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QUALITY OF YIELD AT WHEAT, TRITICALE AND BARLEY SPECIES CULTIVATED IN THE ECOLOGICAL SYSTEM ON ARDS SIMNIC

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Abstract
An assortment consisting of 10 wheat, 8 triticale and 7 barley varieties were cultivated for three years (2010, 2016 and 2017) in two systems of culture: ecological and conventional on the Simnic luvosoil. The quality of yield seen from the perspective of the protein content, test weight and the weight of 1000 grains were studied from the interactions: species x culture system and variety x culture system. The aim is to promote the species and varieties that are distinguished from the point of view of the quality of the production obtained under the conditions of cultivation in an ecological system, a system that ensures the quality of life by the fact that the yield does not use pesticides and chemical fertilizers. All the varieties experienced in all three species recorded diminished yields, statistically assured under ecological conditions in relation to those sown under conventional crop conditions. In terms of quality, only triticale varieties Titan and Oda obtained at all three quality indices (protein content, test weight and the weight of 1000 grains) simultaneously, values is in the ecological system at the level obtained in the conventional system. From the point of view of the quality of the obtained yield, it was shown that the wheat and triticale did not differentiate between ecological and conventional while the barley showed significant decreases in protein content and weight of 1000 grains under the same reported conditions.

Keywords: barley, ecological system, quality yield, triticale, wheat.

1. INTRODUCTION

Organic farming enjoys broad support from both technological and economic considerations in that it does not require large financial investments. However, this system requires an intensive work and respect for nature (Toncea, 2000). Over time, numerous studies and scientific papers by a number of personalities have contributed to the development and consolidation of organic farming.

Sir Albert Haward (1883-1947), sometimes called the founder of the "ecologist" movement, influenced much at the beginning of the 18th century the understanding of soil fertility and its importance on its productivity. He worked for 25 years as an agricultural researcher in India where he developed the composting process and explained on a scientific basis the traditional art of compost. His most famous books are "Agricultural Testament" and "Agriculture and Gardening for Health and Disease" (Boboc, 2005). In 1943, Lady Eve Balfour published the work "The Living Soil" that contributed to the development of organic farming in the UK (Nicolescu et al., 2007). Japanese farmer Masanobu Fukuoka practiced in the 1940s what he calls "agriculture where you do everything without plowing, without fertilizing, without control of herbs and without pesticides". With this method, he could cultivate cereals with productions comparable to those from intensive crops. His best-known books are "The Natural Way of Farming" and "The Revolution with a Straw"

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(Boboc, 2005). Although organic farming is widely practiced in the U.S., Canada, Argentina, however, the European continent remains the leader in terms of the legislative, scientific and practical aspect.

In Europe, especially in developed and highly industrialized countries, in addition to the training of organic farming specialists, they have invested in building a strong research base through subsidies and facilities, researchers achieving outstanding results on:

-valuable genotypes with biologically performing potential in terms of production capacity and genetic resistance to aggression of biotic and abiotic stress factors;

-agro-technical systems that potentiate soil fertility by roughing and work with specific machinery;

-soil fertilization to be carried out only correlated with soil nature, nutrient reserve, crop specific consumption, vegetation phase, irrigation system, climatic conditions specific to the area and year and only with fertilizers accepted in organic farming (manure , different composts, etc).

This context favorable to the development of organic agriculture is due largely to the care consumer to consume healthy food and be more environmentally friendly. The typical consumer is an educated person. The less consumers come from youth and oldman alone. Arguments of those who do not buy such products are usually price, distrust of authenticity, lack of interest (Saucă, 2010). In the top of the countries with the largest areas grown in the organic system, first places are occupied by Australia, with 12 million hectares, followed by Argentina (3.8 million ha) and the United States (1.9 million hectares). The United States ranks first in organic commerce with annual sales of $ 30 billion, followed by Germany by $ 9.2 billion and France by $ 5.2 billion. World trade in organic products is dominated by 65% of three countries. The proportion changes when we talk about the consumption of organic products per capita. If the consumption in the United States is $ 9 per capita, the people who buy most organic products come from Switzerland ($ 250 per habitant), Denmark ($ 226 per habitant) and Luxembourg ($ 186 per habitant).

Romania has a relatively new history on the organic product market, but the growth of operators enrolled in the system is spectacular. Their number increased from 2000 operators in 2008 to almost 26,000 in 2012, this being possible thanks to subsidies granted by the Romanian state. Most manufacturers export their production as prime material due to absence of processing points. Exports of organic products in 2012 were 200 million and the consumer market is estimated at 80 million euros. In terms of consumption per habitant, it is the smallest in Europe, with 1.2 euro per habitant. At present, only 2% of Romania's agricultural area is cultivated in a certified ecological system.

