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COMPARATIVE ANALYSIS OF VARIOUS WINTER WHEAT VARIETIES CULTIVATED UNDER THE CLIMATIC CONDITIONS OF ARDS BRAILA

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Abstract

In the context of ensuring better food security and in line with the objectives of the field crop research strategy, increasing wheat production capacity remains a priority. This has been achieved by studying a set of local and foreign winter wheat varieties to test their genetic potential in specific pedoclimatic conditions of the ARDS Braila area of influence, respectively, the North-East Baragan. During the agricultural years 2020-2021 and 2021-2022, a total of 14 varieties of autumn wheat were tested under conventional technology conditions. Yield levels under the conditions of an optimal rainfall agricultural year 2020-2021 were satisfactory for the wheat crop, and yields in the range of 5582-7994 kg/ha were obtained. In the agricultural year 2021-2022, characterized by very dry rainfall throughout the year, with a total deficit of 155.7 mm compared to the multi-year average, wheat yields were in the range of 5435-6746 kg/ha.

Key words: *winter wheat, pedoclimatic conditions, yield.*

INTRODUCTION

Wheat is the most widely grown crop globally, covering 220.76 million hectares, followed by maize at 205.87 million hectares, and rice at 165.25 million hectares. Wheat accounts for a third of total grain production, estimated at 770 million tons, ranking below rice at 787 million tons and maize at 1,210 million tons (FAOSTAT, 2021; Gulino et al., 2023). Wheat yield is a multifaceted genetic variable influenced by numerous genes that determine both the potential yield and how much of that potential is achieved when the crop faces specific environmental challenges. (Curtis & Halford, 2014).

Wheat with enhanced physiological characteristics is cultivated in high-rainfall and irrigated wheat-producing regions worldwide, potentially increasing global wheat production by 37%, as demonstrated in Argentina and Chile. Worldwide wheat production and yield might potentially double if limited solely by solar radiation, but achieving this is a challenging task on a worldwide level. A 37% increase in world wheat production would suffice to meet the lower estimate of the predicted future grain demand in 2050 without the need to extend the current agricultural cropping area (Guarin et al., 2022).

Choosing the appropriate variety and growth techniques according to the environmental conditions of the year is crucial for achieving consistent yields. Wheat's morphological traits are affected mainly by the variety and environmental conditions rather than the sowing density. Productivity factors are impacted by planting density, variety, and experimental conditions (Melucă et al., 2021).

High-yielding wheat genotypes that lack stability across different settings may be recommended for specific environments where they have shown good performance. This information would assist wheat producers and breeders in choosing suitable wheat cultivars that can thrive in less fertile soil conditions. (Ljubicic et al., 2021)

Developing high-yielding, environmentally adaptable winter wheat cultivars with strong adaptive capabilities is crucial for mitigating the adverse impact of climate change on crop output and guaranteeing food security for nations. One common way for determining the traits of high-yielding varieties is to compare and analyze the parameters of different varieties using certain indicators. Analyzing data can help pinpoint physiological trends linked to high yields (Morgun et al., 2008; Morgun et al. 2019)

The objective of this paper is to present the results obtained for 14 varieties of autumn wheat studied under field conditions in ARDS Braila during two agricultural years, 2020-2021 and 2021-2022, respectively, and to study the evolution of temperatures and rainfall compared to the multiannual average of the region.

MATERIALS AND METHODS

The study was carried out during the agricultural years 2020-2021 and 2021-2022 to evaluate the capacity of 14 genotypes of domestic and foreign autumn wheat to adapt to local conditions. Yield capacity and quality elements such as hectolitre mass HM (kg/hl) and thousand kernel weight TKW (g) were studied for all varieties tested.

The study and field experiments were organized in the EC Chiscani of ARSD Braila on a carbonate vermic chernozem soil with an apparent density ranging from 1.19 g/cm^3 in the worked horizon (Ap) to 1.44 g/cm^3 in the other soil horizons.

Regarding the chemical characteristics of the soil profile in the experimental perimeter of SCDA Brăila, the content of mobile phosphorus, with values ranging from 41 ppm to 62 ppm, the soil falls into the medium and is well supplied with phosphate. Mobile potassium supply is medium, with values ranging from 98 ppm to 108 ppm, and the humus content in the worked layer is 3.04% (Trifan D. et al., 2021).

