower than the control variety. For the same character, the Negoiu (triticale), Univers and Ametist (barley) varieties were highlighted, which were at the control variety level.

In most varieties, the protein content was inferior to the Glosa variety, being exceed, with statistical assurance, only by the Univers and Ametist barley varieties.

The influence of crop systems (C factor). For all the studied characters, in the conventional system, the determined values were significantly higher than those in the ecological system. The higher value of the yield obtained in the conventional system is doubled by the higher value of all the studied characters, the most important being the protein content, an important indicator of the quality of the yield.

CONCLUSIONS

The influence of the system x variety x species interaction resulted in, with no exception, all varieties of wheat, triticale and barley, which recorded significantly higher yields in the conventional system compared to the ecological system, on an average timeframe of over 3 years, the differences being mostly over 2 t/ha and even over 3t / ha in the Utrirom and Vifor varieties of triticale and the Smarald barley variety. Basically, on the Luvisoil of the Agricultural Research and Development Station of Simnic (ARDS) the yield in the ecological system is halved compared to the conventional system. Even if the price of ecological wheat is almost double, the recommendation that it be grown must be accompanied by calculations of economic efficiency based on the gross and net product index.

Comparative results between the yield of the Glosa wheat variety, taken as the control level and the other varieties, regardless of species and crop systems, showed that three of the varieties of barley (Dana, Univers and Ametist), were inferior, with statistical assurance. All the wheat varieties tested were at the control level. In contrast, the varieties of triticale were distinctly significant and significantly higher in the Glosa variety.

The crop system had a strong influence on the protein content for all species and all varieties.

For all the studied characters in the conventional system (plant height, number of grains/ear, weight of grains/ear, 1000 grains weight, test weight, protein content), the values determined were significantly higher than those of the ecological system.

REFERENCES

Bernard, M., Bernard, S. (2005). Molecular Analysis of the Triticale Lines with Different Vrn Gene Systems Using Microsatellite Markers and Hybridization In Situ. *Genome, 5*, 289–295.

Bonciu, E. (2019). The climate change mitigation through agricultural biotechnologies. *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series, 49*(1), 36–43.

Bonciu, E., Roșculete, E., Olaru, A.L., Roșculete, C.A. (2018). Evaluation of the mitodepresive effect, chromosomal aberrations and nuclear abnormalities induced by urea fertilization in the meristematic tissues of *Allium cepa* L. *Caryologia, 71*(4), 350–356.

Bonciu, E. (2017). Food processing, a necessity for the modern world in the context of food safety: a Review. *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series, 47*(1), 391–398.

Burghelea, C., Uzlău, C., Ene, C.M, Topor, D. (2016). Prospects for organic farming in Romania. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 16*, 73–78.

Eldredge, E.P., Karow, S.R., Shock, C.C,. Marx, E., Saunders, L. (1999). *Cereal grain variety trial*. Oregon State University.

Gibson, L.R., Schwarte, A.J., Sundberg, D., Karlen, D. (2004). Planting Date Effects on Winter Triticale Grain and Forage Yield. Iowa State Research Farm Progress Raports.

Giura, A., Mihăilescu, Alexandrina (2000). Metode de cercetare în cultura plantelor. *Metode moderne de reducere a duratei programelor de ameliorare la grâu şi orz*. (17-36) Edit. Agris, Bucureşti.

Giura, A., Mihăilescu A., Verzea, M., Ittu, Gh. (2007). Cercetări de genetică efectuate la Fundulea. *Analele I.N.C.D.A. FUNDULEA, LXXV*, Volum jubiliar genetică şi ameliorarea plantelor.

Ittu, Gh., Săulescu, N.N., Ittu, Mariana, Mustăţea, P. (2006). Progrese în ameliorarea la triticale pentru obţinerea de soiuri cu talia scurtă. *Analele I.N.C.D.A. Fundulea, LXXII*, 19–28.

Karpstein-Machan, M., Heyn, J. (1992). Yield and yield structure of the winter cereals triticale and wheat in the middle mountain areas of northern Hessen. *Agribiol. Res., 45*, 88–96.

Mihăilescu, A. (2007). Orzul golaş – nouă provocare pentru programele de ameliorare. *Probl. Genet. Teor. Aplic., XXXIX*.

Oelke, E.A., Oplinger, E.S., Brinkman, M.A. (1989). Alternative field crops manual. *Triticale*. Univ.

Wisconsin, CES, Madison, WI, Univ. Minnesota CES, St.Paul.

Ortiz-Monasterio, J.I., Pena, R.J., Pfeiffer, W.H., Hede, A.H. (2002). Phosphorus use efficiency, grain, yield, and quality of triticale and durum wheat under irigated conditions. *Proceedings of the 5th International Triticale Symposium, Annex Radzikow, Poland.*

Popescu, C. (1985). Cercetări privind ereditatea principalelor elemente ale capacităţii de producţie la orzul şi orzoaica de toamnă. Probl. Genet. Teor. Aplic., *XVII*(3), 153–173.

Priadcencu, A. (1952). Contribuţii la studiul hibrizilor îndepărtaţi. Analele I.C.A.R.,XX:1.

Săucă, Florentina, (2010). Agricultura ecologică și biodiversitate. Ed. Ex Ponto. ISBN: 978-973-644-988-8

Voica, Maria, (2014). Reacția unor soiuri de grâu și triticale cultivate în sistem ecologic. Anale Fundulea LXXXII. 39-47

Wolsky, T., Pojmaj, M.S. (1995). Some prospect of hybrid triticale breeding. Current opinion for cereal improvement, 185-192.

***, faostat.fao.org

***, Agricultura ecologică. Dinamica operatorilor și a suprafețelor în agricultura ecologică.www.madr.ro

***, Agricultura ecologică crește, dar merge majoritar la export. www.finantariagricole.ro