According to the most recent Research Institute of Organic Agriculture (FiBL) data (2015), there are 179 diverse organic producing countries in the world combining 50.9 million hectares of farmland dedicated to organic production, an area roughly the total size of Spain (Riggio, 2017)**.**

2. MATERIALS AND METHODS

An assortment consisting of 10 wheat (Glosa, Boema, Litera, Miranda, Izvor, Otilia, Pitar, Pajura, Alex, Bezostaia), 8 triticale (Plai, Titan, Stil, Haiduc, Negoiu, Oda, Pisc, TF2) and 7 barley (Dana, Cardinal, Univers, Ametist, Smarald, Simbol, Andreea) varieties were cultivated for three years (2010, 2016 and 2017) in two systems of culture: ecological and conventional on the Simnic luvosoil. The quality of yield seen from the perspective of the protein content, test weight and the weight of 1000 grains were studied from the interactions: species x culture system and variety x culture system.

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The aim is to promote the species and varieties that are distinguished from the point of view of the quality of the production obtained under the conditions of cultivation in an ecological system, a system that ensures the quality of life by the fact that the yield does not use pesticides and chemical fertilizers.

3. RESULTS AND DISCUSSIONS

The study of the interaction species x culture system revealed that in all species the yield was significantly higher when the cultivation was done in a conventional system to the ecological system (Figure 1).

Other studies have shown similar results. Grain (wheat, oat, and barley) yields on organic farms were 77%, 73% and 74%, respectively, of those of conventional farms (Entz et al., 2001). Organic yields were lower than conventional yields for most crops (Kniss et al., 2016). Organic cereals and vegetables have significantly lower yields than crops produced conventionally, −26% and −33%, respectively (Seufert et al., 2012). Conversely, Cavigelli et al. in 2009 shown that wheat yield was similar between systems, averaging 4.09 t ha−1.

Study after study has shown that organic methods have an average of 20% lower yields compared to conventional farming. However, averages do not tell the whole story. Yield stability, which means the ability to count on the same yield from year to year, is generally better with organic agriculture, except in cases of pest outbreaks (Fess and Benedito, 2018).

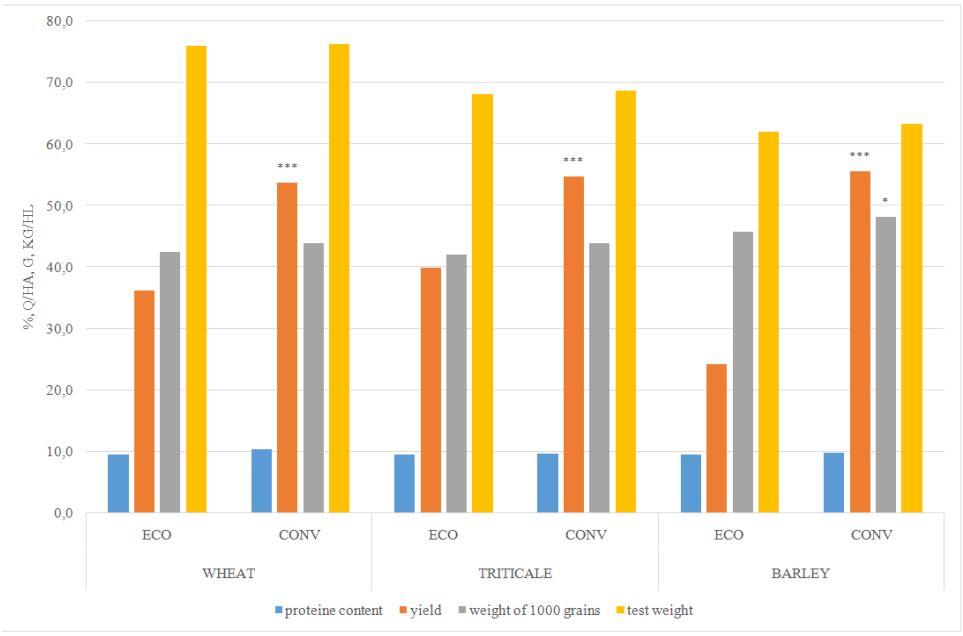

Figure 1. Interaction species x culture system at Simnic (average 2010, 2016 and 2017).

