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RESEARCH ON AGROECOLOGICAL ZONING FOR WINTER WHEAT (*TRITICUM AESTIVUM* L.) IN SOUTH-EASTERN ROMANIA

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Abstract

Pedoclimatic elements and smart technology act simultaneously on the biological processes of agricultural crops and on the level of harvest, which requires the study of their correlation to determine the continuous influence of these factors in obtaining the planned levels of production. In Romania, annually, over 2.1 million hectares of wheat are cultivated, with annual productions of over 10 million tons, placing wheat crops in the first place as economic importance. Knowing the management of natural resources in quantitative terms is especially valuable when we talk about their sustainable use. Our evaluation includes in this paper the relationship between the pedoclimatic resources of South-Eastern Romania and the zoning of wheat varieties in order to obtain superior quantitative and qualitative productions. The last 11 agricultural years are analyzed, both in terms of the influence of global warming and in terms of wheat zoning to obtain sustainable production to highlight the genetic potential of the varieties under the conditions of the Brailei Plain. A stability of the varieties Glosa, Miranda, Litera (varieties over 15 years old) was observed, but not least of the new ones created by the National Research and Development Institute from Fundulea such as: Pitar, Ursita, Adelina, Izvor.

Key words**:** *production, pedoclimatic conditions, varieties, zoning, winter wheat*

INTRODUCTION

Knowledge of resource management in quantitative terms is especially valuable when it comes to their sustainable use. Thus, there is a direct link between the productive potential of varieties and hybrids and zonal pedoclimatic factors [6]. The literature also uses the concept of climatic fertility, according to soil fertility [2]. Eastern Romania, more precisely in the Braila Plain, the knowledge of the climatic variations, of the soil fertility and of the genetic potential of the varieties contributes integrated to the obtaining of superior productions from a quantitative and qualitative point of view.
Knowing the reaction of new varieties to environmental conditions is important for judicious zoning in the territory and for specifying the place it must occupy in the structure of varieties for each area [8, 11].
We are going through a period in which the evaluation of the development of agriculture through the prism of ecological implications requires an increased attention of the interactions between the physico-chemical, biological, physiological and climatic components. In fact, [12] also explains the link between environmental productivity and climate change that requires in-depth analysis. He shows how climate is the critical factor in whether or not to support the sustainability of agricultural systems. On the other hand, geneticists and breeders obviously and systematically contribute to improving the genotypes of agricultural species, to obtain varieties and hybrids with tolerance to biotic and abiotic stressors, with selectivity to some pesticides, with resistance to diseases and pests, but, especially with high productive potential and quality agricultural products. There are also a number of technological links to improve productive potential through treatments with biofertilizers and biostimulators [13]. More than three-quarters of the global land area is unsuitable for agriculture, suffering from severe constraints such as cold weather (13%), dry climate (27%), steep topography (12%) or poor soil conditions (40%). %). In many cases in

developing countries, cultivated land is only moderately suitable for agriculture because of multiple constraints [7]. European statistics on cereal production in the period 2010-2021 show that in the European Union, total annual production was between the minimum value of 260,276 thousand tons in 2010 and 306,219 thousand tons in 2014, and for 2022 a total production is estimated of 298,376 thousand tons (Table 1). For wheat, the annual productions in the last 12 years were between the minimum value of 112,969 thousand tons in 2010 and 132,15 thousand tons in 2019, and the average for the last 5 years was 126,205 thousand tons, estimating in 2022 an increase by 3.9% [5].

Table 1. Total cereal production for each species in the period 2010-2021,with EUROSTAT estimates for 2022

Crop	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020e	2021f	2022p	5-year TrimAvg	5-year TrimAvg vs 2022p
Soft wheat	112,969	115,885	112,652	124,300	133,042	136,106	120,641	128,306	115,751	132,156	119,270	131,040	131,090	126,205	3.9%
Durum wheat	9,443	8,583	8,414	8,054	7,698	8,388	9,675	8,810	8,767	7,476	7,420	7,809	7,630	8,017	-4.8%
Grain maize	59,944	70,696	59,529	66,973	77,736	59,239	62,963	65,049	69,309	70,416	68,252	72,561	73,743	69,326	6.4%
Barley	47,858	46,372	49,480	52,762	53,770	54,607	53,324	51,650	49,931	55,514	54,420	52,418	53,931	52,829	2.1%
Triticale	10,681	10,074	10,051	11,421	13,126	12,676	11,785	11,646	9,770	11,203	12,337	11,778	11,237	11,543	-2.7%
Oat	6,752	7,242	7,300	7,432	6,947	6,784	7,321	7,322	6,887	6,945	8,473	7,554	7,594	7,274	4.4%
Rye	7,694	6,782	8,679	10,417	8,994	7,739	7,349	7,309	6,174	8,455	8,910	7,944	8,231	7,903	4.2%
Sorghum	614	679	497	729	932	720	688	719	833	1,016	1,126	841	878	807	-2.1%
Other cereals	4,320	4,511	5,088	4,032	3,974	3,450	3,625	4,158	3,851	3,879	3,614	3,739	4,043	3,823	5.8%
Total cereals	260,276	270,824	261,689	286,120	306,219	289,709	277,371	284,967	271,272	297,060	283,821	295,685	298,376	288,158	3.5%

NOTE: e = estimate ; f = forecast ; p = projection.
Source: DG Agriculture and Rural Development based on Eurostat crop production annual data [4].