In both years of experimentation, the technology applied was classical, the basic work being ploughing. Base fertilization was done with NPK 18:48:0 complex fertilizer at a rate of 200 kg/ha, and phase fertilization was done with slow-release urea 200 kg/ha in one application, having a prolonged availability for the plants.

Sowing was done on 7 October in the first year of experimentation and on 13 October in the second year at a density of 500 germinable grains per square metre.

The experimental variants were randomized within each block to eliminate data errors variants influence and effect of neighboring.

Analysis of variance (ANOVA) was performed to examine differences and a Fisher's protected least significant difference (LSD) test was used to determine the significance of the differences among the variants results and control (p-values 0.05, 0.01, and 0.001).

RESULTS AND DISCUSSIONS

Climatic aspects

Overall, the agricultural year **2020-2021** was optimal: precipitation totaled 589 mm with a positive deviation of 147 mm from the multi-year monthly average of 442 mm (Table 1, Figure 1).

Autumn was moderately supplied from precipitation, with the months analyzed, October and November, cumulating 52.1 mm, 11.9 mm less than the two-month average.

Winter well supplied with 116.6 mm, 25.6 mm above the multi-season average of 91 mm;

Spring was evenly and well supplied from precipitation, accumulating 160.6 mm precipitation, 51.6 mm above the multi-year average of 109 mm;

Summer was rich in precipitation, with 250.9 mm accumulated and a deviation of +103.9 mm from the multiannual average; June was excessively rainy, recording 173.8 mm and a deviation of +118 mm from the multiannual monthly average.

Table 1. The main climatic elements of agricultural year 2021-2022

Climatic elements		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	Total/ Average
Precipitation (mm)	Agricultural year 2020-2021	26,6	24,5	68	41,2	7,4	31,4	53,3	75,9	173,8	40,4	36,7	10	589
	Normal	30	33	36	28	27	26	35	48	62	46	39	32	442
	Deviation ±	**-3,4**	**-8,5**	**32**	**13,2**	**-19,6**	**5,4**	**18,3**	**27,9**	**111,8**	**-5,6**	**-2,3**	-22	+147
Air Temperature (°C)	Agricultural year 2020-2021	15,1	5,7	4,7	2,2	2,4	4,7	9,4	16,7	20,2	23,9	23,4	16,9	12,1
	Normal	11,5	5,6	0,6	-2,1	-0,2	4,7	11,2	16,7	20,9	22,9	22,1	17,3	10,9
	Deviation ±	**3,6**	**0,1**	**4,1**	**4,3**	**2,6**	**0**	**-1,8**	**0**	**-0,7**	**1**	**1,3**	-0,4	+1,2

Source: Meteorological Station of Braila

Analyzing the thermal regime for the agricultural year 2020-2021, it was found that the annual average air temperature of 12.1°C exceeded the multi-year average of 10.9°C by 1.2°C, which characterizes the agricultural year as very hot (Table 1, Figure 1). In terms of temperature, autumn was warmer than normal for the area; winter was excessively warm by 3.6°C above the seasonal average; spring was cooler than normal by 0.6°C, and summer recorded a deviation of +0.5°C.

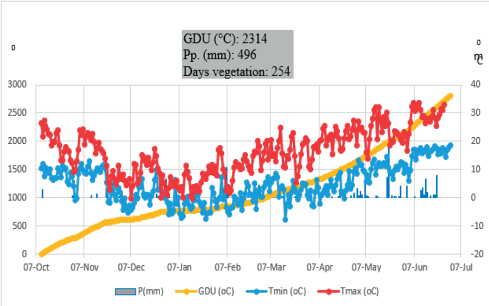

Figure 1. Presentation of climatic conditions and the sum of degrees of useful temperature during the vegetation period for wheat, at ARDS Braila, in 2022

In the 2020-2021 crop year the wheat crop completed 254 growing days in which 496 mm of precipitation accumulated and the sum of useful degrees was 2314°C.