Wheat produced using mineral fertilizer developed more grains per ear than those receiving organic fertility amendments (Gopinath et al., 2008).

From the point of view of the quality characteristics of the yield, in our study, one – weight of 1000 grains was significantly differentiated between the culture systems tested.

The results suggest that the ecological system does not diminish the quality of production, but only its quantity, in all three cultivated species.

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The variety x culture system study highlighted that all the varieties experienced in all three species recorded diminished yields, statistically assured under ecological conditions in relation to those sown under conventional crop conditions.

With regard to the test weight in most varieties of all three species the differences were not statistically assured. However, there have been deviations as follows:

-at wheat, the Miranda variety had a significantly reduced test weight at conventional system compared to organic; Pajura and Bezostaia varieties were distinctly significant, respectively significantly higher at conventional;

-at triticale Haiduc and Negoiu varieties presented differences with statistically ensured in favor of the conventional system;

-at barley, with two exception (Cardinal and Smarald varieties) all tested varieties had superior teste weight at the conventional system versus ecological system (Table 1).

Table 1. Interaction varieties x system farming in Simnic at wheat, triticale and barley (average 2010, 2016 and 2017)

Number	Varieties	Species	System farming	Yield (kg/ha)	Test weight (kg/hl)	Protein content (%)	Weight of 1000 grains (g)
1	GLOSA	wheat	ECO	3738	75.7	9.7	45.7
			CONV	5409***	76.4	10.4**	46.7
2	BOEMA	wheat	ECO	3718	75.1	9.5	42.0
			CONV	5202***	76.2	10.4***	43.0
3	LITERA	wheat	ECO	3340	75.7	9.3	41.3
			CONV	5398***	76.0	10.3***	44.4*
4	MIRANDA	wheat	ECO	4007	76.1	8.5	45.0
			CONV	5967***	74.1^{o}	9.7***	44.2
5	IZVOR	wheat	ECO	3878	77.4	9.5	42.2
			CONV	5165***	76.1	10.5***	45.1
6	OTILIA	wheat	ECO	3890	76.4	8.8	38.2
			CONV	5582***	76.8	10.1***	40.2
7	PITAR	wheat	ECO	3444	76.6	9.7	43.0
			CONV	5350***	76.5	10.4**	46.0
8	PAJURA	wheat	ECO	3843	74.7	9.4	44.2
			CONV	5605***	77.0**	10.3***	44.0
9	ALEX	wheat	ECO	3918	75.9	9.0	39.7
			CONV	5490***	74.6	10.1***	40.9
10	BEZOSTAIA	wheat	ECO	2397	75.3	10.1	42.6
			CONV	4524***	77.4*	11.1***	44.1
11	PLAI	triticale	ECO	4242	71.2	9.2	40.0
			CONV	6107***	71.8	9.6	43.3*
12	TITAN	triticale	ECO	3802	67.5	9.7	42.0
			CONV	5396***	68.3	9.3	43.8
13	STIL	triticale	ECO	4038	69.6	9.9	39.8
			CONV	5638***	70.3	9.3**	45.0**

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14	HAIDUC	triticale	ECO	3923	66.6	9.1	44.0
			CONV	5425***	68.4*	9.3	45.8
15	NEGOIU	triticale	ECO	3824	66.0	9.4	43.4
			CONV	5559***	68.4**	9.4	47.0*
16	ODA	triticale	ECO	3938	69.1	9.6	40.1
			CONV	5021*	68.8	9.7	39.1
17	PISC	triticale	ECO	3884	66.7	9.2	42.4
			CONV	5104**	66.5	9.5	46.6**
18	TF2	triticale	ECO	4268	68.4	9.8	44.8
			CONV	5550**	66.8	10.3*	40.6^{oo}
19	DANA	barley	ECO	2378	60.1	9.6	44.8
			CONV	5533***	62.1*	9.9	51.0***
20	CARDINAL	barley	ECO	2952	63.1	8.6	43.9
			CONV	5643***	62.8	9.2**	46.1
21	UNIVERS	barley	ECO	2673	62.6	9.7	44.5
			CONV	5639***	64.3*	9.6	47.9*
22	AMETIST	barley	ECO	2215	60.0	10.0	46.1
			CONV	5440***	61.7*	9.9	49.2
23	SMARALD	barley	ECO	2334	63.1	8.7	43.6
			CONV	5962***	61.6	9.2*	46.5
24	SIMBOL	barley	ECO	1948	62.1	9.6	46.5
			CONV	5109***	64.6**	9.4	47.9
25	ANDREEA	barley	ECO	2360	62.7	10.2	50.2
			CONV	5525**	65.4**	10.3	48.0
	DL 5%			**813**	**1.7**	**0.5**	**3.2**
	Dl 1%			**1084**	**2.3**	**0.6**	**4.2**
	Dl 0.1%			**1411**	**3.0**	**0.8**	**5.5**

Protein content was strong influenced by the ecological system in the wheat species where all the varieties tested showed statistically assured increases when cultivated in a conventional system according to the ecological system.