Traditionally, Romania is a large producer of cereals, especially corn, but the total production of wheat in the last 11 years was between the minimum of 5.28 thousand tons in 2012 and the maximum of 11.35 thousand tons in 2021, which meant a percentage between 4.67% and 8.65% of the total production of the EU member states (Tables 2 and 3).

Table 2. Total cereal production in the European Union and in Romania (thousand tons)
Cereales-Gross production by all crops (1,000 tonnes) for all Members States

Crop	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Soft wheat	112,969	115,885	112,652	124,300	133,042	136,106	120,641	128,306	115,751	132,156	119,270
Durum wheat	9,443	8,583	8,414	8,054	7,698	8,388	9,675	8,810	8,767	7,476	7,420
Maize	59,944	70,696	59,529	66,973	77,736	59,239	62,963	65,049	69,309	70,416	68,252
Barley	47,858	46,372	49,480	52,762	53,770	54,607	53,324	51,650	49,931	55,514	54,420
Totals	260,276	270,824	261,689	286,120	306,219	289,709	277,371	284,967	271,272	297,060	283,821

Crop	5-year TrimAvg	Latest year vs. 5-year TrimAvg
Soft wheat	126,205	3.87%
Durum wheat	8,017	-4.83%
Maize	69,326	6.37%
Total cereals	288,158	3.55%

Source: DG Agriculture and Rural Development based on Eurostat crop production annual data [4].

Table 3. Total cereal production in Romania (thousand tons)

Crop	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021e
Soft wheat	5,784	7,117	5,276	7,284	7,565	7,955	8,406	10,014	10,123	10,281	6,744	11,354
Durum wheat	28	15	22	13	19	8	25	21	21	17	11	33
Maize	9,042	11,718	5,953	11,305	11,989	9,021	10,746	14,326	18,664	17,432	10,942	15,186
Barley	1,311	1,330	986	1,542	1,713	1,626	1,817	1,907	1,871	1,880	1,155	2,435
Totals	16,651	20,777	12,773	20,842	22,026	19,283	21,721	27,096	31,510	30,372	19,349	29,653

Crop	5-year TrimAvg	Latest year vs. 5-year TrimAvg
Soft wheat	126,205	3.87%
Durum wheat	8,017	-4.83%
Maize	69,326	6.37%
Total cereals	288,158	3.55%

Source: DG Agriculture and Rural Development based on Eurostat crop production annual data [4].

EUROSTAT statistics show an increase in wheat production compared to the average of the last 5 years by 3.87% in Europe, while in Romania, the increase is only 1.90% .

The purpose of the work follows the acclimatization and stability from the genetic and productive point of view of new and old varieties, tested over a longer period of time and their resistance to different biotic and abiotic factors.

MATERIALS AND METHODS

The testing experiments of the different wheat varieties were carried out in the period 2010 - 2021, with the monitoring of the pedoclimatic data continuously, in order to highlight the genetic potential of the varieties in the conditions of the Braila Plain.

Climatic conditions were monitored daily, respectively minimum and maximum air and soil temperature, precipitation, sunshine, wind, wind orientation. Periodic soil analyzes were performed to establish the fertilization plan, according to the nutrient requirements for the optimal wheat cultivation technology.

The wheat varieties tested were different from year to year, depending on the results of the previous year and the requirements of the seed suppliers to be tested and zoned.

All the necessary biometrics have been made to evaluate the adaptation of the tested wheat varieties, but in this paper we will analyze only the productive potential.

The main objective of the research is to evaluate the genetic potential of wheat varieties for cultivation in the Brăila Plain, respectively the production capacity in conditions of pedological drought registered in recent agricultural years [3].

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Climate resources also directly affect the biodiversity of ecosystems, and this paper aims to assess the potential of land in Brăila County in terms of sustainability and climate change for wheat cultivation.

Therefore, we will include in our evaluation a series of evolving indicators that we will analyze further, namely:

- The evolution of the average monthly temperatures during the vegetation period;
- The evolution of the average monthly precipitations during the vegetation period;
- The productions obtained by the different wheat varieties tested in the period 2010 - 2021.

The varieties tested in the experience were: Boema 1, Litera, Miranda, Glosa, Bezostaia, Pitar, Otilia, Izvor, Otilia, Ursita, Adelina. The sown area of the experimental plot was 10 m^2, and the harvested area was 5 m^2. The field experiments were designed according to the experimental technique. The location scheme for the wheat crop is a latin rectangle, with a number of 11 variants.

Because the productivity of different wheat genotypes depends on climate, soil fertility, and water availability, they form the most important categories of environmental

information needed to assess land suitability for production [1].

RESULTS AND DISCUSSIONS

Climate data results

The monitoring of the minimum and maximum daily temperatures allowed the calculation of the monthly averages for each of the 11 agricultural years studied. In the Braila Plain, compared to the multiannual monthly average calculated for the last century, there is a positive deviation in each calendar month, with values between the minimum deviation of + 0.5)^{0}C in October and + 1.75^{0}C in March (Fig. 1).

