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COMPARATIVE STUDY ON THE MORPHOLOGY AND BIOCHEMICAL COMPOSITION OF CEREAL SPECIES CULTIVATED IN THE PEDOCLIMATIC CONDITIONS OF THE CRIȘURILOR PLAIN

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ABSTRACT: The development of resilient crops and crop diversification strategies based on local conditions are of significant importance in the context of climate change and food security. In this study, we evaluated a series of morphological and biochemical indices, as well as the economic efficiency of 23 varieties from 4 main species of autumn cereals and 1 species of spring cereals, grown in the pedoclimatic conditions of Crișurilor Plain (Western region, Romania) during years 2018-2021. An experiment was carried out in 4 repetitions with the following species as experimental variants: V1 – winter wheat (7 varieties); V2 – autumn rye (2 varieties); V3 – autumn triticale (6 varieties); V4 – autumn barley (5 varieties); V5 – spring oats (4 varieties). The varieties included in the study are: V1 variant: Fundulea 4, Glosa, Flamura 85, Dropia, Apache, Lovrin 34, and Libelula; V2: Suceveana and Gloria; V3: Tulnic, Haiduc, Stil, Negoiu, Mv Medal and Oda Fd; V4: Amethyst, Belissa, Cardinal, Laverda, and Lucian, V5: Lovrin 1, Mureșana, Ovidiu and Jeremy. Evaluated parameters were: the height of the plants, the number of caryopses per inflorescence, Thousand Grain Weight (TGW), the hectoliter mass, the production of caryopses, the seed content in proteins, fats, and starch, and economic efficiency. The results offer a better perspective on the possibilities of expansion and diversification of cereal crops in the Western region of Romania.

Keywords: *Triticum aestivum*, *Secale cereale*, *Hordeum vulgare*, *Triticosecale*, morphology, phytochemistry, Romania.

INTRODUCTION

Cereal crop improvement is important in the context of climate change and food security. There is a need to develop resilient crops and crop diversification strategies based on local conditions (Wang et al., 2018; Dhankher and Foyer, 2018).

Climate change is having a negative impact on agricultural production, threatening food security. Studies to date estimate that global average temperatures will increase by 2.5 to 4.5°C by the end of the 21st century. And if temperatures rise by even 1 degree, wheat production could be affected by 3 to 10 percent (Wang et al., 2018). Cereals are a staple food for the majority of the world's population. Estimates for 2050 indicate that grain supplies will need to increase by 70-100% to meet the demands of a population of 9.8 trillion people. Such an increase is unattainable at current production rates in the context of decreasing fertile and arable land (Wang et al., 2018). Proposed solutions include the development of cereals tolerant to changing climatic conditions, increasing production of new varieties, diversifying crops in regions prone to food insecurity, and reducing the impact of agriculture on global warming (Wang et al., 2018).

The introduction of new varieties is seen as a crop diversification measure that can stabilize productivity and reduce negative environmental impacts (Hufnagel et al., 2020). This has already been observed in the case of Poland, where crop diversification has been found to be more intense in areas exposed to climatic risks, particularly drought, and frost, and has been successful in increasing farmers' resilience to climate change and stabilizing incomes (Kurdy's-Kujawska et al., 2021).

Globally, Europe contributes approximately 20% of cereal production, of which it exports around 15% net (Schils et al., 2018). As grain demand rises, Europe's capacity to increase its production will be of great importance, with the largest potential of meeting the challenges identified in Eastern Europe, including Romania. However, it is also in this region that the greatest differences in national yields have been observed (Schils et al., 2018).

In 2020, the main contributor to the total output of the agricultural industry in Romania was crops (64.9%), of which cereals were the main crop category (18.3%) (Săvescu and Rotaru, 2021).

According to the study by Chivu et al. (2020), agriculture is an important factor in the development of a region. In Romania, between 2001 and 2017, the West and North-West regions had some of the lowest efficiencies in agricultural production, including cereal production. Although these regions show an upward trend in the evolution of annual cereal production over the 17 years analyzed, the increase is lower than in the other regions of the country (Chivu et al., 2020). Both Chivu et al. and other authors (Burja and Burja, 2015, Vlad et al., 2015, Cocheci et al., 2016) argue that this is due to several factors that lead to a lack of competitiveness, including the lack of irrigation facilities. They also mention the need for studies

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analyzing efficiency at the regional level, based on indicators relevant to agricultural production, as well as area-specific strategies to reduce the discrepancies in agricultural production efficiency that exist between regions of the country.

