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STUDIES ON THE ADAPTABILITY OF SOME ROMANIAN VARIETIES OF AUTUMN WHEAT TO THE CURRENT CLIMATE CHANGES IN NORTHERN BĂRĂGAN

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Abstract

The paper presents the climate evolution in Northern Baragan Plain and the impact of current climate changes on the winter wheat crop, with the formulation of some recommendations for farmers in this agricultural area. Five Romanian varieties of wheat were studied, which are multiplied at the Agricultural Research and Development Station Braila, in the last five agricultural years, which were the most difficult because of climate changes, due to the pedological drought recorded in Northern Baragan Plain. Atmospheric heat negatively influences the physiology of agricultural plants, through deficiencies in root absorption and photosynthesis, increasing evapotranspiration and having the effect of drying leaves, deficient pollination of flowers and lack of fruiting, i.e. seed formation. The study carried out aims to support the revitalization of the Romanian seed market to ensure better access for farmers to the most efficient seed material in the zonal pedo-climatic conditions. Recommendations were formulated for choosing the best performing wheat varieties, in the pedo-climatic conditions of Northern Baragan.

Key words: *wheat, productivity, climate changes, pedological drought, wheat varieties.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is considered the most important agricultural species worldwide and in Europe, as it occupies the largest cultivated area and has the largest share in human nutrition (Shewry et al., 2013).

In the world, out of all 195 sovereign and independent states, wheat is cultivated in over 100, having an essential importance in the food industry by producing flour from caryopses, in the manufacture of cellulose by processing plant residues remaining after harvesting, as well as in animal feeding with bran remaining after the milling industry or as organic fertilizer by processing all residues remaining after the cultivation and processing of wheat (Shewry & Hey, 2015).

It is statistically proven that in the European Union wheat is the main cereal crop, obtaining more than half of the cereal production annually. The remaining 50% of the cereal production in the EU is represented by maize and barley (17% each) and the rest brings together cereals grown on smaller areas, such as rye, oats, triticale, and spelt (https://agriculture.ec.europa.eu/farming/crop-productions-and-plant-based-products/cereals_ro). Climate change manifested in the last 20 years has had a series of repercussions on wheat production, both at the global, European, and national levels, but especially in South-Eastern Romania, where soil aridification has become increasingly evident.

According to current statistics, in 2024, wheat was cultivated in Romania on an area of 2.19 million ha, and the average yield was 4.99 t/ha (Figure 1; https://ogor.ro/prognoza).

Under current climate change conditions, studies have been conducted on the physiology of wheat plants, leading to the conclusion that the growing season of wheat will gradually decrease, due to the increase in temperature and solar radiation rates in the current situation (Olesen et al., 2011; Valizadeh et al., 2014). In 2016, Bing et al. demonstrated that global wheat production could decline by 4.1-6.4% if global temperatures increased by 1°C. This would mean that of the more than 700 million tons of wheat produced annually worldwide and processed into various products for human and animal consumption, if there were a reduction of just 5% in production, the estimated loss would be 35 million tons each agricultural year.

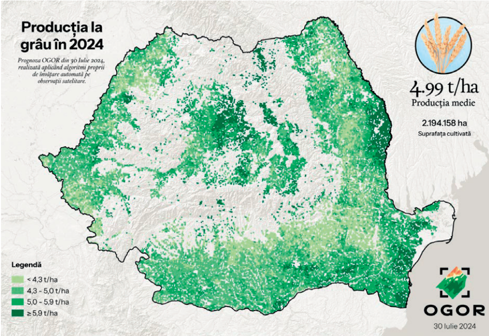

Figure 1. The map of wheat production in 2024 in different areas of Romania

From a temperature point of view, the physiological active zone for wheat is delimited by the temperature of 5ºC, and the requirement for the total sum of useful temperature degrees is 1800 - 2000 GDU (Drăguleasa et al., 2023). In terms of moisture, wheat crop has moderate and balanced requirements during the growing season, needing a minimum of 225 mm from sowing to maturity, but the average optimum being 600 mm. From a soil point of view, wheat is the cereal with the highest requirements, preferring a loamy or clay-loamy texture, with increased permeability, neutral pH, high fertility and a groundwater depth of over 90-100 cm, as it cannot tolerate soils where water stagnates, or sandy, too acidic or too alkaline soils. Planting density is another factor affecting crop yield (Zimeng et al., 2024). The paper presents the climatic evolution of the last five years and the status of wheat production for seeds, affected by these conditions, for the selection of the most performing genotypes for cultivation in this area.