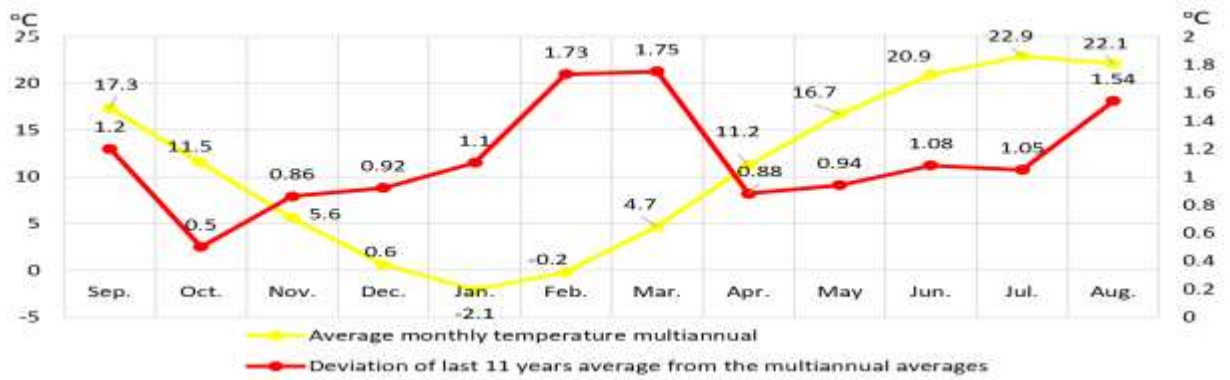

Fig. 1. Average monthly temperatures and deviations for the last 11 agricultural years, compared to multiannual monthly averages
Source: Own results based on CMR Dobrogea [3].

The average monthly precipitation calculated as the average of the last 11 agricultural years registered negative deviations in September, November, April, July and August, with values between the minimum deviation of -0.45 mm in November and the maximum deviation of –11.42 mm in August, while the significant positive deviations were in October (+ 24.42 mm), January (+ 14.04 mm) and June (+ 14.88 mm) (Fig. 2).

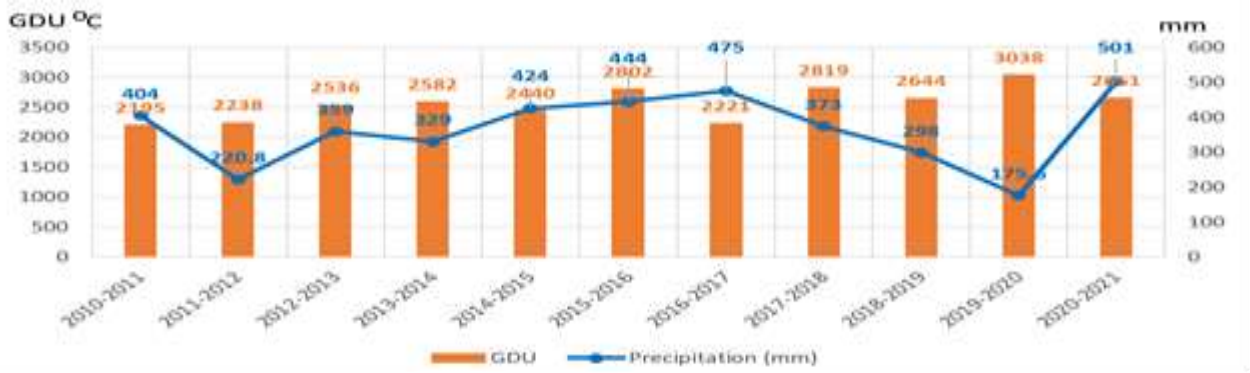

Fig. 2. GDU (growing degree units) and the precipitation accumulated during the wheat vegetation period in the last 11 agricultural years
Source: [3].

Results regarding the productions obtained for the wheat varieties tested in the 11 agricultural years in the Braila Plain, compared to the average production in Romania. The annual production averages were related to the national productions in the analyzed period and positive differences were observed in the good agricultural years, with sufficient precipitation in autumn, while in the dry agricultural years the differences of production compared to the national average were negative, from up to 1.3 t/ha tons (Fig. 3).

Fig. 3. Average productions obtained in the experience compared to the national average productions (red represents the lower productions, and green the higher productions)
Source: [9, 10].

Production results for the varieties tested in the 11 agricultural years, for the zoning of the Romanian wheat varieties in the Braila Plain.

In the agricultural year 2010 - 2011, the best production results were obtained by the Miranda, Boema and Glosa varieties, with production differences compared to the average experience between 667 kg/ha for the Glosa variety and 1,276 kg/ha, while the Izvor varieties and Bezostaia obtained significant negative differences with yields of less than 15-30% (Fig. 4).