In general weight of 1000 grains was not differentiated with statistical assurance between systems than Litera varieties of wheat, Plai, Stil, Negoiu, TF2 at triticale, and Dana and Univers in barley. Of these, only the TF2 variety, the very old variety showed better value in ecological conditions.

In terms of quality, only triticale varieties Titan and Oda obtained at all three quality indices (protein content, test weight and the weight of 1000 grains) simultaneously, values in the ecological system at the level obtained in the conventional system.

In ecological conditions, in relation to the Glosa variety, the most widely used wheat variety in Romania, from the yield point of view, it is only significantly different from the triticale species Plai and TF 2, while all varieties of barley and Litera and Bezostaia wheat varieties had inferior values with statistical assurance (Table 2).

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Table 2. The behavior of varieties of wheat, triticale and barley grown in ecological system at Şimnic (average 2010, 2016 and 2017)

Number	Varieties	Species	Yield (kg/ha)	Test weight (kg/hl)	Protein content (%)	Weight of 1000 grains (g)
1	GLOSA	wheat	3738	75.7	9.7	45.7
2	BOEMA	wheat	3718	75.1	9.5	42.0^{oo}
3	LITERA	wheat	3340^{o}	75.7	9.3^{o}	41.3^{oo}
4	MIRANDA	wheat	4007	76.1	8.5^{ooo}	45.0
5	IZVOR	wheat	3878	77.4*	9.5	42.2^{oo}
6	OTILIA	wheat	3890	76.4	8.8^{oo}	38.2^{ooo}
7	PITAR	wheat	3444	76.6	9.7	43.0^{o}
8	PAJURA	wheat	3843	74.7	9.4	44.2
9	ALEX	wheat	3918	75.9	9.0^{ooo}	39.7^{ooo}
10	BEZOSTAIA	wheat	2397^{ooo}	75.3	10.1*	42.6^{o}
11	PLAI	triticale	4242**	71.2^{ooo}	9.2^{o}	40.0^{ooo}
12	TITAN	triticale	3802	67.5^{ooo}	9.7	42.0^{oo}
13	STIL	triticale	4038	69.6^{ooo}	9.9	39.8^{ooo}
14	HAIDUC	triticale	3923	66.6^{ooo}	9.1^{oo}	44.0
15	NEGOIU	triticale	3824	66.0^{ooo}	9.4	43.4
16	ODA	triticale	3938	69.1^{ooo}	9.6	40.1^{ooo}
17	PISC	triticale	3884	66.7^{ooo}	9.2^{o}	42.4^{o}
18	TF2	triticale	4268**	68.4^{ooo}	9.8	44.8
19	DANA	barley	2378^{ooo}	60.1 ^{ooo}	9.6	44.8
20	CARDINAL	barley	2952^{ooo}	63.1^{ooo}	8.6^{ooo}	43.9
21	UNIVERS	barley	2673^{ooo}	62.6^{ooo}	9.7	44.5
22	AMETIST	barley	2215^{ooo}	60.0^{ooo}	10.0	46.1
23	SMARALD	barley	2334^{ooo}	63.1^{ooo}	8.7^{ooo}	43.6
24	SIMBOL	barley	1948^{ooo}	62.1^{ooo}	9.6	46.5
25	ANDREEA	barley	2360^{ooo}	62.7^{ooo}	10.2^{o}	50.2***
	DL 5%		**354**	**1.6**	**0.4**	**2.6**
	Dl 1%		**480**	**2.2**	**0.6**	**3.5**
	Dl 0.1%		**642**	**2.9**	**0.8**	**4.7**

At the test weight, all triticale and barley varieties were very significantly inferior to the Glosa variety. Only the Izvor wheat variety exceeded 77 kg/hl and was significantly superior to the Glosa variety.

Reports of protein content and weight of 1000 grains were highly differentiated within the species at the two extremes - superior or inferior. At the protein content, the Bezostaia wheat variety was significantly increased and at the weight of 1000 grains the Andreea two rows barley variety was very significantly. Under the ecological conditions, of the 15 varieties sown from 3 cultivated species, only the Pajura wheat variety had the same level of yield and quality of yield as the Glosa wheat variety.