In view of the above, our study contributes new data on the possibilities of expansion and diversification of cereal crops in the Western region of Romania, with 23 varieties of 5 species.

Wheat (*Triticum aestivum* L.) is one of the oldest and most important grain crops, cultivated worldwide and a staple food for many countries. Presently the top producers are China and India because its cultivation requires less water than other crops. Its importance in the human diet, animal feed, and non-food applications, has made it subject to continuous improvement by breeders. New challenges require new studies to ensure its continuous and high-quality production to meet the world's growing demands (Igrejas and Branlard, 2020).

Rye (*Secale cereale* L.) has been cultivated in Europe for over 3000 years, especially in areas where the pedoclimatic conditions are unfavorable for other cereal crops. Its fiber content is one of the highest among the common grain crops and is valued as a great source of nutritional and bioactive compounds. It is the second most used raw material after wheat for bread and bakery products. Its uses cover a much wider range of products destined for human and animal consumption (Ikram et al., 2023). The top global producer is the European Union (65%), followed by Russia (15%), Belarus (7%), Canada and Turkey (3%) (USDA, 2023).

Triticale (*x Triticosecale* Wittm.) is a hybrid between *Triticum aestivum* and *Secale cereale*, created for high yield, disease tolerance, and unique nutritional profile crops (Kamanova et al., 2023). It is suitable for agricultural areas where wheat is less productive, lands affected by lack or surplus of water, poor in nutrients as well as acidic or salty (David et al, 2011; FAO, 2023; Kamanova et al, 2023). Its grains are richer in vitamins and minerals than those of rye or wheat (Chopade et al., 2017). The global demand for Triticale has risen in recent years because of its high nutritional value, high protein content (particularly lysine), and specific phytochemical profile with health benefits like dietary products for patients with metabolic diseases (ex. diabetes) (FAOSTAT, 2018, Kamanova et al, 2023). The main Triticale producers for more than 10 years are countries like Poland, Germany, France, and Belarus (FAOSTAT 2018, 2023).

Barley (*Hordeum vulgare* L.) is one of the first domesticated crops, used for both human and animal consumption, and malt production. While has remained an essential food source for some cultures in Asia and North Africa, in other parts of the world, its use as a food grain has been neglected for a while in favor of wheat. However, the interest in barley has recently increased, given its content of dietary fibers (particularly beta-glucans) and health benefits (hypocholesterolemic and hypoglycemic effects), and has the potential for partial or full replacement of currently used grains for a wide variety of cereal-based products. Its world production has remained relatively stable for the past 15 years, with the European Union being the lead producer (Lukinak and Jukić, 2022).

Oat (*Avena sativa* L.) is one of the oldest crops, being cultivated worldwide for over 2000 years. This cereal crop is being valued not only for its nutritional value in human and animal diets but also for its bioactive compounds (phenolic acids, tocols, sterols, avenacosides, avenathramides) valuable for health care and cosmetics (Paudel et al., 2021). The top oat producers are the European Union, Russia, and North America, in 2020 accounting for 79% of global production. Even so, in 2021, the European Union imported over 9000 tons of raw oats from countries like Ukraine, Uruguay, and Russia. Approximately 50% of the current global oats production is used for animal feed and under 10% is destined for human consumption (IUCN NL, 2023).

For this study, 23 varieties of 5 cereal species were selected: 6 for wheat, 2 for rye, 6 for triticale, 5 for barley, and 4 for oats. These varieties were included in previous studies focused on each species, and showed good adaptability to the soil and climatic conditions of the Crișurilor Plain (Western Region of Romania) (Ungureanu et al., 2019, 2020a, 2021a, 2022).

A series of morphological indices influencing crop production were analyzed, as well as biochemical indices relevant to the nutritional value and the possible crop uses. Finally, economic efficiency was calculated, an essential criterion in the optimization of the crop structure (Ungureanu et al., 2021b).

MATERIALS AND METHODS

The experimental crops were cultivated on alluvial soil with the following characteristics: pH = 7 – 7,5; Humus = 3,1 – 3,9 %; Argil = 33 – 35 %; Groundwater depth = 50 – 60 cm; Mobile Phosphorus = 13,44 mg/100g soil; Total Nitrogen = 0,16 – 0,18 mg/100g soil. The plots had a surface of 20 m^2, with 10 m Length, and 2 m Width, with a protection space of 3 m Width, 2 m space between repetitions, and 0,5 m rows between variants.