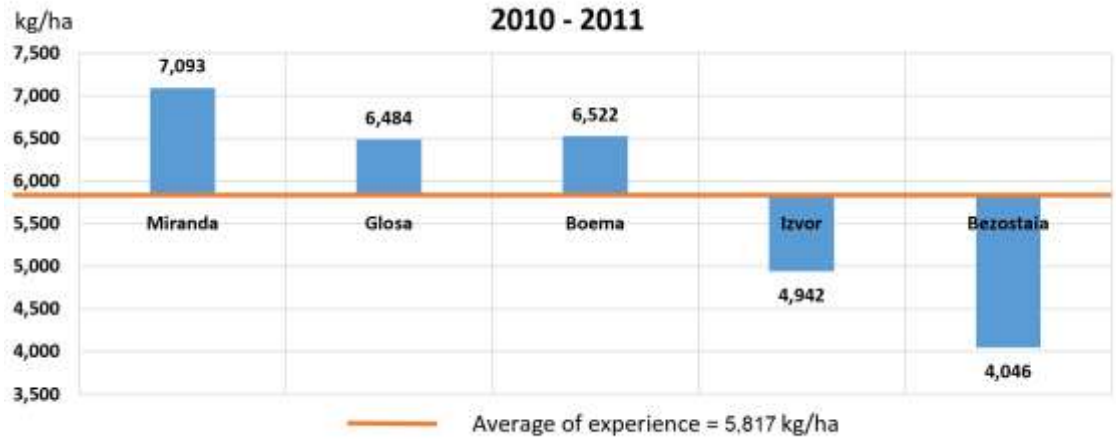

Fig. 4. Average productions obtained for the wheat varieties in 2010-2011, compared to the average experience
Source: Own results [10].

In the agricultural year 2011 - 2012, the production results were insignificant compared to the average experience, with differences between -1.04% for the Izvor variety and + 1.42% for the Glosa variety (Fig. 5). The average production in 2013 was 6,620 kg/ ha, and the best results compared to this average were obtained by the Glosa varieties, with a production difference of + 5.18%, and the weakest result was obtained by the variety Spring, with a production difference of -3.5% compared to the average experience and 9.1% compared to the Glosa variety (Fig. 6).

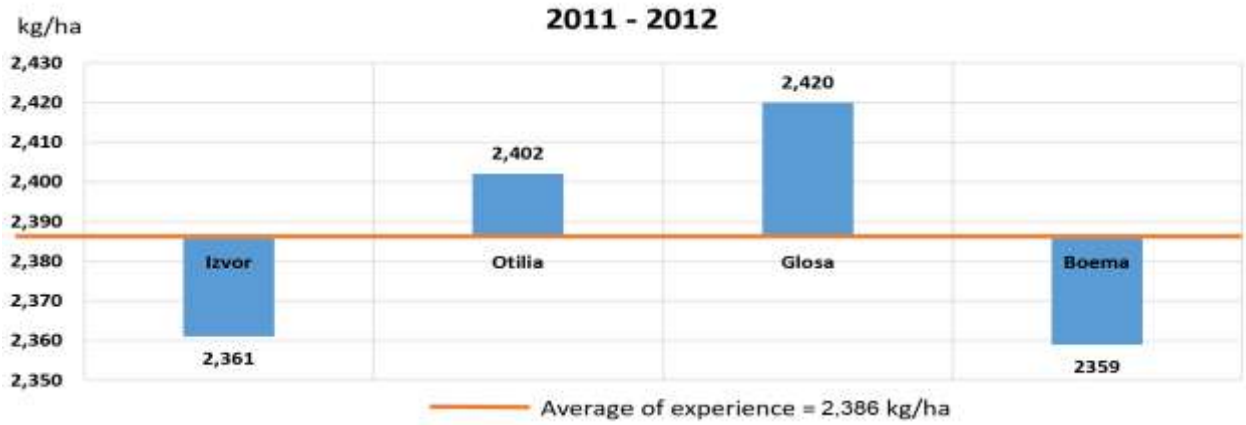

Fig. 5. Average productions obtained for the wheat varieties in 2011-2012, compared to the average experience
Source: Own results [10].