MATERIALS AND METHODS

The research was carried out in the Chiscani Experimental Centre according to the satellite map in the Figure 2.

At the Chiscani Experimental Centre, climatic data are monitored with a meteorological station every agricultural year, and in 2023, a soil profile was carried out for a more detailed pedoclimatic characterization.

The diagnosis of the soils and their classification in the classification system was carried out in accordance with the Romanian Soil Taxonomy System (SRTS-2012), considering the morphological properties of the soils. For physical and chemical characterization of the soil, soil samples were collected for laboratory analysis, for samples in natural and modified settings.

Figure 2. The satellite map with the Experimental Centre Chiscani

The collection of samples from the pedological profile was carried out on genetic horizons and sub horizons, respectively 6 agrochemical soil samples, 12 soil samples in undisturbed structure.

RESULTS AND DISCUSSIONS

The soil profile characterizes the soil as CALCAREOUS CHERONZIOM ALUVIC (SRTS, 2012) located in Experimental Centre Chiscani from Braila Plain (Northen Bărăgan), at Latitude: N 45.20363, and Longitude: E 027.92138, with absolute altitude: 20 m, and the main relief form is plain, with horizontal or quasi-horizontal surface (with predominantly less than 2% slope) with unevenness.
Parental materials are loess and carbonate loess deposits, and the groundwater depth: > 5 m.
Overall natural drainage is good, humidity regime is ustic-seric, and temperature regime is mesic.
Soil landscape: Alluvial calcareous chernozems are associated with saline alluvial chernozems (Figure 3).

Figure 3. Images of the soil profile from CE Chiscani of the Agricultural Research and Development Station Braila, Romania

Morphological characteristics of soil (SRTS, 2012) are:
Apk 0-11 cm: clay, very dark brown (10YR 2/2) and very dark gray, brown (10YR 3/2) in dry state, structure modified by cultivation, reavon, weakly compact, weakly cohesive, weakly plastic, hard in dry state, thin roots frequent; coprolites frequent, moderate effervescence, gradual transition.
Aptk 11-32 cm: clay, very dark brown (10YR 2/2) and very dark gray, brown (10YR 3/2) in dry state, grain structure medium developed, reavon, moderately compact, weakly cohesive, weakly plastic, friable in wet state, hard in dry state, thin roots rare, coprolites frequent, strong effervescence, wavy transition.
Am/Ck 32-48 cm: dusty clay, very dark grey, brown (10YR 3/2) in wet state and dark grey, brown (10YR 4/2) in dry state, poorly developed grain structure, loose, poorly compact, friable in wet state, hard in dry state, weakly cohesive, weakly plastic, very strong effervescence, gradual wavy transition.
Ck 48-67 cm: dusty clay, dark grey, brown (10YR 4/2) in wet state and grey, brown (10YR 5/2) in dry state, massive, loose, hard, weakly cohesive, weakly plastic, frequent friable $CaCO_3$ concretions, violent effervescence, gradual straight transition.
Cca1 67-100 cm: dusty clay; yellowish brown (10YR 5/6) in the wet state and brownish yellow (10YR 6/6) in the dry state, massive, loose, weakly cohesive, weakly plastic, frequent friable $CaCO_3$ concretions, violent effervescence, gradual wavy transition.
Cca2 100-120 cm: dusty clay, pale yellow (10YR 7/4) in the wet state and yellow (10YR 7/6) in the dry state, massive, wet, weakly cohesive, weakly plastic, violent effervescence.
The physicochemical properties of the soil profile are highlighted in Tables 1 and 2.
Figure 4 shows the evolution of average annual temperatures, for each agricultural year, in Northern Baragan Plain, observing a significant increase compared to the multiannual average, in the last five agricultural years.

Table 1. Physical properties of the soil profile from the Chiscani Experimental Centre, Braila County

Horizon	UM	Apk	Aptk	Am/Ck	Ck	Cca1	Cca2
Deep	cm	0-11	11-32	32-48	48-67	67-100	100-120
wi	% g/g	15.1	15.9	16.7	11.7	10.4	9.7
Dawi	g/cm^3	1.18	1.38	1.18	1.17	1.31	1.28
RP	Kgf/cm^2	14	25	18	19	32	27
IC	-	0.0090	0.0044	0.0042	0.0064	0.0077	0.0078
ksat	mm/h	6.86	8.57	35.16	54.36	14.92	3.60
PTwi	% v/v	55.5	48.1	55.5	56.1	50.8	51.9