The experimental varieties were:

- *Triticum aestivum* L. from the varieties: Fundulea 4, Glosa, Flamura 85, Dropia, Apache, Lovrin 34, and Libelula;
- *Secale cereale* L. of the varieties: Suceava, Gloria;
- *Triticosecale* varieties: Tulnic, Haiduc, Stil, Negoiu, Mv Medal, Oda Fd;
- *Hordeum vulgare* L. from the varieties: Amethyst, Belissa, Cardinal, Laverda, and Lucian;
- *Avena sativa* L. from the varieties: Lovrin 1, Muresana, Ovidiu, Jeremy.

Soil works consisted of autumn plowing at 20 - 25 cm depth, keeping clean of weeds until sowing; disking with a harrow in springtime, and preparing the germination layer with a combine harvester at 4 - 5 cm depth. Sowing was done in autumn, in the first decade of October, and in the spring in the first decade of March at a depth of 3-5 cm. During the vegetation periods, the plots were kept clean of weeds by specific care works.

Fertilization was made during the preparation of the germination layer with NPK complex fertilizer, as follows: for wheat, triticale, and rye - N = 100 kg/ha, P = 45 kg/ha, K = 90 kg/ha; for barley and oats - N = 80 kg/ha, P = 60 kg/ha, K = 50 kg/ha.

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The experiment was carried out with 5 species of cereals in 4 repetitions with the following experimental variants: V1 - wheat; V2 – rye; V3 – triticale; V4 - barley; V5 – oats (Săndoiu, 2012).

RESULTS AND DISCUSSIONS

Climatic conditions from 2018-2021

The temperature conditions, rainfalls, nebulosity, and relative humidity didn't register significant differences compared to the multiannual media.

The temperatures, during the autumn wheat cultivation period, respectively the months from October to June, were slightly above the average. Regarding precipitation, the species requirements were met during most of the growing season, but the lack of precipitations in late April and early May affected varieties sensitive to this climatic factor. During the period of ear/spikes formation and grain filling (April 20 - May 10), a lack of humidity was recorded along with a temperature rise, which decreased water and thermal comfort with implications for the growth and development of plants from variants that included several varieties of lower drought-resistance.

Despite the temperature and precipitation changes mentioned above, the climatic conditions during 2018-2021 allowed the successful cultivation of the 5 species of crops. (Figures 1,2,3,4).

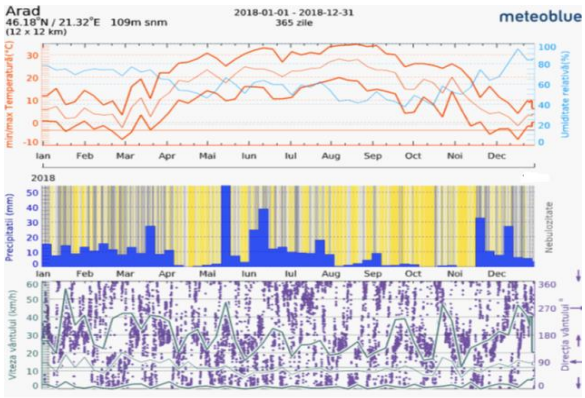

Fig. 1. Average values of temperatures and precipitations for the year 2018 in the Arad area. Red – min/max temperature (°C), Light blue – relative humidity (%), Dark blue – precipitations (mm), Vertical grey stripes – nebulosity, Green – wind speed (km/h), Purple arrows – wind direction (https://www.meteoblue.com- Arhiva meteo Arad).

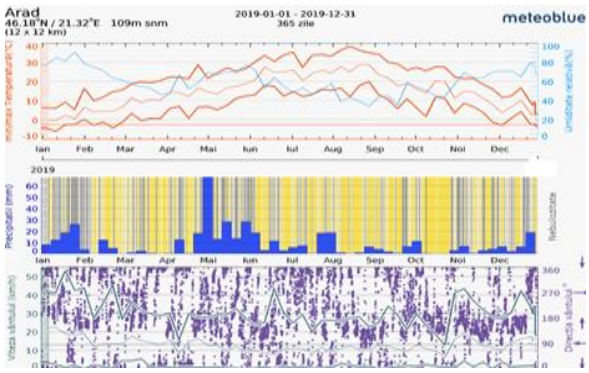

Fig. 2. Average values of temperatures and precipitations for the year 2019 in the Arad area. Red – min/max temperature (°C), Light blue – relative humidity (%), Dark blue – precipitations (mm), Vertical grey stripes – nebulosity, Green – wind speed (km/h), Purple arrows – wind direction (https://www.meteoblue.com- Arhiva meteo Arad).