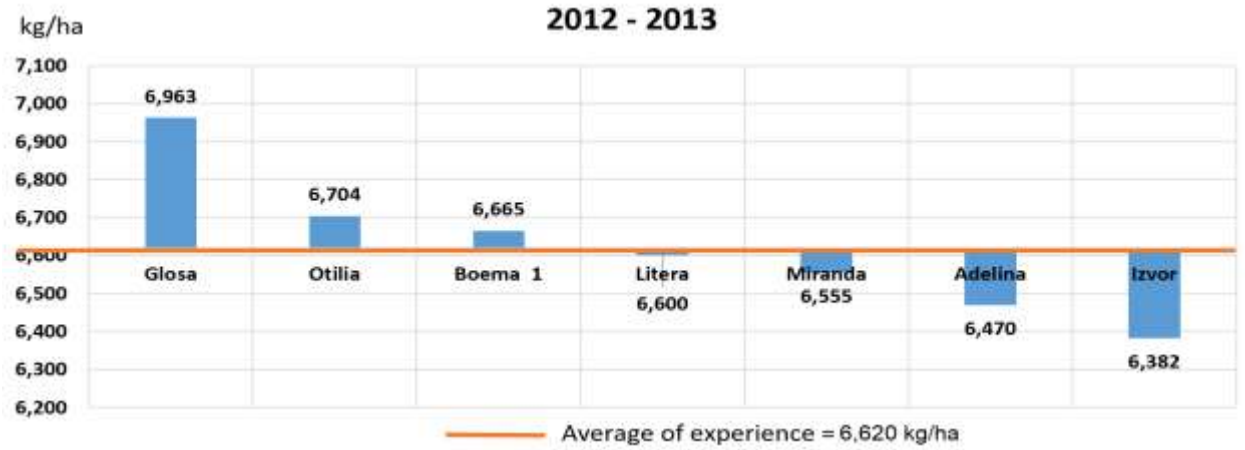

Fig. 6. Average productions obtained for the wheat varieties in 2013, compared to the average experience
Source: Own results [10].

In 2014, the best production results were obtained by the Boema variety, with a percentage of + 6.7%, followed by the Miranda varieties (with an increase of + 0.4%), and the weakest production result was of the Izvor variety with a production difference of - 4.39% compared to the control (Fig. 7).

In Figures 10, 11, 12, 13, 14 are presented the results for yields in the coming agricultural years compared to the average experience.

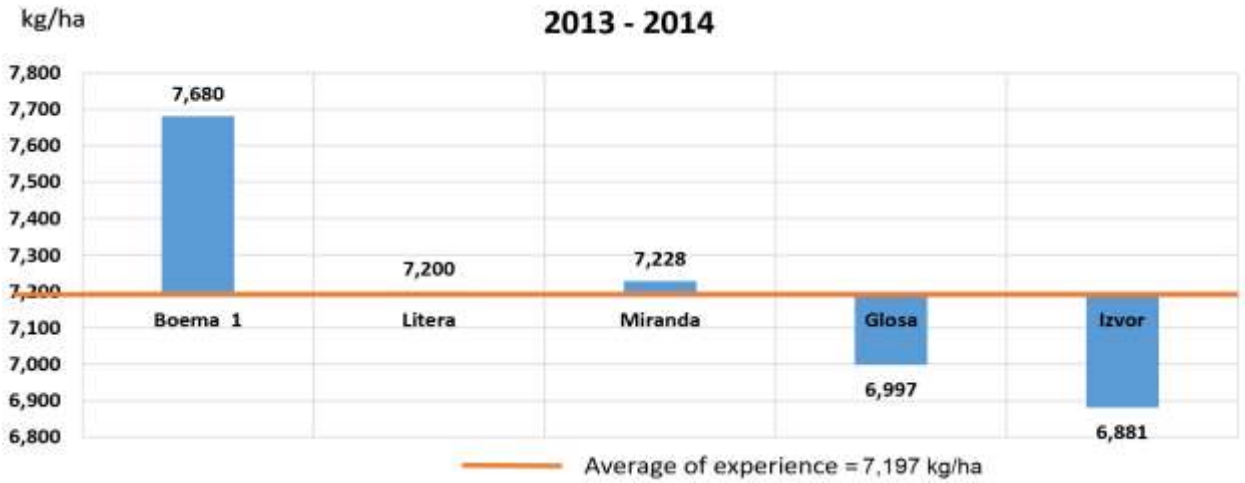

Fig. 7. Average productions obtained for the wheat varieties in 2014,compared to the average experience
Source: Own results [10].

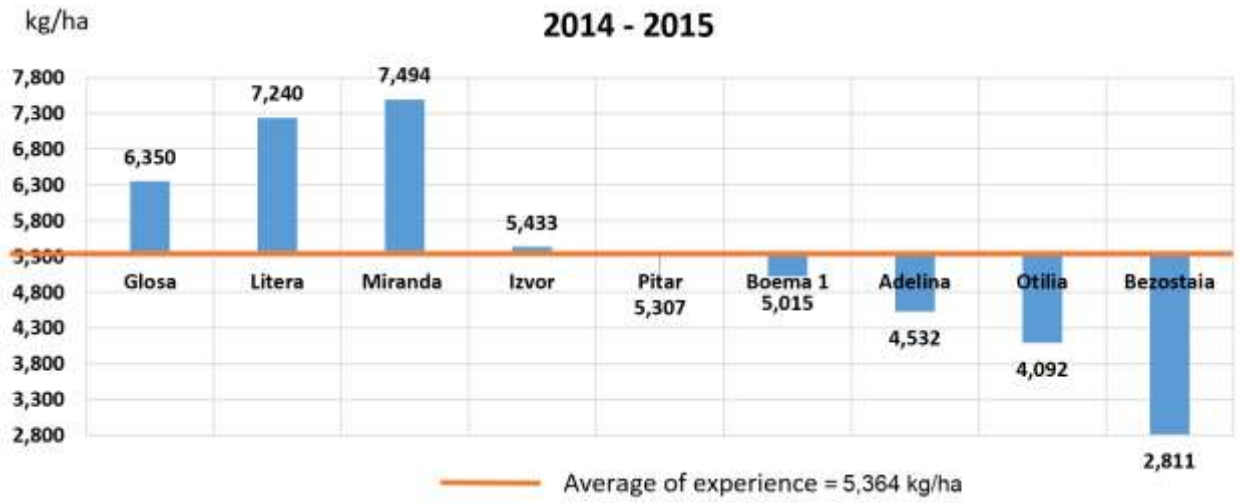

Fig. 8. Average porductions obtained for wheat varieties in 2015, compared to the average experience
Source: Own results [10].