Table 2. Chemical properties of the soil profile from the Chiscani Experimental Centre, Braila County

Horizon Deep	UM cm	Apk 0-11	Aptk 11-32	Am/Ck 32-48	Ck 48-67	Cca1 67-100	Cca2 100-120
pH	pH unit	8.15	8.19	8.32	8.37	8.43	8.59
Humus (Cx1.72)	%	2.86	1.91	1.37	1.07	0.89	0.48
N total	%	0.156	0.136	0.103	0.091	0.064	0.044
P AL	mg/kg	115	74	36	25	21	15
P AL corected	mg/kg	50	31	13	8	6	15
Kmobile	mg/kg	174	257	160	255	201	169
Residue	mg/kg	49	51	44	41	43	40

Compared to the period 1945 – 2000, with average thermal values mostly below 11°C (average for 118 years), from 2000 to the present, thermal values have increased progressively, at a rate of 0.05°C/year.

Starting from this rate, a perspective of an increase in the average temperature by 0.4°C by 2025 (respectively reaching the average value of 12.1°C), and by 1.6°C in 2050 (respectively reaching the average value of 13.3°C) results (Patriche et al., 2024).

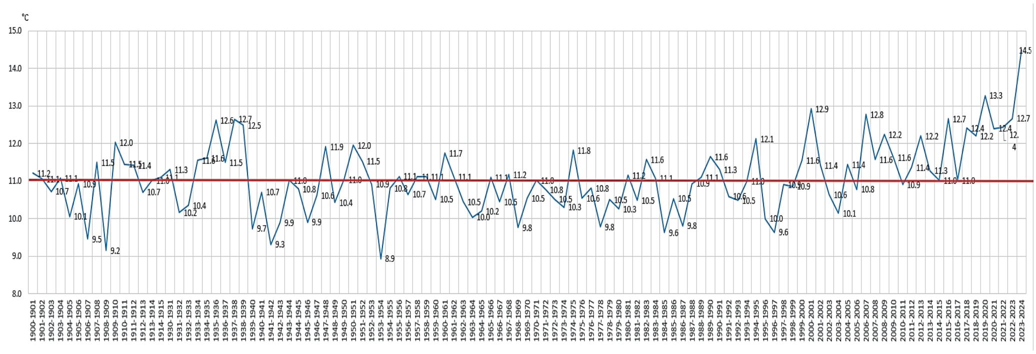

Figure 4. Dynamics of average annual temperatures in Northern Baragan Plain, from 1900 until 2024

Solar radiation has high values, of 125 kcal/cm^2/year, being linked to the duration of sunshine which in the areas of interest, namely in Chiscani area, records a number of 2200 h/year (only 75 days in a year without sun). During the year, the average monthly temperatures register a continuous increase from February to July, then a decrease from August to January, highlighting the thermal contrasts between winter and summer.

The Figure 5 presents the situation of annual cumulative precipitation over the last 20 years in Northern Baragan Plain, compared to potential evapotranspiration.

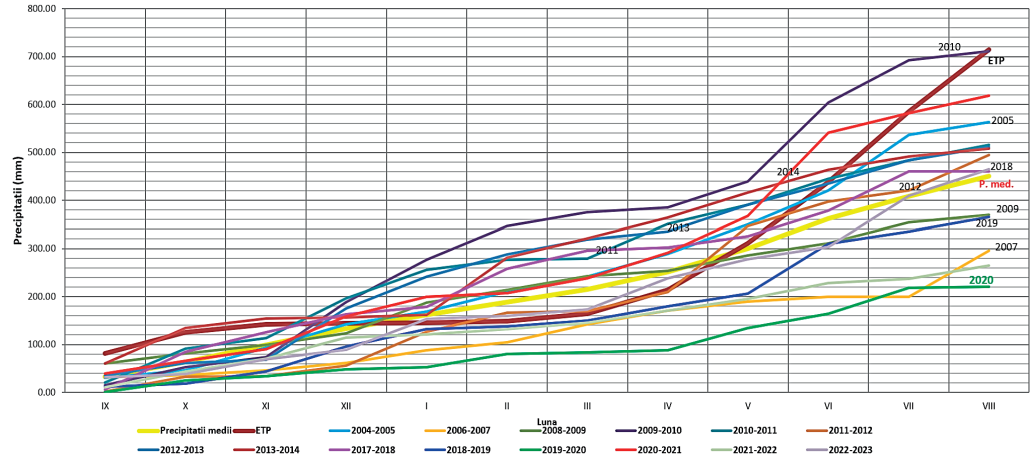

Figure 5 Dynamics of annual precipitation cumulated over the last 20 years in Northern Baragan Plain