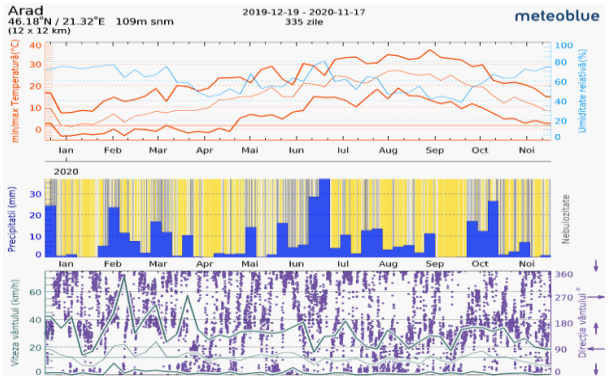

Fig. 3. Average values of temperatures and precipitations for the year 2020 in the Arad area. Red – min/max temperature (°C), Light blue – relative humidity (%), Dark blue – precipitations (mm), Vertical grey stripes – nebulosity, Green – wind speed (km/h), Purple arrows – wind direction (https://www.meteoblue.com- Arhiva meteo Arad).

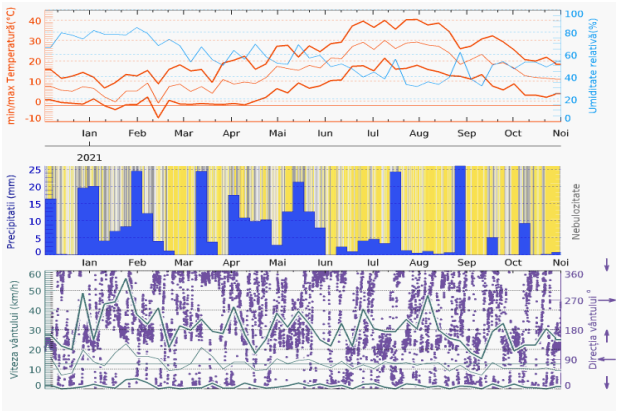

Fig. 4. Average values of temperatures and precipitations for the year 2021 in the Arad area. Red – min/max temperature (°C), Light blue – relative humidity (%), Dark blue – precipitations (mm), Vertical grey stripes – nebulosity, Green – wind speed (km/h), Purple arrows – wind direction (https://www.meteoblue.com- Arhiva meteo Arad).

Results

In the case of the selected varieties of wheat, rye, triticale, barley, and oats, the pedoclimatic conditions of Crișurilor Plain during 2018-2021, and the use of cultivation methodology recommended by cereal specialists (Săndoiu, 2012), resulted in the optimal growth and development of the crops. The maximum plant height was recorded in rye cultivars with an average value of 143.5 cm, and the minimum plant height was found in wheat with a length of 89 cm. The other species taken into the study had an average plant height of 113.5 cm (triticale), 99 cm (barley), and 95 cm (oats), respectively (Table 1).

Table 1.

The influence of pedoclimatic conditions on the plant size of wheat, rye, triticale, barley, and oats during 2018 - 2021

No	Species	Variety	Plant size (cm)	Difference to wheat (cm)	Difference to average (cm)
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	84	0	-19
		Glosa	95		
		Flamura 85	86		
		Dropia	90		
		Apache	91		
		Lovrin 34	94		
		Libelula	88		
		Average value	89		
2	Rye (*Secale cereale* L)	Suceveana	136	54.5	35.5
		Gloria	151		
		Average value	143.5		
3	Triticale (*Triticosecale*)	Tulnic	115	24.5	5.5
		Haiduc	117		
		Stil	110		
		Negoiu	116		
		Mv Medal	111		
		Oda Fd	112		
		Average value	113.5		
4	Barley (*Hordeum vulgare* L.)	Ametist	95	10	-9
		Belissa	108		
		Cardinal	97		
		Laverda	102		
		Lucian	93		
		Media	99		
5	Oats (*Avena sativa* L.)	Lovrin 1	87	6	-13
		Mureșana	102		
		Ovidiu	98		
		Jeremy	93		
		Average value	95		
6	Reference	Average	108	-19	0