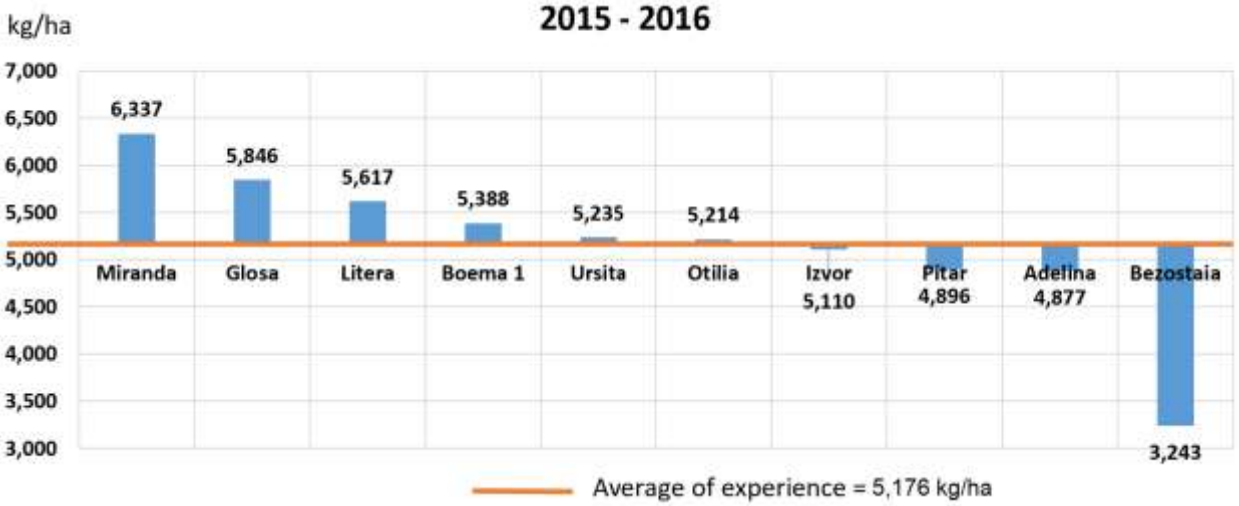

Fig. 9. The graph of the average productions obtained for the wheat varieties in 2016,compared to the average experience
Source: Own results [10].

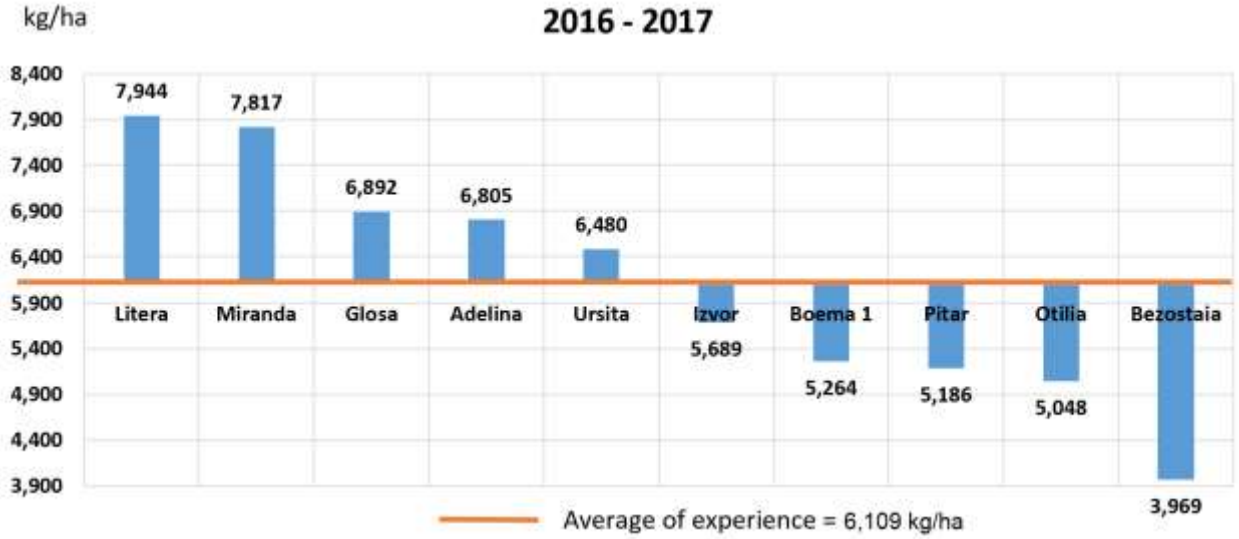

Fig. 10. Average productions obtained for wheat varieties in 2017, compared to the average experience
Source: Own results [10].