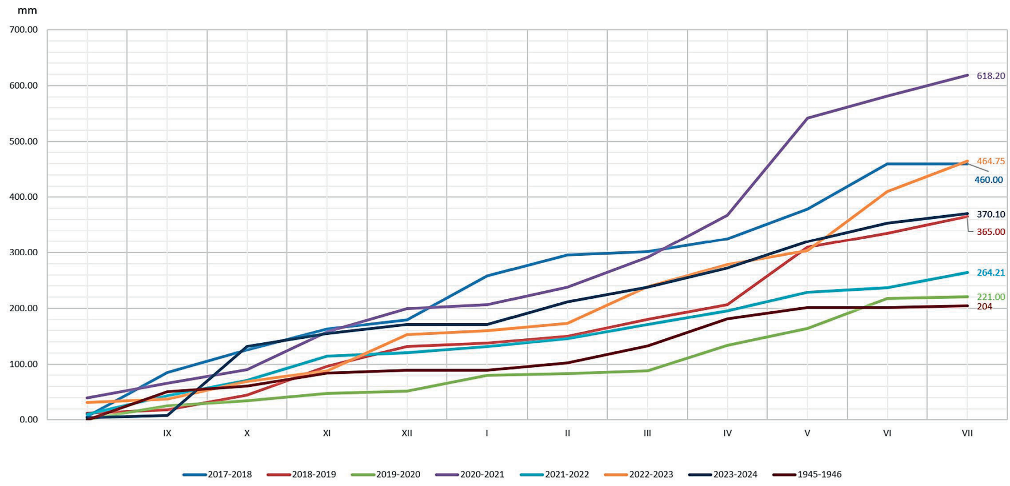

Figure 6. The situation of annual cumulative precipitation in the last 7 years, compared to the driest agricultural year 1945-1946

The driest agricultural year in historical data was the agricultural year 1945-1946, in which the cumulative precipitation was 204 mm, and Figure 6 presents the graph with the cumulative precipitation in the last 7 agricultural years, noting that the agricultural year 2019-2020 accumulated 221 mm, followed by the agricultural year 2021-2022 with 264.2 mm, 2018-2019, with 365 mm and 2023-2024, with 370.1 mm.

A wide range of adaptation options exists in most European regions to mitigate many of the negative impacts of climate change on crop production in Europe (Olesen et al., 2011).

Climatic conditions in the last 5 years have drastically affected wheat production due to soil drought, as well as biotic and abiotic stress. Thus, high atmospheric temperatures, lack of precipitation, as well as the need for irrigation in some years even from March, due to the water deficit in the soil, have affected the physiology of wheat plants and increased the attack of diseases and pests in some vegetation phenophases.

The average wheat yield obtained within the Agricultural Research and Development Station of Braila, in the last five years, ranged between the minimum value of 2166 kg/ha in the agricultural year 2019-2020 and the maximum value of 6174 kg/ha in the agricultural year 2020-2021 (Figure 7).

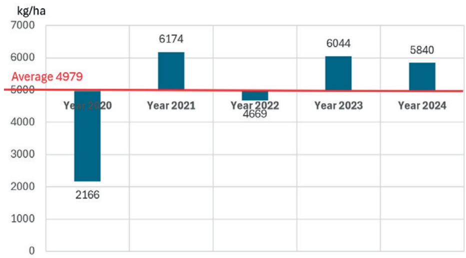

Figure 7. The wheat average yield in the last five year, at ARDS Braila

In 2020, the wheat yield was very low for all varieties tested, and compared to the average of experience, by 2166 kg/ha, the best results were obtained by the variety Ursita, followed by Miranda and Voinic, with insignificant differences, from 151 to 49 kg/ha, and Glosa obtained the lowest production compared to the average, with a difference of -271 kg/ha (Figure 8).

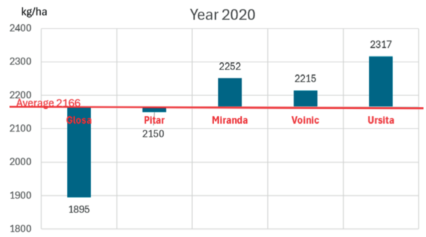

Figure 8. Wheat yield obtained by the five varieties tested in agricultural year 2019-2020

In 2021, compared to the experience average of 6174 kg/ha, the best production results were obtained by the Miranda variety, with a difference of +926 kg/ha and the Pitar variety, with a difference of +686 kg/ha, the other three varieties having below average production, the weakest variety being Glosa, followed by Voinic and Ursita (Figure 9).