The pedoclimatic conditions from 2018-2021 in the Crișurilor Plain along with the applied cultivation methodology, had a positive influence on the growth and development of the selected cereal crops and is well reflected in the number of caryopses per inflorescence. It should be noted that in oats, where the inflorescence is a panicle, the average number of caryopses / inflorescence was 91.5, and in the other cereals where

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the inflorescence is a spike the number of caryopses / inflorescence was 54 for rye, 46 for barley, and 34 for wheat and triticale, respectively (Table 2).

The Thousand Grain Weight (TGW) of the 5 species cultivated recorded an average value of 46.2 g. Barley had the highest TGW, with a value of 49 g, highlighting the crops' good adaptation to the pedoclimatic conditions. The lowest TGW was found in oats with a value of 34.4 g. For the other grains, TGW had the following values: triticale: 46 g, wheat: 43 g, and rye: 40.5 g (Table 3).

Table 2.

The influence of pedoclimatic conditions on the number of caryopses / inflorescence during 2018 - 2021

No	Species	Variety	No. of caryopses/ inflorescence	Difference to wheat	Difference to average
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	33	0	- 9.25
		Glosa	34		
		Flamura 85	34		
		Dropia	35		
		Apache	33		
		Lovrin 34	35		
		Libelula	34		
		Average value	34		
2	Rye (*Secale cereale* L)	Suceveana	55	20	10.75
		Gloria	53		
		Average value	54		
3	Triticale (*Triticosecale*)	Tulnic	35	0	-9.25
		Haiduc	34		
		Stil	33		
		Negoiu	35		
		Mv Medal	33		
		Oda Fd	34		
		Average value	34		
4	Barley *(Hordeum vulgare* L.)	Ametist	44	12	2.75
		Belissa	51		
		Cardinal	45		
		Laverda	47		
		Lucian	43		
		Average value	46		
5	Oats *(Avena sativa* L.)	Lovrin 1	92	57,5	48.25
		Mureșana	90		
		Ovidiu	93		
		Jeremy	91		
		Average value	91.5		
6	Reference	Average	43.25	9.25	0

Table 3.

The influence of pedoclimatic conditions on the Thousand Grain Weight (TGW) during 2018 - 2021

No	Species	Variety	TGW (g)	Difference to wheat (g)	Difference to average (g)
1	Wheat *(Triticum aestivum L.)*	Fundulea 4	40	0	0.4
		Glosa	43		
		Flamura 85	44		
		Dropia	45		
		Apache	42		
		Lovrin 34	44		
		Libelula	41		
		Average value	43		
2	Rye *(Secale cereale L)*	Suceveana	41.5	-2.5	-2.1
		Gloria	39.5		
		Average value	40.5		
3	Triticale *(Triticosecale)*	Tulnic	45	3	3.4
		Haiduc	48		
		Stil	47		
		Negoiu	46		
		Mv Medal	48		
		Oda Fd	44		

No	Species	Variety	TGW (g)	Difference to wheat (g)	Difference to average (g)
		Average value	46		
4	Barley (*Hordeum vulgare* L.)	Ametist	49	6	6.4
		Belissa	50		
		Cardinal	48.5		
		Laverda	49.5		
		Lucian	48		
		Average value	49		
5	Oats (*Avena sativa* L.)	Lovrin 1	32	-8.5	-8.1
		Mureșana	35		
		Ovidiu	38		
		Jeremy	33		
		Average value	34.5		
6	Reference	Average	42.6	-0.4	0

The hectoliter mass (HM), is of particular importance for the grading of cereals, and their silage but also for the correlation between this parameter and the quality of flour, especially. The HM value was between 47 kg for oats and 77 kg for wheat, with intermediate values obtained for triticale: 73.5 kg, rye: 73 kg, and barley: 64.5 kg (Table 4).

Table 4.