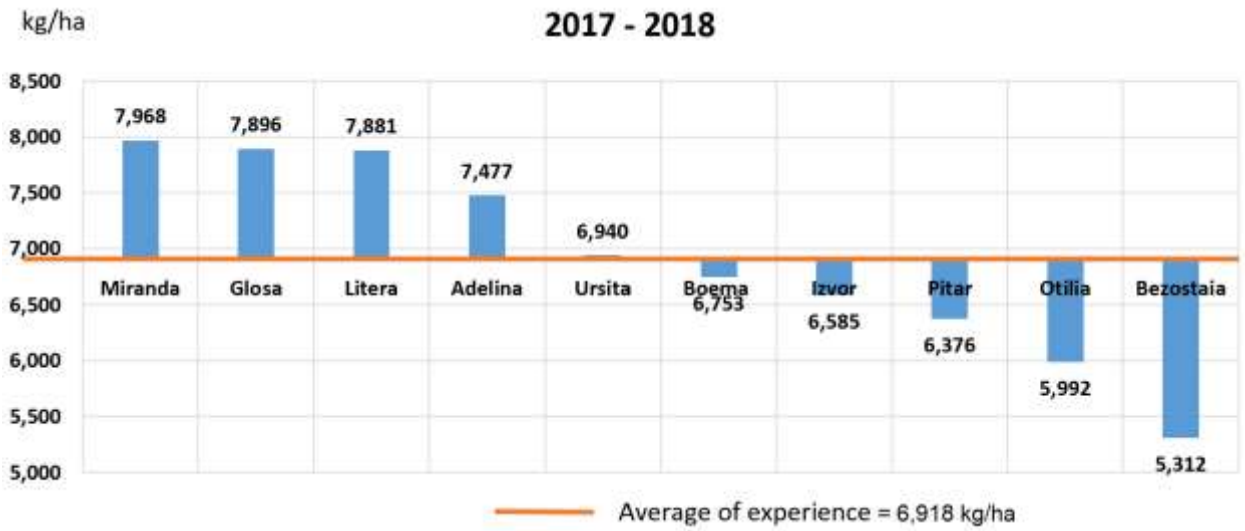

Fig. 11. Average productions obtained for the wheat varieties in 2018, compared to the average experience
Source: Own results [10].

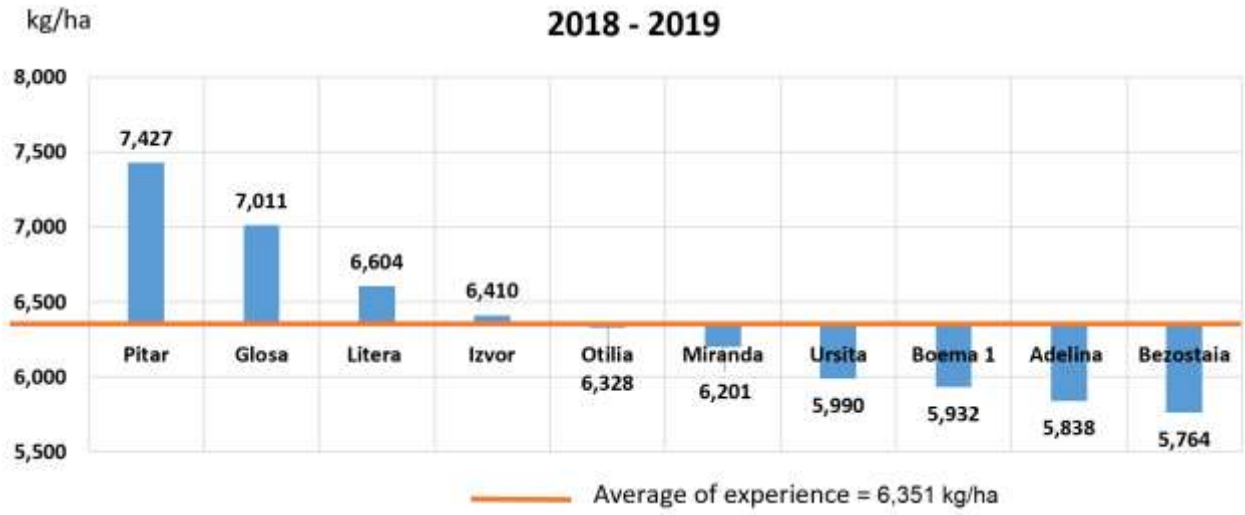

Fig. 12. Average productions obtained for the wheat varieties in 2019, compared to the average experience
Source: Own results [10].