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Under conventional system conditions, reported to Glosa, from the point of view of yield, the Miranda wheat variety, the Plai triticale variety and the barley variety Smarald were superior with statistical assurance, while the Bezostaia wheat variety was very significantly inferior (Table 3).

Table 3. The behavior of varieties of wheat, triticale and barley grown in conventional system at Şimnic (average 2010, 2016 and 2017)

Number	Varieties	Species	Yield (kg/ha)	Test weight (kg/hl)	Protein content (%)	Weight of 1000 grains (g)
1	GLOSA	wheat	5409	76.4	10.4	46.7
2	BOEMA	wheat	5202	76.2	10.4	43.0^{oo}
3	LITERA	wheat	5398	76.0	10.3	44.4
4	MIRANDA	wheat	5967**	74.1^{oo}	9.7^{o}	44.2
5	IZVOR	wheat	5165	76.1	10.5	45.1
6	OTILIA	wheat	5582	76.8	10.1	40.2^{ooo}
7	PITAR	wheat	5350	76.5	10.4	46.0
8	PAJURA	wheat	5605	77.0	10.3	44.0^{o}
9	ALEX	wheat	5490	74.6^{o}	10.1	40.9^{ooo}
10	BEZOSTAIA	wheat	4524^{ooo}	77.4	11.1^{o}	44.1
11	PLAI	triticale	6107**	71.8^{ooo}	9.6^{o}	43.3^{o}
12	TITAN	triticale	5396	68.3^{ooo}	9.3^{ooo}	43.8^{o}
13	STIL	triticale	5638	70.3^{ooo}	9.3^{ooo}	45.0
14	HAIDUC	triticale	5425	68.4^{ooo}	9.3^{ooo}	45.8
15	NEGOIU	triticale	5559	68.4^{ooo}	9.4^{oo}	47.0
16	ODA	triticale	5021	68.8^{ooo}	9.7^{o}	39.1^{ooo}
17	PISC	triticale	5104	66.5^{ooo}	9.5^{oo}	46.6
18	TF2	triticale	5494	66.8^{ooo}	10.3	40.6^{ooo}
19	DANA	barley	5533	62.1^{ooo}	9.9	51.0**
20	CARDINAL	barley	5643	62.8^{ooo}	9.2^{ooo}	46.1
21	UNIVERS	barley	5639	64.3^{ooo}	9.6^{o}	47.9
22	AMETIST	barley	5440	61.7^{ooo}	9.9	49.2
23	SMARALD	barley	5962**	61.6^{ooo}	9.2^{ooo}	46.5
24	SIMBOL	barley	5109	64.6^{ooo}	9.4^{oo}	47.9
25	ANDREEA	barley	5525	65.4^{ooo}	10.3	48.0
	DL 5%		**390**	**1.37**	**0.62**	**2.69**
	Dl 1%		**529**	**1.86**	**0.85**	**3.65**
	Dl 0.1%		**708**	**2.49**	**1.13**	**4.88**

At the test weight, all triticale and barley varieties were very significantly inferior to the Glosa variety, as in the ecological system. In addition, wheat varieties Miranda and Alex presented a value inferior of test weight to that recorded by the Glosa variety. Reports in the case of the protein and the weight of 1000 grains were differentiated within species than in the case of sowing in the ecological system.

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Under the conditions of conventional sowing, of the 15 varieties sown in 3 species cultivated only the Litera, Izvor and Pitar wheat varieties had the same level of yield and the quality of yield as Glosa variety.

4. CONCLUSIONS

All the varieties experienced in all three species recorded diminished yields, statistically assured under ecological conditions in relation to those sown under conventional crop conditions.

In terms of quality, only triticale varieties Titan and Oda obtained at all three quality indices (protein content, test weight and the weight of 1000 grains) simultaneously, values is in the ecological system at the level obtained in the conventional system.

Under the ecological conditions, of the 15 varieties sown from 3 cultivated species, only the Pajura wheat variety had the same level of yield and quality of yield as the Glosa wheat variety.

Under the conditions of conventional sowing, of the 15 varieties sown in 3 species cultivated only the Litera, Izvor and Pitar wheat varieties had the same level of yield and the quality of yield as the Glosa wheat variety.

From the point of view of the quality of the obtained yield, it was shown that the wheat and triticale did not differentiate between ecological and conventional while the barley showed significant decreases in protein content and weight of 1000 grains under the same reported conditions.

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