The analysis of the rainfall regime for the 2021-2022 agricultural year allows us to specify the following features:

The autumn of 2021, through October and November, provided a rainfall of 60.2 mm, typical for this period, with a deficit of only 2.8 mm compared to the multiannual average for these months (63 mm).

Table 2. The main climatic elements of agricultural year 2021-2022

Climatic elements		Month values												Total/ Average
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	
Precipitation (mm)	Agricultural year 2021-2022	33.1	27.1	43.8	6.5	11.5	13.8	25.1	24.3	33.3	8.9	26.9	32	**286.3**
	Normal	30	33	36	28	27	26	35	48	62	46	39	32	**442**
	Deviation ±	**3.1**	**-5.9**	**7.8**	**-21.5**	**-15.9**	**-12.2**	**-9.9**	**-23.7**	**-28.7**	**-37.1**	**-12.1**	**0**	**-155.7**
Air Temperature (°C)	Agricultural year 2021-2022	10.2	8.1	2.5	1.3	4.1	3.8	11.9	18	22.7	24.8	24.9	17.9	**12.5**
	Normal	11,5	5,6	0,6	-2,1	-0,2	4,7	11,2	16,7	20,9	22.9	22.1	17.3	**10.9**
	Deviation ±	**-1.3**	**2.5**	**1.9**	**3.4**	**4.3**	**-0.8**	**0.7**	**1.3**	**1.8**	**1.9**	**2.8**	**0.6**	**+1.5**

Source: Meteorological Station of Braila

The analysis of the rainfall regime for the 2021-2022 agricultural year allows us to specify the following features (Table 2, Figure 2):

The autumn of 2021, through October and November, provided a rainfall of 60.2 mm, typical for this period, with a deficit of only 2.8 mm compared to the multiannual average for these months (63 mm).

Winter started with a wet December, with 43.8 mm of rainfall, 7.8 mm above the multiannual average. However, January and February recorded deficits of 21.5 mm and 15.9 mm, respectively. Overall, winter was also poorly supplied by rainfall, with a total deficit of 29.6 mm compared to the multiannual average of 91 mm.

The spring of 2022 brought a deficient water supply, totalling 63.2 mm, 45.8 mm below the multiannual average (the multiannual average is 110 mm). The months of March, April, and May were dry, with rainfall deficits ranging from 9.9 to 23.7 mm.

Summer 2022 started with June providing 33.3 mm of rainfall, 28.7 mm below the multi-year average of 62 mm. July recorded only 8.9 mm with a deficit of 37.1 mm, and August recorded 26.9 mm and a deficit of 12.1 mm. September was generally supplied with precipitation (32 mm)

The particularities of the thermal regime specific to the 2021-2022 agricultural year show that in autumn 2021, October was cooler than the multiannual monthly average by 1.3°C, and November was very warm, exceeding the multiannual monthly average by 2.5°C.

Winter was warm, recording a positive deviation of 3.2°C from the multiannual seasonal average. Spring 2022 as a whole, with an average temperature of 11.3°C, exceeding the spring multi-year (10.9°C) by 0.4°C, can be characterised as a near normal season. Summer 2022, with an average temperature of 24.1°C exceeded the multiannual seasonal average by 2.1°C being very warm. On the whole, the period analyzed can be characterized from a rainfall point of view as very dry throughout the agricultural year, with a total deficit of 155.7 mm compared to the multi-year average. From a thermal point of view, it is warm in winter and the first month of summer and close to normal in autumn and spring. Under the conditions of the very dry agricultural year 2021-2022 it was necessary to apply irrigation at an average rate of 400 m^3/ha.

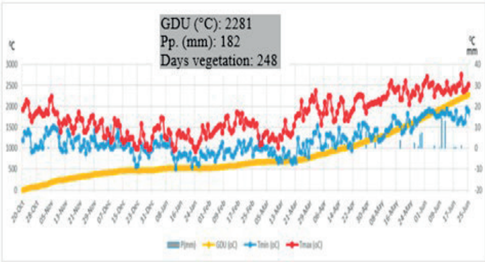

Figure 2. Presentation of climatic conditions and the sum of degrees of useful temperature during the vegetation period for wheat, at ARDS Braila, in 2022

In the 2021-2022 crop year the wheat crop completed 248 growing days in which 182 mm of precipitation accumulated and the sum of useful degrees was 2281°C.