The influence of pedoclimatic conditions on the hectoliter mass (HM) during 2018 - 2021

No	Species	Variety	HM (Kg)	Difference to wheat (Kg)	Difference to average (Kg)
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	77	0	10
		Glosa	78		
		Flamura 85	79		
		Dropia	80		
		Apache	75		
		Lovrin 34	75		
		Libelula	76		
		Average for wheat	77		
2	Rye (*Secale cereale* L)	Suceveana	73.5	-4	6
		Gloria	72.5		
		Average for rye	73		
3	Triticale (*Triticosecale*)	Tulnic	74	-3.5	6.5
		Haiduc	73		
		Stil	73		
		Negoiu	73		
		Mv Medal	74		
		Oda Fd	74		
		Average for triticale	73		
4	Barley (*Hordeum vulgare* L.)	Ametist	64	-2.5	-2.5
		Belissa	65		
		Cardinal	63		
		Laverda	64.5		
		Lucian	66		
		Average for barley	64.5		
5	Oats (*Avena sativa* L.)	Lovrin 1	46	-30	-20
		Mureșana	47		
		Ovidiu	47.5		
		Jeremy	47.5		
		Average for oats	47		
6	Reference	Average	67	-10	0

The positive impact of the pedoclimatic conditions of the area and cultivation methodology is also reflected in the seed production in relation to the surface unit. It should be noted that in triticale and barley, the productions exceeded 7000 kg/ha with values of 7870 kg/ha and 7130 kg/ha respectively. The other experimental variants (wheat, rye, oats) achieved valuable productions, indicating a good adaptation to the climate and soil conditions of the area (Table 5).

In this study, we also analyzed the effect of the pedoclimatic conditions on the seed contents in proteins, fats, and starch. The average value for all species, which also served as a witness / reference, was 12.54%, the oats displaying the highest seed protein content (14.4%), and the rye having the lowest seed protein content (3%).

Usually, the high production of cereals, particularly wheat, is negatively correlated with the protein content, and it is known to affect the biological stability by denaturing the primary structure of proteins, the amino acid chain, with direct repercussions in food processes, such as panification (Ungureanu *et al*, 2020b; Chen et al., 2022). In this case, the wheat varieties registered an

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average value of 12 % seed protein content, considered favorable for panification (YARA, 2011) (Table 6).

Regarding the seed fat content, it can be observed in Table 7 that it was highest in oats, with an average value of 4.9 %, followed by barley: 2.4 %, wheat: 1.8 %, rye - 1.7 %, and triticale 1.6 %.

Table 5.

The influence of pedoclimatic conditions on the seeds production / surface unit during 2018 - 2021

No	Species	Variety	Seeds production (Kg/ha)	Difference to wheat (Kg/ha)	Difference to average (Kg/ha)
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	5400	0	10
		Glosa	6800		
		Flamura 85	5800		
		Dropia	6200		
		Apache	6100		
		Lovrin 34	5900		
		Libelula	5700		
		Average for wheat	6000		
2	Rye (*Secale cereale* L)	Suceveana	6350	-4	6
		Gloria	5250		
		Average for rye	5800		
3	Triticale (*Triticosecale*)	Tulnic	7870	-3.5	6.5
		Haiduc	8160		
		Stil	7750		
		Negoiu	8050		
		Mv Medal	7920		
		Oda Fd	7480		
		Average for triticale	7870		
4	Barley *(Hordeum vulgare* L.)	Ametist	6930	-2.5	-2.5
		Belissa	7260		
		Cardinal	6980		
		Laverda	7310		
		Lucian	7170		
		Average for barley	7130		
5	Oats *(Avena sativa* L.)	Lovrin 1	4350	-30	-20
		Mureșana	4420		
		Ovidiu	4840		
		Jeremy	4510		
		Average for oats	4530		
6	Reference	Average	6266	-10	0

Table 6.

The influence of pedoclimatic conditions on the seeds' protein content during 2018 - 2021

No	Species	Variety	Protein contents (%)	Difference to wheat (%)	Difference to average (%)
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	11	0	-0.54
		Glosa	13		
		Flamura 85	12		
		Dropia	13		
		Apache	11		
		Lovrin 34	13		
		Libelula	12		
		Average for wheat	12		
2	Rye (*Secale cereale* L)	Suceveana	12.8	1	0.46
		Gloria	13.2		
		Average for rye	13		
3	Triticale (*Triticosecale*)	Tulnic	12.1	-0.3	-0.84
		Haiduc	11.5		
		Stil	11.4		
		Negoiu	11.6		
		Mv Medal	11.9		
		Oda Fd	12		
		Average for triticale	11.7		
4	Barley	Ametist	11	-0.4	-0.94

No	Species	Variety	Protein contents (%)	Difference to wheat (%)	Difference to average (%)
	(Hordeum vulgare L.)	Belissa	13.2		
		Cardinal	10.6		
		Laverda	12.9		
		Lucian	10.3		
		Average for barley	11.6		
5	Oats *(Avena sativa* L.)	Lovrin 1	14.4	2,4	1.86
		Mureșana	14.1		
		Ovidiu	14.3		
		Jeremy	14.8		
		Average for oats	14.4		
6	Reference	Average	12.54	0.54	0

Table 7.

