CLIMATIC CHARACTERIZATION OF THE AGRICULTURAL AREA FROM THE MĂRCULEȘTI AGRICULTURAL RESEARCH-DEVELOPMENT STATION

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Abstract. *Mărculești Agricultural Research-Development Station is located in the south-east of the country, in the center of the Bărăgan plain. Throughout the years, it has developed and perfected the cultivation technologies for cereals, technical plants and fodder, in the pedoclimatic conditions of the area. According to Köppen climatic classification, Bărăgan region is part of the BSax province, the mean value for annual temperature is 10.9^{0}C and the mean annual value for precipitation is 480 mm. Fertile soils of chernozem type with a relatively good supply of nutrients are characteristic of this region. The present paper presents the climatic evolution in the South-eastern part of Bărăgan, based on comparison of the values of temperature and precipitation measured at the location during 2017-2022 with the multiannual mean values of these parameters. The results of the data analysis showed an increase in temperature and a decrease in precipitation, which are most likely to have negative effects on yields. Precipitations are of great importance for the autumn cultures because they provide the quick and uniform growing of the plants, and they ensure the accumulation of moisture in the soil during the winter season. Considering the obtained results, the following recommendations can be made: changes of the agricultural technology used for the main cultures in Bărăgan - autumn cereals, rape, maize and sunflower, early spring sowing, and the choice of hybrids cultivars with a medium vegetation period.*

Keywords*: climatic characterization, temperature, precipitations*

INTRODUCTION

The Mărculești Agricultural Research-Development Station is situated in the center of Southern Bărăgan, in the N-E part of Călărași county, being located on the geographical coordinates of 27º30′ east longitude, 46º25′ north latitude and at an altitude of 40 m. From an agro-ecosystem point of view, the territory of the station belongs to the Romanian Plain, being almost completely included in the steppe zone, the results obtained within the station being applicable both in the southern area of Bărăgan and in the central area.

The relief is characteristic of the area of the Romanian Plain with interfluvial portions (ACHIM, 2020), bordered by deep valleys with wide meadows and terraces in the southeastern part, being poorly traversed by secondary valleys causing the appearance of smooth areas but with numerous hollows (GHERGHINA et al., 2008).

In the northeast part, where the areas are drier, the roofs are missing and a slightly wind-swept relief is characteristic.

The Hagienilor plain located in the eastern part of the southern Bărăgan presents smoother land surfaces, while in the central Bărăgan there are lakes formed in old fluvial firths (Lake Fundata, Strachina) or in old depressions of the relief (Lake Tătaru, Colțea, etc.).

According to a horizontal zonality of soils, Bărăgan is part of cernisols zone (STĂNILĂ AND DUMITRU, 2016). The association of different types of soils is characteristic near Mărculești Research Station. The predominant association consists of loamy chernozems formed on loess and leached chernozims, in hollows, characteristic of smooth areas with deep groundwater.

Between the interfluves, typical chernozems predominate due to the existing drainage, and in areas with relatively poor drainage subtypes of wet, phreatic chernozems appear. Depending on the area, the soil texture is loamy, for the most part, loamy-sandy, in the N-E part, carbonate, in the eastern part where carbonates are present on the surface of the soil, and to the west they are located in the depth of the layer, a typical leached chernozem type soil (22.3%) being present. The leached chernozem also occupies most of the hollows and interdunes, but clay-iluvial chernozems are also found, where the drains are more pronounced.

Meadow soils occupy significant areas (21.0%), especially alluvial soils, with different structures, degrees of glaciation and salinization (GHERGHINA et al., 2010).

Due to the strong winds from the Romanian Plain, in the eastern part, where the area is more arid, there is a narrow strip where loamy soils with loamy-sandy texture (0.5%) predominate.

Ialomiței Meadow, which separates the southern Bărăgan from the central one, has extensive areas with salinized/glazed soils.

Psammosols or mollic-cambic soils, with a sandy texture (0.6%), due to the dune relief and sandy deposits, are also found in small areas. Eroded chernozems and medium-textured regosols are found on the coasts, towards the valleys.

Vegetation is characteristic of the area and of the soil derived from the parent material – loess, associations of *Festuca valesiaca* L., *Cleistogenes serotina* L., *Artemisia austriaca* L., *Agropyron pectiniforme* L., *Stipa capillata* L., *Chrysopogon Grylusa* L., *Chrysanthemus millefolium* L., clumps of *Prunus spinosa* L., *Amygdalus nana* L., *Cerasus fructicosa* L. and *Quercus pubescens* L. being dominant.