Grain yield

Analysis of production potential for all genotypes of winter wheat studied (Table 3) showed higher values in the crop year 2020-2021 with an average yield of 6778 kg/ha under conditions of a well-supplied rainfall year, and in the crop year 2021-2022, yield levels were lower influenced by the drier crop year.

Table 3. Grain yield obtained in winter wheat genotypes, 2021-2022

Varieties	Yield 2021 kg/ha	Yield 2022 kg/ha	Yield Average kg/ha	(%)	Diff. by control	Significance
Glosa	6288	6048	6168	97.2	-175	-
Boema	5582	6121	5851	92.2	-492	ooo
Miranda	7125	6098	6611	104.2	268	-
Pitar	6540	5626	6083	95.9	-260	-
Potential	6364	6469	6416	101.2	73	-
Apache	7994	6746	7370	116.2	1027	***
Athlon	5687	5724	5706	89.9	-638	ooo
Andino	6311	6322	6317	99.6	-27	-
Altezza	7880	5467	6674	105.2	331	*
Forhand	6265	5521	5893	92.9	-450	oo
Genesi	6288	5746	6017	94.9	-326	o
Jaguar	7740	5549	6645	104.7	301	*
Iris	7036	5846	6441	101.5	98	-
Angelica	7795	5435	6615	104.3	271	*
Average (control)	**6778**	**5908**	**6343**	**Mt.**	**Mt.**	
LSD 5% = 268,31 kg/ha, LSD 1% = 357,56 kg/ha, LSD 0,1% = 465,53 kg/ha						

Yield values recorded in 2020-2021 ranged from 5582 kg/ha for the Boema variety to 7994 kg/ha for the Apache variety, and in the 2021-2022 crop year, yield values ranged from 5435 for the Angelica variety to 6746 kg/ha for the Apache variety.

The average yield recorded in the two test years varied between 5706 kg/ha for the variety and 7370 kg/ha for the variety Apache.

Compared to the average of 6343 kg/ha of the two years tests, a very significant positive result was recorded for Apache with a difference from the average of 1027 kg/ha, and significantly positive results for Altezza, Jaguar, and Angelica with differences from the average between 271 and 331 kg/ha. The varieties Boema and Athlon recorded very significant negative results compared to the average of the tests, the variety Forhand a distinctly significant negative result, and the variety Genesi a significant negative result.

Table 4. Thousand-kernel weight (TKW) results 2021-2022

Varieties	TKW 2021 (g)	TKW 2022 (g)	TKW Average (g)	(%)	Diff. by control	Significance
Glosa	44.77	44.73	44.75	109.4	3.83	***
Boema	44.10	41.50	42.80	104.6	1.88	**
Miranda	46.43	40.73	43.58	106.5	2.66	***
Pitar	44.36	41.37	42.87	104.8	1.95	**
Potential	37.86	36.23	37.05	90.5	-3.87	ooo
Apache	36.53	35.80	36.16	88.4	-4.75	ooo
Athlon	42.53	38.33	40.43	98.8	-0.49	-
Andino	47.07	41.60	44.34	108.4	3.42	***
Altezza	40.69	43.00	41.85	102.3	0.93	-
Forhand	44.33	42.33	43.33	105.9	2.41	***
Genesi	34.98	35.33	35.16	85.9	-5.76	ooo
Jaguar	39.26	38.81	39.04	95.4	-1.88	oo
Iris	38.29	37.67	37.98	92.8	-2.94	ooo
Angelica	43.86	43.23	43.55	106.4	2.63	***
Average (control)	**41.79**	**40.05**	**40.92**	**Mt.**	**Mt.**	
LSD 5% = 1.25 g, LSD 1% = 1.67 g, LSD 0,1% = 2.17 g						

Thousand kernel weight (TKW) values for the analyzed autumn wheat varieties (Table 4) ranged between 34.98 and 47.07 g in 2021, with the highest value recorded for the variety Andino. In 2022, TKW values ranged between 35.33 and 44.73 g, with the best result recorded for the variety Glosa.

The average TKW values over the two years of testing ranged from 35.16 g for Genesi to 44.75 g for Glosa, a Romanian variety grown in large areas in the country and with superior stability and quality.