The influence of pedoclimatic conditions on the seed fat content during 2018 - 2021

No	Species	Variety	Fat contents (%)	Difference to wheat (%)	Difference to average (%)
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	2	0	-0.68
		Glosa	1.7		
		Flamura 85	1.8		
		Dropia	1.5		
		Apache	1.9		
		Lovrin 34	1.6		
		Libelula	2		
		Average for wheat	1.8		
2	Rye (*Secale cereale* L)	Suceveana	1.8	-0.1	-0.78
		Gloria	1.6		
		Average for rye	1.7		
3	Triticale (*Triticosecale*)	Tulnic	1.5	-0.2	-0.88
		Haiduc	1.6		
		Stil	1.7		
		Negoiu	1.7		
		Mv Medal	1.6		
		Oda Fd	1.5		
		Average for triticale	1.6		
4	Barley *(Hordeum vulgare* L.)	Ametist	2.4	0.6	-0.08
		Belissa	2.2		
		Cardinal	2.5		
		Laverda	2.3		
		Lucian	2.6		
		Average for barley	2.4		
5	Oats *(Avena sativa* L.)	Lovrin 1	4.8	3.1	2.42
		Mureșana	5.2		
		Ovidiu	5		
		Jeremy	4.6		
		Average for oats	4.9		
6	Reference	Average	2.48	0.68	0

The percentage of seed starch content is acceptable for human consumption as well as for animal feed and industrial processes (Maningat et al., 2009). The analyzed genotypes contained on average 62.26 % starch, with a maximum in barley - 65.1 %, and a minimum in oats - 49.3 %; the wheat - 62.8 %, triticale - 62.2 %, and the rye - 61.9 % having similar values (Table 8).

Table 8.

The influence of pedoclimatic conditions on the seeds' starch content during 2018 - 2021

No	Species	Variety	Starch contents (%)	Difference to wheat (%)	Difference to average (%)
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	62.6	0	0.54
		Glosa	63.1		
		Flamura 85	62.9		
		Dropia	62.8		
		Apache	62.6		
		Lovrin 34	62.7		
		Libelula	62.9		

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No	Species	Variety	Starch contents (%)	Difference to wheat (%)	Difference to average (%)
		Average for wheat	62.8		
2	Rye (*Secale cereale* L)	Suceveana	62.5	-0.9	-0.6
		Gloria	61.3		
		Average for rye	61.9		
3	Triticale (*Triticosecale*)	Tulnic	62.2	-0.6	-0.06
		Haiduc	62.4		
		Stil	62.0		
		Negoiu	62.3		
		Mv Medal	62.2		
		Oda Fd	62.1		
		Average for triticale	62.2		
4	Barley (*Hordeum vulgare* L.)	Ametist	65	2.3	2.84
		Belissa	63.5		
		Cardinal	66		
		Laverda	64.5		
		Lucian	66.5		
		Average for barley	65.1		
5	Oats (*Avena sativa* L.)	Lovrin 1	49.5	-13.5	-12.96
		Mureșana	48.7		
		Ovidiu	49.1		
		Jeremy	49.9		
		Average for oats	49.3		
6	Reference	Average	62.26	-0.54	0

From an economic point of view, the cultivation of the selected cereal varieties in the pedoclimatic conditions of the Crișurilor Plain has led to positive results, with profits between 2310 RON/ha (barley) and 3217 RON/ha (oats). The profit for triticale was 3196 RON/ha, positioning this crop as the second-best choice next to oats, closely followed by wheat and rye, for which the profits were 2700 RON/ha, and 2321 RON/ha, respectively (Table 9).

Table 9.