In the meadow areas, *Poa pratensis* L. and *Agropyron repens* L. predominate, with marshy areas and halomesophilp vegetation, with stands of *Populus sp.*, *Salix sp.*, *Ulmus campestris*, *Quercus robur*, single or mixed.

With the exception of the meadows, the ground water is located at a great depth (ENEA AND CORLATEANU, 1974) and in the last period, due to the climatic conditions and the lack of precipitations, it is necessary to irrigate the crops in order to obtain satisfactory productions (VRÎNCEANU et al., 2009).

MATERIAL AND METHODS

The data used were recorded and transmitted by the sensors of the automatic weather station for agriculture, composed of the pieces of equipment from Adcon Telemetry, which also includes the combined temperature and relative air humidity sensor and the rain gauge for measuring the intensity of precipitation. The sensors are powered for a short period of time and read by the RTU (Remote Telemetry Unit) every 3 minutes. Every 15 minutes, the RTU calculates an average value from the 5 measurements made in that interval. Every hour, the RTU transmits to the Data Presentation Server, through the data concentrator (gateway), the 4 average values calculated for each parameter.

The Adcon TR1 measures temperature and has a measuring range from -40ºC to 60ºC with accuracy of ± 0,2ºC. It was developed in order to offer a highly accurate sensor with excellent long-term stability. A professional radiation shield protects the sensor from direct sunlight and provides sufficient ventilation. Solid UV resistant elements reflect radiation on their white surface, while the black inside absorbs accumulating heat.

The precipitation measurements are done by a double tipping bucket system that's factory calibrated to remain within a < 2% accuracy in rain falls up to 60mm per hour. The steep angle of the buckets makes water run of quickly and thus prevents the build-up of residue, like sand or dust in the buckets.

RESULTS AND DISCUSSIONS

According to Köppen-Geiger climate classification (KOTTEK et al., 2006), Bărăgan is part of the BSax province, which is described as dry steppe with hot summers and a maximum amount of precipitations in spring or at the beginning of summer and a lack of precipitations in the end of summer. From the recorded climate data, the average annual temperature is 10.9ºC, the average annual precipitation is 480 mm, the evapotranspiration is 700 mm, and the aridity index is 23.

Analyzing the climate data recorded at Mărculești, regarding the monthly and annual temperatures of the last 5 years, a temperature increase of 1.9ºC is observed compared to the multiannual average of 10.9ºC (Table 1).

The 2019/2020 agricultural year was the warmest year, with an average temperature of 13.5°C, the deviation from the multiannual average being 2.6°C (Table 1).

An increase in average annual temperatures is observed in all studied agricultural years, with deviations between 1.5ºC (2018/2019, 2021/2022) and 2.6ºC (2019/2020) (Table 1).

Analyzing the monthly climatic conditions, February month stands out, with a deviation from the multiannual average of 3.6°C, being characterized as the warmest month of the 2017/2022 period. Next month is January, with a deviation from the multiannual average of 3.1°C and by December with a deviation of 2.6°C from the multiannual average (Table 1).

From the data presented in Table 1, it can be seen that the average temperatures recorded in the 5 studied agricultural years are positive in all calendar months. In December, January and February, the average temperatures for the period 2017/2022 were positive, with deviations between 2.6°C (December) and 3.6°C (February) from the multi-year average.

Table 1

Monthly and annual temperatures (^{0}C) recorded at Mărculești between 2017-2022 and the multi-year average

MONTH	Agricultural year					Normal value	Mean value 2017/2022	Deviation
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022			
IX	20.1	19.1	19.3	20.9	17.6	**17.5**	**19.4**	**1.9**
X	13.1	13.7	13.9	15.7	10.5	**11.4**	**13.4**	**2.0**
XI	8.4	5.3	11.1	5.5	8.2	**5.8**	**7.7**	**1.9**
XII	3.8	-0.2	4.3	4.9	2.8	**0.5**	**3.1**	**2.6**
I	1.1	-0.6	1.0	2.5	1.5	**-2.0**	**1.1**	**3.1**
II	1.4	3.8	4.8	2.9	3.9	**-0.2**	**3.4**	**3.6**
III	3.2	9.0	8.9	4.8	3.2	**4.7**	**5.8**	**1.1**
IV	15.0	10.8	11.6	9.8	12.0	**11.0**	**11.8**	**0.8**
V	19.0	17.3	16.6	17.1	17.4	**16.9**	**17.5**	**0.6**
VI	21.9	23.3	21.4	20.4	22.2	**20.4**	**21.8**	**1.4**
VII	22.4	22.7	24.1	24.4	24.7	**22.6**	**23.7**	**1.1**
VIII	24.3	24.4	24.7	24	24.7	**22.3**	**24.4**	**2.1**
Annual Average	**12.8**	**12.4**	**13.5**	**12.7**	**12.4**	**10.9**	**12.8**	**1.9**

Maximum monthly and annual temperatures (°C) recorded at Mărculești in the period 2017/2022, compared to the multiannual average, shows a deviation of 1.4°C (Table 2).