The average of 2021 and 2022 TKW was 40.92 g, and very significant positive results compared to the average were recorded for Glosa, Miranda, Andino, Forehand, and Angelica, and distinctly significant positive results for Boema and Pitar. Highly significant negative values were also recorded for Potential, Apache, Genesi, and Iris, and a distinctly significant negative result was recorded for Jaguar.

In 2021, **the hectolitre mass (HM)** values for the autumn wheat varieties analyzed (Table 5) ranged from 69.23 to 76.73 kg/hl, with the highest value recorded for the variety Glosa. In 2022, the HM values ranged from 79.10 to 84.43 kg/hl, with the best result recorded for the variety Boema.

Table 5. Hectolitre mass results 2021-2022

Varieties	HM 2021 (kg/hl)	HM 2022 (kg/hl)	HM Average (kg/hl)	(%)	Diff. by control	Significance
Glosa	76.73	83.87	80.30	104	3.07	***
Boema	76.60	84.43	80.52	104.2	3.28	***
Miranda	74.90	81.67	78.28	101.4	1.05	*
Pitar	76.23	83.53	79.88	103.4	2.65	***
Potential	73.13	79.10	76.12	98.6	-1.12	°°
Apache	72.87	79.37	76.12	98.6	-1.12	°°
Athlon	71.87	80.37	76.12	98.6	-1.12	°°
Andino	72.90	81.63	77.27	100	0.03	-
Altezza	74.40	81.27	77.83	100.8	0.60	-
Forhand	74.20	81.40	77.80	100.7	0.57	-
Genesi	69.23	78.43	73.83	95.6	-3.40	°°°
Jaguar	70.00	80.20	75.10	97.2	-2.13	°°°
Iris	72.10	80.27	76.18	98.6	-1.05	°
Angelica	72.00	79.87	75.93	98.3	-1.30	°°
Average (control)	**73.37**	**81.10**	**77.23**	**Mt.**	**Mt.**	
LSD 5% = 0.86 kg/hl, LSD 1% = 1.11 kg/hl, LSD 0,1% = 1.45 kg/hl						

Average HM values over the two years of testing ranged from 73.83 g in Genesi to 80.52 g in Boema.

The average HM in 2021 and 2022 was 77.23 g, and there were very significant positive results compared to the average in Glosa, Boema, and Pitar and significant in Miranda. There were also very significant negative values compared to the average for Genesi and Jaguar, distinctly significant negative values for Potential, Apache, Athlon, and Angelica, and a significant negative result for Iris.

CONCLUSIONS

The crop year 2020-2021, characterized by well-supplied rainfall, has exhibited higher grain yield than the drier crop year 2021-2022. This highlights the significant influence of environmental factors, particularly rainfall, on wheat yield.

Varieties such as Apache consistently showed higher yields across both years, while others like Boema and Angelica exhibited lower yields. This suggests genetic variability in yield potential among the studied wheat varieties.

Apache showed a very significant positive deviation from the average yield of the two test years, indicating its superior performance. Conversely, varieties like Boema, Athlon, and Forhand demonstrated significant negative deviations from the average, indicating poorer performance.

TKW values varied among different varieties and years, with some varieties consistently exhibiting higher TKW, such as Glosa and Andino, while others, like Genesi and Jaguar, had lower TKW. This indicates varietal differences in seed size and density.

Similar to TKW, HM values varied over many years. Glosa and Boema consistently showed higher HM values, while Genesi and Jaguar had lower values. This suggests differences in kernel density and grain quality among varieties.

Glosa consistently exhibited superior performance in terms of both TKW and HM, indicating its stability and quality across different environmental conditions. This suggests that Glosa could be a promising variety for cultivation due to its consistent performance.

The variations observed in grain yield, TKW, and HM among different varieties underscore the importance of genetic factors and environmental adaptation in determining wheat productivity and quality.

In summary, the study highlights the significant influence of genotype and environmental factors on wheat yield and quality, with certain varieties showing superior performance across multiple metrics. These findings could be valuable for wheat breeding programs and agricultural practices to improve productivity and resilience in varying environmental conditions.

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