The influence of pedoclimatic conditions on the economic efficiency of evaluated cereal crops during 2018 - 2021

No	Species	Variety	Grain production (kg/ha)	Value grain production (RON/ha)	Profit (RON/ha)	Difference to wheat (%)	Difference to average (%)
1	Wheat (*Triticum aestivum* L.)	Fundulea 4	5400	5130	2130	0	-48.8
		Glosa	6800	6460	3460		
		Flamura 85	5800	5510	2510		
		Dropia	6200	5890	2890		
		Apache	6100	5795	2795		
		Lovrin 34	5900	5605	2605		
		Libelula	5700	5415	2415		
		Average for wheat	6000	5700	2700		
2	Rye (*Secale cereale* L)	Suceveana	6350	5715	2815	-379	-427.8
		Gloria	5250	4727	1827		
		Average for rye	5800	5221	2321		
3	Triticale (*Triticosecale*)	Tulnic	7870	6296	3196	496	447.2
		Haiduc	8160	6528	3428		
		Stil	7750	6200	3100		
		Negoiu	8050	6440	3340		
		Mv Medal	7920	6336	3236		
		Oda Fd	7480	5984	2884		
		Average for triticale	7870	6296	3196		
4	Barley (*Hordeum vulgare* L.)	Ametist	6930	6237	3037	507	468.2
		Belissa	7260	6534	3334		
		Cardinal	6980	6282	3082		
		Laverda	7310	6579	3379		
		Lucian	7170	6453	3253		
		Average for barley	7130	6417	3217		

No	Species	Variety	Grain production (kg/ha)	Value grain production (RON/ha)	Profit (RON/ha)	Difference to wheat (%)	Difference to average (%)
5	Oats (*Avena sativa* L.)	Lovrin 1	4350	4785	2165	-390	-438.8
		Mureșana	4420	4862	2212		
		Ovidiu	4840	5324	2674		
		Jeremy	4510	4961	2311		
		Average for oats	4530	4961	2310		
6	Reference	Average	62.26	6266	2748.8	48.8	0

1 kg wheat grains = 0.95 RON; Production cost/ha = 3000 RON; 1 kg rye grains = 0.9 RON; Production cost/ha = 2900 RON; 1 kg triticale grains = 0.8 RON; Production cost/ha = 3100 RON; 1 kg barley grains = 0.9 RON; Production cost/ha = 3200 RON; 1 kg oats grains = 1.1 RON; Production cost/ha = 2650 RON; Profit = production value – production cost.

CONCLUSIONS

The 23 varieties of 5 cereal species (wheat, rye, triticale, barley, and oats) cultivated in the pedoclimatic conditions of the Crișurilor Plain showed positive results for all the analyzed morphological and phytochemical indices.

The average plant height was 108 cm and the number of caryopses / inflorescence indicates a good adaptability of the selected varieties to the soil and climatic conditions of the Crișurilor Plain. The best result was given by the rye varieties Suceveana and Gloria with an average of 143.5 cm, followed by triticale - 113.5 cm, barley - 99 cm, and oats - 95 cm.

The highest yields were obtained from triticale varieties (especially Haiduc and Negoiu) and barley (Belissa, Laverda, and Lucian varieties) where average yields exceeded 7000 kg/ha, with values of 7870 kg/ha and 7130 kg/ha respectively, while selected wheat varieties ranked second with an average yield of 6000 kg/ha and can be considered viable for cultivation in this region.

The average percentages of protein (12.54%), fat (2.48%), and starch (62.26%) were within normal limits for all the varieties studied.

The best results from an economic point of view were obtained for barley, which with a yield of 6417 RON/ha yielded a profit of 3217 RON/ha, followed by triticale, which with a yield of 6296 RON/ha yielded a profit of 3196 RON/ha.

According to the experimental data, the least efficient crop varieties for the Crișurilor Plain, with a profit of 2310 RON/ha and 2321 RON/ha respectively, are oats and rye. However, further studies are needed for a better understanding of their potential.

AUTHORS CONTRIBUTIONS

Conceptualization, O.C.U. and V.T.; methodology, O.C.U., I.O.S., M.E. and E.U.; data collection, O.C.U., M.C.; data validation, O.C.U., E.M., E.U., I.O.S. and V.T.; data processing O.C.U., E.M. and V.B.B.; writing—original draft preparation, O.C.U., I.O.S., M.C. and V.B.B.; writing—review and editing, E.U., E.M. and V.T.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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