From a thermal point of view, the month of January recorded the highest value, with a deviation from the multiannual average of 2.7°C, followed by February with a deviation of

2.3ºC and the month closest to normal was April, with a deviation from the multiannual average of 0.2°C (Table 2).

Table 2

The maximum monthly and annual temperatures (^{0}C) recorded at Mărculești between 2017-2022 and the multi-year average

MONTH	Agricultural year					Normal value	Mean value 2017/2022	Deviation
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022			
IX	25.5	25.9	26.6	29.8	24.4	**24.2**	**26.4**	**2.2**
X	19.2	20.4	21.5	21.1	16.1	**18.7**	**19.7**	**1.0**
XI	8.9	7.9	8.1	9.8	13.1	**9.2**	**9.6**	**0.4**
XII	7.7	2.3	8.3	7.7	4.8	**5.7**	**6.2**	**0.5**
I	4.2	2.2	5.9	6.0	5.7	**2.1**	**4.8**	**2.7**
II	6.3	8.3	10.3	7.1	10.5	**6.2**	**8.5**	**2.3**
III	8.3	16.0	14.6	10.1	9.4	**10.7**	**11.7**	**1.0**
IV	21.4	16.1	19.7	15.3	18.1	**17.9**	**18.1**	**0.2**
V	25.3	23.0	22.7	22.4	24.2	**23.0**	**23.5**	**0.5**
VI	27.0	28.5	27.7	29.6	28.3	**25.2**	**28.2**	**3.0**
VII	27.0	28.3	26.6	24.4	31.5	**26.2**	**27.6**	**1.4**
VIII	33.0	31.6	29.6	22.2	31.1	**27.8**	**29.5**	**1.7**
Annual Average	**17.8**	**17.5**	**18.5**	**17.1**	**18.1**	**16.4**	**17.8**	**1.4**

Analyzing the minimum monthly and annual temperatures (°C) recorded at Mărculești in the period 2017/2022 and the multi-year average, an increase of 0.7°C compared to the multi-year average can be observed (Table 3).

The highest values were recorded in September, with a deviation from the multiannual average of 2.0°C, and in February there was a decrease in minimum temperatures, with a deviation from the multiannual average of -0.3°C (Table 3).

March recorded average minimum temperatures of 1.1°C, with a deviation from the multi-year average of 0.1°C, being the month closest to normal in terms of average minimum temperatures recorded in the 2017/2022 agricultural years (Table 3).

Table 3

The minimum monthly and annual temperatures (^{0}C) recorded at Mărculești between 2017-2022 and the multi-year average

MONTH	Agricultural year					Normal value	Mean value 2017/2022	Deviation
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022			
IX	13.1	12.6	17.6	14.5	10.4	**11.6**	**13.6**	**2.0**
X	8.6	8.6	5.8	10.5	5.6	**6.0**	**7.8**	**1.8**
XI	4.1	2.7	2.4	1.9	5.5	**2.1**	**3.3**	**1.2**
XII	2.4	-2.2	1.2	2.6	-0.4	**0.2**	**0.7**	**0.5**
I	-3.2	-2.5	-2.4	-0.9	-2.2	**-2.8**	**-2.2**	**0.6**
II	0.8	0.2	0.9	-1.0	-1.7	**0.1**	**-0.2**	**-0.3**
III	1.1	2.8	3.9	0.0	-2.3	**1.0**	**1.1**	**0.1**
IV	7.9	5.5	3.2	3.6	5.9	**4.8**	**5.2**	**0.4**
V	12.7	12.4	11.4	11.2	10.7	**11.7**	**11.7**	**0.0**
VI	15.9	17.4	14.6	15.5	15.9	**15.0**	**15.9**	**0.9**
VII	18.7	16.3	17.3	14.6	17.5	**16.4**	**16.9**	**0.5**
VIII	17.3	17.2	17.0	15.8	18.8	**17.0**	**17.2**	**0.2**
Annual Average	**8.3**	**7.6**	**7.7**	**7.4**	**7.0**	**6.9**	**7.6**	**0.7**

Regarding the pluviometric regime, the multiannual average amount of precipitation for the area of influence of the Research Station Mărculeşti was 495.3 mm, unevenly distributed over the entire vegetation period of the plants.