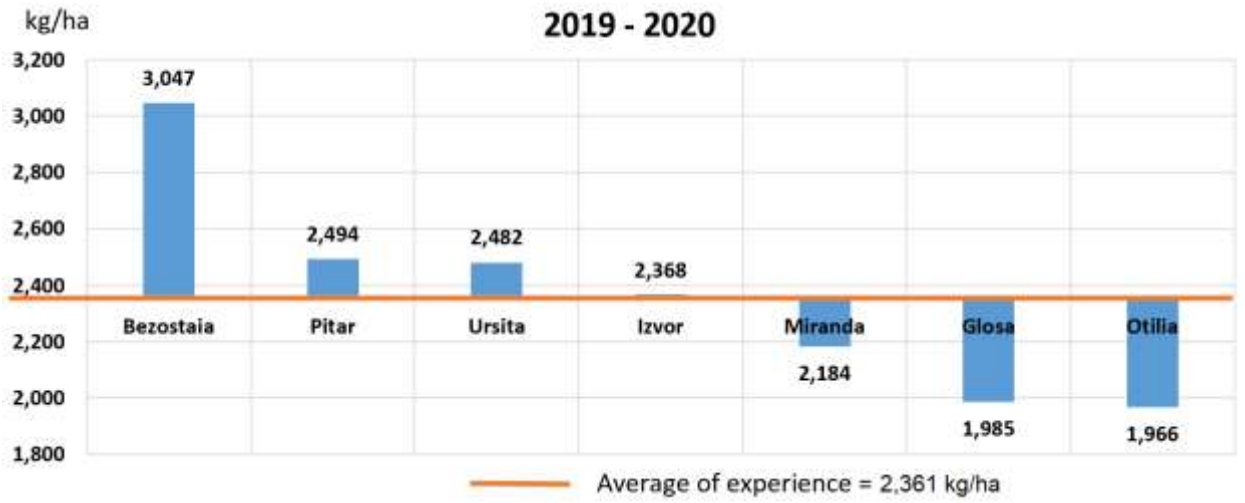

Fig. 13. Average productions obtained for wheat varieties in 2020, compared to the average experience
Source: Own results [10].

It is noteworthy that the Bezostaia variety, an old Romanian variety, obtained the best results in the driest year in the Braila Plain, with a production increase of + 29.05% compared to the average experience, followed by the Pitar and Ursita variety, with + 5.63% and 5.12% respectively (Fig. 13).

In the good years from the point of view of the autumn precipitations and at the end of winter, the most productive Romanian wheat varieties remain Ursita, Glosa, Adelina and Izvor, while the varieties Bezostaia, Pitar, Miranda, Otilia remain very good for the dry years (Fig. 14).

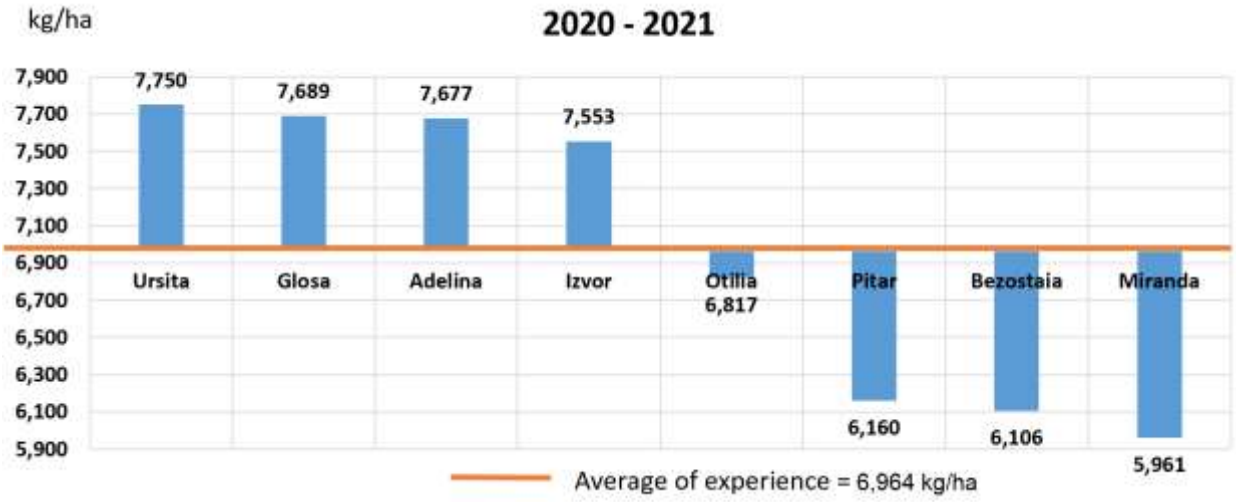

Fig. 14. Average productions obtained for wheat varieties in 2021, compared to the average experience
Source: Own results [10].

CONCLUSIONS

- The new winter wheat varieties are much more productive, compared to the older varieties, such as Bezostaia and Glosa, but they are much more resistant to current climate change, offering a stable production.
- The wheat varieties tested at S.C.D.A Braila in the period 2010 - 2022 reacted differently to the environmental conditions, being registered productions and a different hierarchy of them from year to year.
- There was a stability of the Glosa, Miranda, Litera varieties (varieties over 15 years old from the approval), but last but not least of the new ones created by the National Research-Development Institute from Fundulea such as: Pitar, Ursita, Adelina, Izvor.
- Some of the varieties mentioned above have entered the process of multiplication carried out by S.C.D.A. Brăila.
- In this way, quality seed material adapted to the pedoclimatic conditions specific to the area of influence in South-Eastern Romania is ensured.
-It was found a weak and positive correlation between temperatures and wheat yields , and a positive high correlation coefficient between yields and average rainfalls.

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