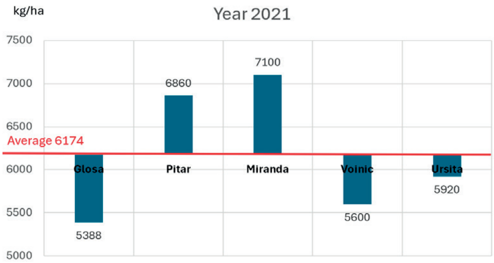

Figure 9. Wheat yield obtained by the five varieties tested in agricultural year 2020-2021

In 2022, the best production results compared to the average experience were obtained by the Miranda variety and the Pitar variety, with differences of +2294 kg/ha for Miranda and +1081 kg/ha for Pitar (Figure 10).

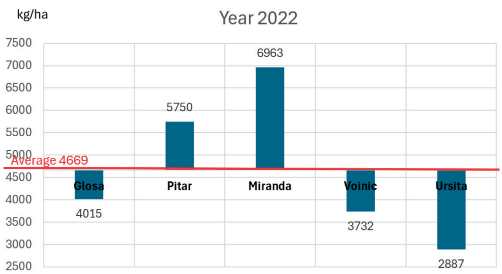

Figure 10. Wheat yield obtained by the five varieties tested in agricultural year 2021-2022

For 2023, the most productive wheat variety was Glosa, followed by Miranda and Voinic, with production differences compared to experience average of +826 kg/ha for Glosa, +556 kg/ha for Miranda, and +536 kg/ha for Voinic (Figure 11).

In 2024, the best production results for winter wheat were obtained by the Miranda variety, with a difference of +610 kg/ha, followed by the Glosa and Ursita varieties, with a difference of +260 kg/ha compared to the average of the experience. The lowest production compared to the average of the experience was obtained by the Pitar variety in 2024, with a difference of -1140 kg/ha (Figure 12).

Figure 11. Wheat production obtained by the five varieties tested in agricultural year 2022-2023

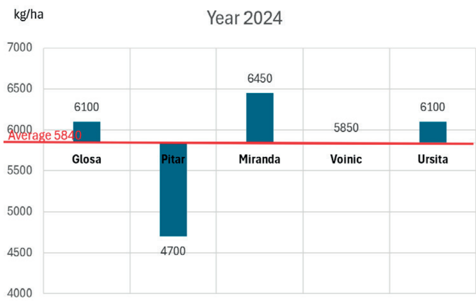

Figure 12. Wheat production obtained by the five varieties tested in agricultural year 2023-2024

The average wheat yield over the last 5 years was 4979 kg/ha, and the best production results were obtained by the Miranda variety, compared to the average over the last five years, with production values in the range of 7100 kg/ha in 2021, 6963 kg/ha in 2022, 6600 kg/ha in 2023, and 6450 kg/ha in 2024 (Figure 13).

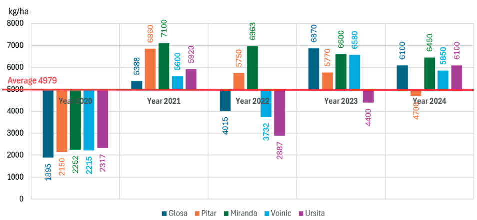

Figure 13. The average productions of the five wheat varieties in the last five years at ARDS Brăila

The common winter wheat variety MIRANDA was obtained at INCDA Fundulea from the complex hybrid combination ERYT26221/ 96869G1-// GLOSA by individual selection following rapid homozygosity through the *Zea* system (https://www.incda-fundulea.ro/fise/miranda.pdf).

CONCLUSIONS

- Atmospheric heat negatively influences the physiology of wheat plants, through deficiencies in root absorption and photosynthesis, increasing evapotranspiration and resulting in leaf drying, poor pollination of flowers and lack of fruiting, i.e. seed formation.
- On the other hand, where intensive irrigation is used, disease and pest attacks frequently occur, weed invasion occurs and implicitly technology costs increase through the application of irrigation and phytosanitary treatments.
- Even if satisfactory production is maintained on irrigated lands, economic and operational challenges significantly limit the profitability of wheat cultivation for seed production.
- In the experience with five winter wheat varieties multiplied at ARDS Brăila in the last five agricultural years, the best performing variety proved to be Miranda, with better adaptation to biotic and abiotic stress conditions.

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