Table 4

Monthly and annual precipitation (mm) recorded at Mărculești between 2017-2022 and the multi-year average

MONTH	Agricultural year					Normal value	Mean value 2017/2022	Deviation
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022			
IX	2.0	10.4	4.4	29.6	6.0	**37.9**	**10.5**	**-27.4**
X	99.0	4.4	44.0	30.0	53.2	**35.6**	**46.1**	**10.5**
XI	57.0	39.6	28.0	22.2	26.0	**37.9**	**34.6**	**-3.3**
XII	48.5	33.4	7.2	69.0	42.8	**38.6**	**40.2**	**1.6**
I	32.8	30.6	0.8	66.6	3.4	**33.3**	**26.8**	**-6.5**
II	44.4	5.4	30.2	8.2	14.0	**24.1**	**20.4**	**-3.7**
III	30.4	12.6	4.2	15.6	5.0	**29.2**	**13.6**	**-15.6**
IV	0.2	18.4	33.0	4.2	35.8	**35.3**	**18.3**	**-17.0**
V	4.4	15.0	26.8	46.0	24.4	**56.1**	**23.3**	**-32.8**
VI	134.6	56.8	111.0	174.6	28.8	**69.0**	**101.2**	**32.2**
VII	79.6	20.8	43.2	41.2	9.2	**55.3**	**38.8**	**-16.5**
VIII	7.4	21.2	1.0	13.4	66.4	**43.0**	**21.9**	**-21.1**
Annual Average	**540.3**	**268.6**	**333.8**	**520.6**	**315.0**	**495.3**	**395.7**	**-99.6**

Of the 5 years studied, the 2018/2019 agricultural year was the driest, with a deviation of 226.7 mm, the annual average being approximately half - 268.6 mm, and the rainiest year was the 2017/2018 agricultural year, with an annual average of 540.3 mm, exceeding the multi-year average by 45.0 mm. This year, the rainiest months were June with 134.6 mm and December with 99.0 mm (Table 4).

The driest month, in the period 2017/2022, was May, with a deviation from the multi-year average of -32.8 mm, and the rainiest month compared to the multi-year average was June, with an average over the years of 101.2 mm, the deviation being 32.2 mm (Table 4).

CONCLUSIONS

The limiting factor of the production of agricultural plants, cultivated in Bărăgan, was and remains water. Until the introduction of irrigation in 1969, production was based only on water from precipitation, approx. 480 mm/year, which was insufficient to obtain profitable productions, especially if we take into account their uneven distribution in the critical water periods of cultures.

Until the introduction of irrigation, modest productions of about 2 t/ha were obtained for cereals, 3-4 t/ha for corn and 1.5 t/ha for sunflowers. Irrigation brought spectacular increases in production, reaching 5-6 t/ha for cereals, 8-10 t/ha for corn and 2.5-3 t/ha for sunflowers, because it was possible to complete the plants' water needs in critical periods (MORARU et al., 1987).

Thus, for cereals and rape, in dry autumns, it was necessary to apply a spring irrigation (COADĂ et al.,2021). Spring irrigation is often done during the phases of maximum water consumption corresponding to the formation and filling of the grain.

The situation was more critical with spring crops (corn, sunflower) whose maximum water consumption coincides with summer droughts and heat (KOMLÓSI et al., 2020). The water deficit is completed with a watering of about 800 m^3/ha for sunflowers and 3-4 waterings of 800 m^3/ha for corn.

After 1990, the irrigation situation has deteriorated (LUP AND MIRON, 2015), most of the cultivated areas have returned to the conditions before the introduction of irrigation, so the crops are made only with water from the rains that fall in this area.

This is also the reason why we analyzed the climate situation of southern Bărăgan in the last 5 years.

The increase in temperatures, the lack or insufficient water in the critical periods for the water of the plants grown in Bărăgan, led the specialists to rethink the technologies of growing plants (SIMA et al., 2015; SAUCA AND LAZAR, 2016). Determining the optimal sowing date is of great importance for the improvement of yields and for reducing water consumption (GAO et al., 2021).

Thus, if during the period when it was possible to ensure water according to the plant's requirements, later cultivars were preferred, which also gave higher productions, in the new conditions, semi-early cultivars sown earlier are preferred (ZAHRA et al., 2021), in order to avoid or exclude as much as possible, the periods of heat and drought in summer.

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